

भारतीय प्रौद्योगिकी संस्थान रुड़की  
रुड़की – 247 667 (भारत)  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE  
ROORKEE - 247 667 (INDIA)



सीनेट की छियासीवीं बैठक हेतु कार्यसूची  
AGENDA FOR THE 86<sup>th</sup> MEETING  
OF THE SENATE OVER WebEx

बैठक सं०	: छियासीवीं
MEETING NO.	: 86 <sup>th</sup>
स्थान	: वैबेक्स के द्वारा
VENUE	: Over WebEx
दिनांक	: 9 फरवरी 2021
DATE	: 9 <sup>th</sup> February 2021
समय	: 04.00 बजे अपरान्ह
TIME	: 04.00 P.M.

भारतीय प्रौद्योगिकी संस्थान रुड़की  
**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
रुड़की 247 667  
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**कार्यसूची / A G E N D A**

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86.1	सीनेट की दिनांक 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2.2020 एवं 18.12.2020 को आयोजित हुई 81वी, 82वी, 83वी, 84वी एवं 85वी बैठकों के कार्यवृत्त की पुष्टि करना। To confirm the minutes of the 81 <sup>st</sup> , 82 <sup>nd</sup> , 83 <sup>rd</sup> , 84 <sup>th</sup> and 85 <sup>th</sup> Senate meetings held on 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2020 & 18.12.2020, respectively.	1
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	<p>To consider the proposal of Department of Biotechnology regarding B.Tech. (Biotechnology):</p> <ol style="list-style-type: none"> <li>1. To change the programme name of B.Tech. (Biotechnology) to B.Tech. (Biosciences and Bioengineering)</li> <li>2. Revised structure and syllabi of B.Tech. of Department of Biotechnology.</li> </ol>	
86.6	<p>वास्तुकला विभाग के मौजूदा बीआर्क पाठ्यक्रम में लघु विशेषज्ञता और विभागीय ऑनर्स पाठ्यक्रम (एमएससी/डीएचसी) को शामिल करने के प्रस्ताव पर विचार करना।</p> <p>To consider the proposal of Department of Architecture &amp; Planning to include Minor Specialization and Departmental Honours Courses (MSC/DHC) in the existing B. Arch curriculum.</p>	42-46
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86.10	<p>श्री विवेक कुमार मिश्रा, एमटेक(पीपी) और श्री इल्यास खेरान्डीस, एमटेक(डब्ल्यूआर) द्वारा साहित्यिक चोरी के मामलों में संस्थान शैक्षणिक आचार समिति की सिफारिशों पर विचार करना।</p> <p>To consider the report on the plagiarism complaint against Mr. Vivek Kumar Mishra, M.Tech. (PP) and Mr. Elyas Khairandish, M.Tech. (WR).</p>	172-192
86.11	<p>सिफारिशों के आधार पर अध्यक्ष, सीनेट द्वारा दी गई मंजूरी को रिपोर्ट करना।</p> <p>To report the approvals accorded by the Chairman, Senate.</p>	193-212
अन्य मुद्दे अध्यक्ष की अनुमति से/Under any other item with the permission of the Chair.		

**Item No. 86.1: To confirm the minutes of the 81<sup>st</sup>, 82<sup>nd</sup>, 83<sup>rd</sup>, 84<sup>th</sup> and 85<sup>th</sup> Senate meetings held on 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2020 & 18.12.2020, respectively.**

The minutes of the 81<sup>st</sup>, 82<sup>nd</sup>, 83<sup>rd</sup>, 84<sup>th</sup> and 85<sup>th</sup> Senate meetings held on 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2020 & 18.12.2020, respectively were circulated to the members vide e-mail dated 04.02.2020, 13.07.2020, 10.11.2020, 04.12.2020 and 23.12.2020. No comments have been received.

The Senate may consider confirming the said minutes.



**Item No.86.2: To report on the actions taken to implement the decisions of the Senate taken in its 81<sup>st</sup> , 82<sup>nd</sup> , 83<sup>rd</sup>, 84<sup>th</sup> and 85<sup>th</sup> Senate meetings held on 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2020 & 18.12.2020, respectively.**

The minutes of the 81<sup>st</sup>, 82<sup>nd</sup> , 83<sup>rd</sup>, 84<sup>th</sup> and 85<sup>th</sup> Senate meetings held on 08.01.2020, 09.07.2020, 22.10.2020, 24.11.2020 & 18.12.2020, respectively were circulated to the members vide e-mail dated 04.02.2020, 13.07.2020, 10.11.2020, 04.12.2020 and 23.12.2020 . The status of actions taken is as under:

Item No.	Reference to the Senate minutes	Extracts of the Minutes	Status of action taken
<b>Meeting dated 08.01.2020</b>			
81.3	Proposal to introduce a provision for repeating a credit course in B.Tech./IDD/IMS/IMT.	The Senate approved the proposal with the modification that the condition regarding CGPA be removed. Further, issues regarding appearance of the earlier and new grades on the transcript and computation of SGPA/CCPA be considered by the IAPC.	Notified.
81.5	Requests of the students for name restoration due to non-submission of documents.	The Senate did not accept the request of Mr. Anargha Rakesh (Sl. No. 1). The Senate accepted the request of Mr. Ajay Handa (Sl.No. 2)	Notified.
81.6	Proposal to revise the UG regulation on self-study courses.	The Senate accepted the proposal with minor modifications.	Notified.
81.7	Proposed revision in the regulation on minor specialization courses in terms of CGPA criteria.	The Senate approved the proposal.	Notified.

81.8	Proposal of Department of Management Studies to offer minor specialization courses in Management.	The Senate approved the proposal with minor modifications.	Notified.										
81.12	Requests of students regarding continuation of program and extension beyond permissible time limit.	<div>The Senate decided as under: Category A:<table><tr><td>Sl. No 1-5</td><td>The Senate accepted the requests of students if they earn SGPA <math>\geq 4</math> after second/re-exam.</td></tr><tr><td>Sl. No 6-11</td><td>The Senate accepted the requests of students.</td></tr><tr><td>Sl. No 12</td><td>The Senate accepted the request for continuation of program. His Autumn Semester 2019-20 will be treated as withdrawn.</td></tr><tr><td>Sl. No 13&amp;14</td><td>The Senate did not accept the requests.</td></tr><tr><td>Sl. No 15</td><td>The Senate accepted the request.</td></tr></table> Category B: The Senate did not accept the requests of students.</div>	Sl. No 1-5	The Senate accepted the requests of students if they earn SGPA $\geq 4$ after second/re-exam.	Sl. No 6-11	The Senate accepted the requests of students.	Sl. No 12	The Senate accepted the request for continuation of program. His Autumn Semester 2019-20 will be treated as withdrawn.	Sl. No 13&14	The Senate did not accept the requests.	Sl. No 15	The Senate accepted the request.	Notified.
Sl. No 1-5	The Senate accepted the requests of students if they earn SGPA $\geq 4$ after second/re-exam.												
Sl. No 6-11	The Senate accepted the requests of students.												
Sl. No 12	The Senate accepted the request for continuation of program. His Autumn Semester 2019-20 will be treated as withdrawn.												
Sl. No 13&14	The Senate did not accept the requests.												
Sl. No 15	The Senate accepted the request.												
81.13	Formulation of policy regarding course work completion requirement in the case of professionals (working at senior positions) joining Ph.D. program.	The Senate approved the proposal with modifications	Dean of Academics Affairs has been informed.										

81.14	Request for permission to submit Ph.D. thesis before minimum stipulated period (02 years from the date of candidacy for full time students).	The Senate approved the request.	Notified.
81.15	Requests for extension in time beyond	<p><b>A. Maximum stipulated period of 06 years (Full-Time) for submission of Ph.D. thesis.</b></p> <p>The Senate approved the request. The student may submit the thesis upto last date of registration in Autumn Semester 2020-21.</p> <p><b>B. Maximum stipulated period of candidacy and possible extension afterwards.</b></p> <p>The Senate approved the request.</p> <p><b>C. Extension given by the Senate for Ph.D. Thesis submission.</b></p> <p>The late submission of thesis beyond last date of previous extension given by the Senate to Mr. Veerendra Yadav (Enrol. No. 13914026), Ms. Jahnavi K. (Enrol. No. 13914012) and Mr. Amrish Kumar (Enrol. No. 12926015) is approved.</p> <p>The Senate also approved extension in time to submit thesis upto last date of registration in the Autumn Semester 2020-21 to Ms. Lipi Mishra (Enrol. No. 13914014), Mr. Susheel Kumar Katariya, (Enrol. No. 12914013) and Mr. Nikhil</p>	Notified.

		Kant Kulshrestha (Enrol. No. 13918009).	
81.16	Mercy appeals for reinstating Ph.D. registration as name was struck off due to not making request for extension within time frame.	<p><b>A. Thesis submission cases.</b></p> <p>The Senate approved reinstatement of academic program and extension in time to submit thesis upto last date of registration in the Autumn Semester 2020-21.</p> <p><b>B. Candidacy cases:</b></p> <p>The Senate approved reinstatement of academic program and completion of candidacy by June 30, 2020 to Mr. Mohd. Shoaib (Enrol. No. 17909027) and Mr. Vivek Kumar Yadav (Enrol. No. 17922009).</p>	Notified.
81.17	Mercy appeals for reinstating Ph.D. registration as name was struck off due to.	<p><b>A. Completion of maximum stipulated period for candidacy.</b></p> <p>The Senate approved reinstatement of academic program and completion of candidacy by June 30, 2020 to Mr. Sandeep kumar Singh (Enrol. No. 17906005), Mr. Piyush (Enrol. No. 17912017) and Mr. Saurabh Singhal (Enrol. No. 17915016).</p> <p><b>B. Non submission of mandatory documents related to Ph.D. admission.</b></p> <p>The Senate approved reinstatement of academic program of Mr. Deepak (Enrol. No. 19920007) and Mr. Yogesh Kumar (Enrol. No. 19909015).</p>	Notified.

		<b>C &amp; D:</b> The Senate did not accept the requests	
81.18	Requests from students to re-join Ph.D. program.	The Senate did not accept the requests.	Applicants were informed.
81.19	Change(s) in minimum academic qualification for Ph.D., M.Tech./M.Arch./MURP programs.	The Senate approved the proposals. The same will be effective w.e.f. Spring Semester 2019-20.	Notified.
81.20	Changes in the selection criteria for MBA Admission from 2020-21 onwards.	The Senate approved the selection criteria. Further, the Senate approved 10% relaxation in the CAT score cut-off for the short-listing of female candidates of all categories.	Implemented.
81.21	Allowing deferred admission to:	(A) International Students and Sponsored Indian Students in Master Programs (M.Tech./M.Arch./MURP/M.Sc./MBA)  (B) International Students in the Ph.D. Program The Senate approved the proposal.	Dean, International Relations has been informed.
81.22	Addressing similarity-check report alerts at the time of submission of Bachelors, Masters and Ph.D. thesis.	The Senate decided that the current practice in this regard be replaced as under:  1. All Bachelors, Masters and Ph.D theses should be subject to a similarity-check using appropriate software. With the help of the supervisor, the candidate should address the similarities flagged by the software which merit corrective action.  2. Point 10 of Ph.D. Thesis submission form "Copy of plagiarism check enclosed" be revised to	Notified.

		<p>“Copy of similarity-check report enclosed”.</p> <p>3. The Bachelors and Masters thesis/report similarity-check reports be submitted to the concerned DAPC/CAPC.</p>	
81.27	Seat Matrix for MBA admission from the academic year 2020-21 onwards.	The Senate approved the seat matrix.	Implemented.
<p>(i) Item No. 81.4 was withdrawn.</p> <p>(ii) Item Nos. 81.9, 81.10 and 81.23 to 81.26 were only for reporting to the Senate.</p> <p>(iii) Item No. 81.11 was for ratification.</p>			
<b>Meeting dated 09.07.2020</b>			
82.1	To consider the conduct of the upcoming Autumn Semester 2020-21 and its Academic Calendar.	<p>The Senate considered the recommendations of the IAPC and decided as under:</p> <p>1. The registration for all the students will be carried out in online mode.</p> <p>2. Entire teaching will be carried out in online mode. Time-table for the semester would be prepared as usual. The lecture and tutorial slots in the time-table will be used for live sessions with the students. These sessions may be used for live lectures, tutorials, doubt clearing sessions etc. as per the needs of the course contents and choice of the faculty, so as to ensure the best possible e-learning of the students. To achieve the learning objectives and the assessment requirements of different courses, assistance of TAs can be taken in all the courses.</p>	Notified.

		<p>3. Mid-term examinations will not be conducted. Instead, continuous assessment will be carried out in the form of assignments, quizzes, mini-projects, viva-voce etc.</p> <p>4. There would be conventional end-term examinations after the return of the students to the campus.</p> <p>5. Wherever possible, the laboratory courses or courses with laboratory components in the autumn semester be exchanged with the theory courses of the spring semester, only for this academic year. All possible ways be explored for meeting this objective. For the courses with theory and laboratory components both, only the laboratory component and its credits can be transferred to the spring semester. Thus, for example, laboratory components of different courses in the autumn semester can possibly be combined to create new laboratory course(s) in the spring semester of this academic year. There may be other ways also of meeting the objective of exchanging laboratory components of the autumn semester with theory components of the spring semester. Proposals from the departments for such one-time changes in their academic programs will be considered by the IAPC for approval.</p> <p>6. The weightages of course components will be as under:</p> <p style="text-align: center;">CWS: 50-60 % and ETE: 40-50 %.</p>	
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		<p>7. Attendance rule is suspended this semester.</p> <p>8. The Academic Calendar for the Autumn Semester 2020-21 will be as given in <b>Appendix-A</b>. If required, the academic calendar would be revisited in the month of October 2020.</p>	
<b>Meeting dated 22.10.2020</b>			
83.1	To consider the proposals from the Convocation Committee and decide the mode and timing of Convocation 2020.	<p>The background of the two proposals of the Convocation Committee as mentioned in the agenda was presented followed by a deliberation on the proposals.</p> <p>After deliberations, the following was decided:</p> <p>A virtual Convocation 2020 will be held in 4-6 weeks without waiting for the pandemic to subside. All attempts will be made to ensure as good a virtual Convocation as possible. The degrees and certificates will be sent by post immediately after the Convocation. However, once the situation normalizes, the Institute will organize a reunion of the students who will be awarded degrees at this year's Convocation. The reunion can be planned in suitable groups.</p>	Convocation was held on 29.11.2020.
<b>Meeting dated 24.11.2020</b>			
84.1	To consider award of Degrees/Diplomas to the students who have qualified for the award of degrees/diplomas in various	The Senate considered and recommended to the Board of Governors the award of Degrees/Diploma to 1889 students who have duly qualified for the	Awarded.



	disciplines/courses for the session 2019-20.	same.  Further, the Senate withheld the Ph.D. degree of Mr. Pramod Sharma (Enr. No. 15918005) and M.Tech. degree of Mr. Elyas Khairandish (Enr. No. 185480006) on the recommendations of the IRC and IAPC, respectively.	
84.2	To consider Awards/Medals for 2020.	The Senate approved the list.	Awarded.
<b>Meeting dated 18.12.2020</b>			
85.1	To reconsider the Autumn Semester 2020-21 completion plan for all students (excluding UG I year).	<p>The Senate considered and approved the proposal with the following observations:</p> <ol style="list-style-type: none"> <li>1. Online examination is the most suitable option available for conducting the End Term Examinations due in January 2021. Depending on the size of the class, the nature of the course contents, and the views of the students registered in a course, the course instructor may decide the choice of platform, application, mode of ETE etc.</li> <li>2. There is a need for more flexibility in the window for conducting ETEs and the duration of an ETE. IAPC is authorized to deliberate on these issues and provide more flexibility. The window of ETE schedule should take into account the date of GATE examination.</li> <li>3. Changes from the earlier announced weightages or introduction of a new distinct component of evaluation, such as Viva-Voce, can</li> </ol>	Notified.

		<p>also be done after taking the students of the course into confidence, and with the approval of IAPC.</p> <p>4. Although many lab courses were shifted to the spring semester, if some lab-oriented course is running this semester, it can be completed using online methods/demonstrations, viva-voce, written examination etc. However, if there is a field/lab course which may be difficult to complete meaningfully using only online tools, the concerned department should approach IAPC for a solution.</p> <p>5. If a student feels the need, she/he is free to take the help of any institute or entity in his/her neighborhood for taking the examinations.</p>	
85.2	To consider the mercy appeal of Mr. Sunil Kumar (En. No.12918025), ex-Ph.D. student, Department of Electrical Engineering., to re-join his Ph.D. program (in the light of the decision of Hon'ble High Court of Uttarakhand).	The Senate considered the appeal of Mr. Sunil Kumar in the light of the rules regarding maximum time allowed for completing Ph.D., minimum time required to submit the thesis after candidacy and the relevance of course work done more than six years back. The Senate noted that the maximum time allowed for completing Ph.D. is six years, followed by a possibility of one year extension, i.e. a total of seven years from the date of initial registration and the minimum time required to submit thesis after candidacy is three years. Further, the Senate was of the view that courses done more than six years back will not play the role they are intended to play. The Senate also felt that accepting such kind of appeals is not	Informed.

		in the interest of the Institute. The Senate decided not to accept the mercy appeal but noted that Mr. Sunil Kumar is free to apply afresh and, if he chooses to apply, his case be considered on merit.	
85.3	To consider online re-examination for the Spring Semester 2019-20.	The Senate decided that re-examination for Spring Semester 2019-20 be conducted online before the ETE of the Autumn Semester 2020-21.	Examination conducted.
85.4	To consider the application of Praveen Badvath, a B.Tech. (MME) student of IIT Ropar seeking transfer to IIT Roorkee.	<p>The Senate considered the item and observed the following:</p> <p>(i) His medical reports and academic performance are quite old and may not reflect his current medical situation and academic performance.</p> <p>(ii) Presently, the classes are being conducted online, and there is no clarity as to when on-campus classes will be resumed. Therefore, there is no urgency to decide this application.</p> <p>The Senate decided that a committee be constituted by the Director to ascertain his current status and related questions. The report of the committee be placed before the Senate.</p>	

**Item No. 86.3: To consider the proposal of Department of Electronics and Communication Engineering to start an online M.Tech. (Microelectronics and VLSI) for working industry professionals.**

The IAPC in its 86<sup>th</sup> meeting held on 09.06.2020 considered the proposal to start an online M. Tech (Microelectronics and VLSI) programme **(Appendix-A)**. The courses need to be customized and made flexible to meet the needs of professionals working in the core areas of Microelectronics/VLSI who want to advance their career but cannot attend regular On-Campus classes.

The said online degree is intended to prepare students for senior engineering roles in the industry. The duration of the programme to be nominally 3 years (two-year course work and 1 year dissertation).

The IAPC recommended the proposal with modifications.

The above is submitted for consideration and approval of the Senate.

**Department of Electronics and Communication Engineering**

**Indian Institute of Technology Roorkee**

Proposal for Online Post Graduate Engineering Program

Master of Technology (Microelectronics and VLSI)

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### Goal:

An online version of the present M. Tech in Microelectronics and VLSI is proposed to be floated with minor modifications in the course/curriculum. It is proposed that the course will be customized and flexible to meet the needs of working professionals working in the core areas of Microelectronics/VLSI.

## Motivation

### Need of economic self-sufficiency

\* As government pushes IITs for generating their own funds, starting economically viable and popular programs is imperative, not just optional.

\* HEFA (Higher Educational Fund Authority) will require accruals from our side to give us funds. Also, future pay-commissions may require generating a part of employee salary from the institute itself.

### Up-skilling of professionals with rich technical experience

- IITR is already running short-courses and FDPs to provide high-quality education to non-IIT students. However, these programs are not sufficient to attract top talent. Short-nature of such courses is insufficient to train a student from bottom-up.
- For people working in industry for a few years, it will be a good option for up-skilling and career growth. Many such professionals join job right after an undergraduate degree, due to their financial situations and other reasons. Hence, they are unable to take higher degrees right after their UG. However, after a few years of work, they feel the need of up-skilling themselves and also have savings/flexibility to do so. Many of them are interested in pursuing masters/research.
- However, they cannot attend on-campus classes. They are unable to quit their job due to financial reasons, personal reasons (e.g., family) and because they may be highly interested in their current job role. There is a need to accommodate such motivated professionals with rich technical experience. We need a dedicated program which they can do while continuing their job on site. This online degree will be intended to prepare professionals for senior engineering roles in the industry.
- Industry jobs in Microelectronics/VLSI domain require specialized training and knowledge since the area survives on novel products. In design work, it often involves understanding new concepts and comprehending latest research papers. In several areas of VLSI, the industry leads research and collaboration with industry is a must for academics.
- The existing option for professionals is to do regular MTech, where they can register as sponsored students. Here, they take 8-9 courses over 2 semesters plus thesis/dissertation of one year duration. Students take 4-5 courses per semester. Overall, a total of 70 credits are required to earn a degree. However, this brings several challenges to those professionals.

- On-campus residence means they have to take a leave/sabbatical. They cannot do anything else during this period. Taking a leave is difficult due to administrative reasons.
  - If and when the MTech fee for regular on-campus (institute-assisted) MTech is hiked (as proposed in 2019), leaving the job becomes very difficult.
  - Coping with high course-load is difficult.
- Many companies encourage their employees to attend such online degree programs. In fact, some of them reimburse the fee if the student has got more than a certain grade.
  - Through this program, we can build strong connections in the industry. We will have several students who are well established in the industry. Since industrial collaboration is a must in several areas of VLSI for carrying out good research, this program would be very helpful for IIT Roorkee.

### Examples of such programs in IITs/NITs

\* Other IITs/IIITs/NITs have already launched such programs, e.g.,

IISc Bengaluru: <https://eecs.iisc.ac.in/mtechai/>

IIT Hyderabad: <https://ai.iith.ac.in/>

IIIT delhi: <https://iiitd.ac.in/education/mtech/data-engg>

IIIT Hyderabad: <https://iiit-h.talentsprint.com/aiml/index.html>

IIIT Bengaluru: <https://www.iiitb.ac.in/pg-diploma-data-science>

NIT Warangal: [edureka.co/post-graduate/machine-learning-and-ai](http://edureka.co/post-graduate/machine-learning-and-ai)

Many foreign universities also offer such online programs and they are in high-demand by Indian students.

## Eligibility criterion and admission:

The candidates will be selected through initial shortlisting followed by written test and/or interview. The test will be conducted in GNEC (if necessary, also in Bangalore and Hyderabad and IITR campus).

The program is open for candidates with recognized B.Tech./B.E degree in EE/ECE/CSE (or equivalent) with minimum first class.

Shortlisting criteria could be higher than the minimum qualification criteria.

GATE-score will NOT be mandatory for admission to this program, although it may have a weightage.

This program is NOT for those freshers who do not have a very high GATE score and want to somehow enter into the MTech program by paying high amount of fee. For stopping such students, we will place the condition of "work experience of >K years" and "currently employed".

The student who graduate from this program will NOT be eligible to sit in the IITR placements.

There is no reservation policy.

## Academic Issues

### Course/lab work

1. The curriculum would be the same as that of the regular M.Tech (Microelectronics and VLSI) program. The course content and rigor of the program is not compromised. The students can also take a limited credits of NPTEL courses, as allowed by the IITR senate.
2. Regular online tests would be conducted for continuous evaluation. Submission and evaluation would be through a learning-management-system (LMS), such as Moodle.
3. This online program will be coordinated from the Greater Noida Extension Center (GNEC) of IIT Roorkee for administrative purposes such as student registration and a few academic purposes such as conducting examinations of ECN – 576 (Simulation lab -1) etc. MTE and ETE would be conducted in GNEC and, if necessary, a center in Bangalore/Hyderabad. One faculty member and IIT Staff (non-academic) and TAs would be present at the test site(s), as necessary.
4. These courses will only be available to registered candidates after logging into an Online Learning Platform with downloading restrictions.



5. The instructors, along with the TAs/staff of the course, would be present in the GNEC campus on at appropriate intervals for tutorials and discussion. Remuneration for the involved staff/TAs would be discussed with the institute.
6. A typical student will take at least 8 credits (typically two courses) per semester. Students have the option of taking lesser number of courses in different semesters and complete the course requirement in 2-3 years. Thus, the student will take a minimum of 2 years and a maximum of 3 years to complete the course-credits. After this, they have 1 year for completing the thesis credits. Thus, the students can finish the entire program in 3 to 4 years. Delays due to exceptional situations will be treated on case-to-case basis.
7. Teaching of regular courses: The regular courses may be taught in one of the two ways: (1) both on-campus (regular) and off-campus students attend the class simultaneously or (2) the class is given separately to the off-campus students. The choice of the mode is left to the discretion of the instructor.
8. The regular M.Tech classes would be run in the afternoon in IIT Roorkee's smart class room/conference room and would be live telecast as well as recorded.
9. It can be taken at IITR campus or remotely through video-enabled online courses. Students can also have live-interaction with faculty during the class.
10. The grading policy of the course based M.Tech. program will be on par with regular M.Tech. program.
11. For lab sessions, the department will take the decision whether the labs involve only software work (that may be done remotely) or do they require hardware work (that requires access to equipments available only at Roorkee campus).
12. The labs requiring only software work do not need a special provision. The lab experiments for Simulation Lab-I (ECN 576) and Simulation Lab-II (ECN-598) would be held within the respective companies of the students. The students would have to submit a lab report electronically to the lab instructor within a time window. ECN - 700 (2-credit seminar) would be presented in the GNEC campus on an appropriately scheduled date.
13. The lab session for Microelectronics Lab – I (ECN-575) & Microelectronics Lab – II (ECN-597) would be conducted within 5-10 days (4 hours per day) during the summer/winter vacations.
14. The student will be eligible for institute medals based on CGPA given during the convocation program for regular students.

#### Thesis Work

We may rename the thesis to capstone (since that is the commonly used term in the online degrees) if senate feels so. For thesis, there are two options:

15. Option 1: Student does the thesis at IIT Roorkee. It just means that there is no industry supervisor and the IITR faculty alone is the guide. The student need

not travel to IITR for doing thesis in this mode. However, we think This may happen rarely. IP remains with IIT Roorkee.

16. Option 2: Student does it at his/her own office.

- a. The employer must provide a letter approving the conduct of the dissertation at their site. [To be provided by the candidate at the time of registration ]
- b. If found necessary, appropriate MoUs may be signed by IIT Roorkee with the employer. Once an MoU is signed with a company, in future, employees of that company will have much less paperwork to do.
- c. The work for dissertation can be done in office/non-office hours using the company's facilities, in case necessary. The employer has to provide a letter approving the conduct of the dissertation at their site. This letter shall be provided by the candidate at the time of registration into the program.
- d. An IITR faculty (dissertation supervisor) shall evaluate and approve the problem-statement. A mentor would also be selected from the company of the M.Tech dissertation. IITR faculty supervisor reviews the progress periodically. In this case, the IP remains with the company.

### Organizational/management issues:

- Extensive inputs from industry would be taken for the purpose. A standing committee of the program would be constituted with a significant representation from the industry.
- Online Program will be coordinated from Greater Noida Extension Center (GNEC) IIT Roorkee for student registration and lab sessions
- Transfer from online M.Tech. to regular (on-campus) M.Tech. programs or vice-versa will not be allowed.
- A student will not be eligible for any stipend/fellowship, even if he has a valid GATE score.
- Number of students admitted to the program is initially 20. Based on the feedback from students and success of the program, the intake may be increased in the future.
- To continue in the program, an SGPA of at least 6 must be obtained in each semester.
- The program is non-residential type (i.e., the students will not be eligible for hostel accommodation). However, any request for accommodation will be handled on case-to-case basis.
- The maximum time for completion of the program is 4 years.

- A faculty from MEV stream of ECE department will be a program-coordinator. He/she will announce well-in-advance the dates when the student needs to visit the campus. This will allow the students to plan their visit.
- VPN access will be provided to the student to access on-campus resources, e.g., library, journal subscription, etc.

## Effort required from IITR/faculty

If the faculty members choose to combine on-campus and off-campus students, then, there is no increase in their teaching load. In case a faculty member wishes to teach separately to the online program students, he may be allowed to do so. The honorarium/remuneration paid to the faculty members would be decided by a committee of the director, Dean (AA) and HoD (ECE).

If required, we could get people from industries or research labs to teach a state-of-art or popular course as guest faculty for the program.

Signing an MoU with the employer will be required.

Online program means no need of providing long-term accommodation. However, students will need accommodation when they visit for exams or lab-sessions, etc.

## Answers to FAQs of Students

### Admission related

- Q. One of the eligibility criteria for the programme is minimum X years of work experience. By which date one should have this minimum work experience? Can this be relaxed if I am missing it by few days?
- Ans: You should have X years of work experience by the last date for submitting online applications. This criteria cannot be relaxed.
- Q: What if I want to do only the course-credits and not the thesis credits?  
Answer: Currently, we do not have the provision of an early-exit degree, so to get the degree, one must do all the credits, including the thesis credits.
- Q: After completing this program, are we eligible for campus placements as regular students?
- Answer: No, you are not eligible. The program is meant for professionals who are already working in the industry.
- Q. What will be the alumni status for the students under this program?

- Answer: On successful completion of this program, a student gets the same alumni status as any other on-campus student of IITR.

- Q: Can I do this programme from abroad?
- Answer: The courses are conducted remotely. You only need to visit the campus only few times in a semester. The dates would be announced quite early for you to plan the visits.
- 

#### Academic/graduation related

- Q. How many times will a candidate need to visit IITR campus at Roorkee or GNEC (in a semester and throughout the program)?
- Ans. For evaluation of simulation labs and for lab experiment/measurement based courses. Typically 4 times in the entire span of three years.
- Q. What should I do if I am not able to take all the courses that are required to be done in a semester?
- Ans. A student is allowed to take fewer number of courses per semester. However, in the 1st - 4th semesters, the student must pay the fees for all the courses that are offered in the semester. From 5th - 6th semester, one can take the courses that one has missed in the first four semesters by paying only an additional per semester registration fee. Note that students can start the thesis only when they have completed all the course-credits.

#### Graduation/degree related

- Q: What will the degree certificate of a student show?
- Ans. "Master of Technology in VLSI and Microelectronics".
- Q. Is the degree on-par with the regular MTech degree.
- Ans. YES! The student will receive M.Tech. Degree on par with the regular M.Tech. degree. This will qualify the student to apply for a PhD program at institutes in India or abroad.
- 
- Q. Will I be able to pursue a PhD in ECE after this program?
- Yes, the degree you will receive after this program is similar to a regular MTech degree from IITR.

## Issues to think

1. In IITH, 1 credit =14 hours for on-campus students and 1 credit=9 hours for MDS students. Should we have something like this.
2. We take an MoU from the company of an employee at the beginning of first year. But what if he changes the company after 2 years?
3. In IITM, such program requires company sponsorship; the candidate cannot pay the fee on his own. In some other IITs, no MoU is required from the company and the candidate can pay the fee himself. Which model do we want.
4. After doing this MTech, if I pursue PhD at IITR, will you allow transfer of course credits (if this is allowed for regular courses)?

**Item No. 86.4: To consider the proposal of renaming the Department of Biotechnology as Department of Biosciences and Bioengineering.**

The Centre of Biosciences was established in the year 1980 and upgraded to a full-fledged academic department of Biosciences and Biotechnology in 1986. Later on, it was renamed as the Department of Biotechnology in the year 2002. In the initial phase, the teaching started with an M.Sc. course in Biosciences. Subsequently, DBT supported M.Sc. program in Biotechnology was initiated in 1991. Later, the two Master's programs were merged and named as M.Sc. in Biotechnology.

In 2005, B. Tech. Biotechnology program was started and the status of the department was changed to Engineering Department from Science Department. Further, in 2016-17, M. Tech. program in Bioprocess Engineering was also instituted. Over time, programs and areas of research have widened. Further, having identified few areas for growth and excellence, there is a need to hire prospective faculty in the areas of computational biology and biological engineering. The department has undertaken extensive informal and formal discussions in this regard and students' feedback has also been taken. On the basis of deliberations and the changed scenario, the departments has proposed to rename itself as per the proposal at **Appendix-A**.

The proposal to rename the Department of Biotechnology to Department of Biosciences and Bioengineering is placed before the Senate for consideration and recommendation to the BoG.

**Proposal to rename the Department from ‘Biotechnology’ to ‘Biosciences and Bioengineering’**

**The Origin**

The Department of Biotechnology at IIT Roorkee is well known for excellence in research and teaching and aspires to be at the forefront of cutting edge research and education globally. The aim of the department is to provide an ecosystem for a high quality interdisciplinary research and training by bringing in together a broad spectrum of faculty expertise and through active collaborations with national and international institutions of repute. The main focus of current research is to generate and utilize knowledge to address the problems in health science and related areas that has direct link to betterment of human life. In teaching, the department aims to provide an academic environment for students to learn, discover, create and innovate. The balanced academic programs with research orientation are the main thrust to produce future leaders in the field.

The department has made considerable progress since its inception as Centre of Biosciences in 1980. It was upgraded to a full-fledged academic Department of Biosciences and Biotechnology in 1986 and then renamed as the Department of Biotechnology in the year 2002. At the initial phases, the teaching started with a M.Sc. course in Biosciences. Subsequently, DBT supported M.Sc. program in Biotechnology was initiated in 1991. Later, the two Master's programs were merged and named as M.Sc. in Biotechnology. In 2005, B.Tech. Biotechnology program was started and the status of the department was changed to Engineering Department from Science Department. Recently, an M.Tech program in Bioprocess Engineering has been initiated in 2016-2017.

Although department has made tremendous progress, there has always been a view, from within and outside, that the name of the department fails to reflect the actual research and teaching focus of the department. It has been felt that the term ‘Biotechnology’, although very attractive, is limited by a broad aspect of science and technology and thus seems to lack the focus that department deserves. The term ‘Biotechnology’ rather imparts an impression that the department is only involved in development of technology and does not emphasize on teaching and research programs in biological sciences and bioengineering, more precisely in fundamental aspects of these areas. The research focus of most of the faculty members is oriented towards biological sciences and not biotechnology per se. Having identified few areas of improvement and excellence, the department plans to hire prospective faculty members in the area of computational biology and biological engineering. The teaching programs, UG program in particular, needs to be reoriented and focused rather than catering to all aspects of biotechnology. It has been noted that many students who join the program are not enthusiastic about continuing higher education in the same field. Rather, they prefer to take up jobs in non-core areas. There is a general opinion of many student and faculty colleagues that, being an

engineering department, a focused program oriented towards biosciences and bioengineering will align well with the aims and focus of the institute. It will help in attracting meritorious students to the program and promote them to take up higher studies and jobs in the core areas. For the past few months, there have been elaborate discussions and brain-storming in the department on related issues. The extensive informal and formal discussions in DFC and student feed-back has led to the conclusion that the department needs to refocus and put all energies on specific themes/research areas and reorient teaching programs accordingly keeping in view the present strengths and future prospects.

### **The national and international scenario**

#### **National**

The 'Biotechnology' was a buzz word back then and no surprise that the department was renamed as the Department of Biotechnology. Many Universities and Institutes in India started and named their programs accordingly. There is Department of Biotechnology in some IITs, however, IIT Kanpur and IIT Bombay named the departments as 'Biological Sciences and Bioengineering' and 'Biosciences and Bioengineering' respectively. The focus of Department of Biochemical engineering and Biotechnology at IIT Delhi is biochemical engineering and therefore the terminology 'biotechnology' was apt there. Also, IIT Delhi has a School of Biological Sciences. Recently, the name of the Department of Biotechnology has been changed to Department of Biosciences and Bioengineering at IIT Guwahati.

#### **International**

A review of the nomenclature of the various departments of some of the premier institute across the world rarely depicts it as Department of Biotechnology. On the contrary, designations like 'Biological Engineering' or 'Bioengineering', Biological sciences or their different combinations are common in premier institutes. For example, the top Universities in US has bioengineering department e.g. UC Berkeley, Stanford University, University of Pennsylvania, Princeton University, Cornell University, Duke University, Rice University etc. The focus of these departments in terms of research and teaching is quite clear as per the name of the department.



### **Future directions**

The department, keeping in view the present strength and future prospects, proposes to restructure the current research and teaching programs to align well with future goals and rename the department to reflect the actual research and teaching focus.

**Major research areas:** The department would like to focus its strengths and resources on specific research theme(s) keeping in view the research expertise of present faculty members and prospective faculty members through future hiring. The main research theme of the department would continue to be in the areas related to health sciences. Towards that goal, the department has resolved to focus in three major research areas namely, Structural & Computational Biology; Cell & Molecular Biology; and Biological Engineering. The knowledge in the basic and applied areas of computational biology, biological sciences and biological engineering can be combined to understand and develop the innovative solutions in health science and related areas.

**Course curriculum:** We are in process of revising the present course curriculum of B.Tech. program to bring in practical and research-based learning in specific areas of biological sciences and biological engineering. The name of the program will also be changed accordingly. We plan to reorient the program in a way that curriculum reflects the focus on computational biology and bioengineering along with basic biology courses. That would actually help students focus their goals according to their choice both for academics and industry.

**Renaming the department:** The reputation of an institute certainly is paramount in terms of attracting bright students through JEE and JAM, as well as students for PhD programs. However, the name of the department or a course plays a critical role. It imparts the first hand impression to the students and parents and influences their choice in selection of institute, department and finally the program. After a lot of discussion and brainstorming among faculty members and student feedback, the department has decided that the name of the department should be changed from 'Biotechnology' to 'Biosciences and Bioengineering'.

In conclusion, the proposed changes will help the department to attain excellence in teaching and research and get recognition at national and international level in the fields of biological sciences and bioengineering with main thrust on providing solution in the area of health sciences.

**Item No. 86.5: To consider the following proposal of Department of Biotechnology regarding B.Tech. (Biotechnology):**

- 1. To change the programme name of B.Tech. (Biotechnology) to B.Tech. (Biosciences and Bioengineering)**
- 2. Revised structure and syllabi of B.Tech. of Department of Biotechnology.**

The IAPC in its 91<sup>st</sup> meeting held on 01.10.2020 recommended the proposal at Sl. No. 1 for change of name of B. Tech. (Biotechnology) to B.Tech. (Biosciences and Bioengineering) with effect from session 2021-22.

The IAPC in its 95<sup>th</sup> meeting held on 09.12.2020 recommended the proposal at Sol. No. 2 in principle with minor modifications. The IAPC advised the Department to circulate the modified proposal to all the members of the IAPC and submit the proposal after incorporating views/ suggestions received to Academic Affairs Office. The modified structure and syllabi are given at **Appendix-A**.

The above is submitted for consideration and approval of the Senate.

Program Code : 111 - B.Tech. (Biotechnology)

Department : Department of Biotechnology

Year : I

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>FIRST YEAR (Autumn)</b>														
1.	MAN-001	Mathematics-I	BSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	PHN-007	Modern Physics	BSC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	20-35	-	20-30	40-50	-
4.	HSN-001 B	Communication Skills (Advance)	HSSC	2	-	-	-	-	-	-	-	-	-	-
5.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
6.	HSN-002	Introduction of Psychology	HSSC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
7.	BT-101	Introduction to Biotechnology	PCC	2	2	0	0	2	0	-	-	-	100	-
8.	BT-103	Computer Programming	ESC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
<b>Total</b>				<b>23</b>										
<b>FIRST YEAR (Spring)</b>														
1.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-102	Biochemistry	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
3.	BT-104	Cell Biology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
4.	BT-106	Microbiology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
5.	CYN- 002	Organic and Inorganic Chemistry	BSC	4	3	0	2	3	2	10-25	25	15-25	30-40	-
6.	CEN-108	Fluid Mechanics	ESC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
<b>Total</b>				<b>24</b>										

Program Code: 111 - B.Tech. (Biotechnology)

Department : Department of Biotechnology

Year : II

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>SECOND YEAR (Autumn)</b>														
1.	MIN-106	Engineering Thermodynamics	ESC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
2.	BT-201	Genetics and Developmental Biology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
3.	BT-203	Immunology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
4.	BT-205	Bioinformatics	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
5.	BT-207	Process Calculations	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	HSN-ELE	HSS Elective Course	HSSMEC	3	2	1	0	3	0	20-35	-	20-30	40-50	-
<b>Total</b>				<b>23</b>										
<b>SECOND YEAR (Spring)</b>														
1.	BT-202	Structural Biology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
2.	BT-204	Physiology of Animals and Plants	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-206	Transport phenomenon in Biological System	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	BT-208	Biomaterials and Devices	PCC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
5.	BT-210	Molecular Biology and Genetic Engineering	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
6.	ECN-102	Fundamentals of Electronics	ESC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
<b>Total</b>				<b>24</b>										

Program Code : 111 - B.Tech. (Biotechnology)

Department : Department of Biotechnology

Year : III

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit										
THIRD YEAR (Autumn)														
1.	BT-301	Bioprocess Engineering	PCC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
2.	BT-303	Animal and Plant Tissue Culture	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
3.	BT-305	Computational Biology	PCC	4	3	-	2	3	0	10-25	25	15-25	30-40	-
4.	BT-ELE1	Department Elective Course - I	PEC	4	3	1	-	3	0	20-35	-	20-30	40-50	-
5.	OEC/BM-ELE	Management Studies/ Open Elective Course*	HSSMEC/OEC	3	3	0	0	3	0	20-35	-	20-30	40-50	-
6.	BT-391	Technical Communication	PCC	2	0	2	0	0	0	-	-	-	100	-
				Total	21									
THIRD YEAR (Spring)														
1.	BT-300	Case Study	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-302	Genomics, Proteomics and Metabolomics	PCC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
3.	BT-304	Molecular Diagnostics	PCC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
4.	BT-ELE2	Department Elective Course - II	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	MSC1/DHC1	Minor Specialization Course-I / Departmental Honours Course-I	MSC/DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	OEC/BM-ELE	Management Studies/ Open Elective Course*	HSSMEC/OEC	3	3	0	0	3	0	20-35	-	20-30	40-50	-
7.	BT-399	Educational Tour	PCC	0	0	0	0	0	0	-	-	-	-	-
				Total	19-23									

\* One course each from the OEC and the HSSMEC categories is to be opted either in the Autumn or in the Spring semester in the third year. The HSSMEC course should be selected from the list (basket) of Management Studies Elective Course.

Program Code : 111 - B.Tech. (Biotechnology)

Department : Department of Biotechnology

Year : IV

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit										
					L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
FOURTH YEAR (Autumn)														
1.	BT-400A	B.Tech. Project	PCC	4	0	0	8	0	0	-	-	-	-	-
2.	BT- ELE3	Department Elective Course -III	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT- ELE4	Department Elective Course -IV	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	MSC2/ DHC2	Minor Specialization Course-II Departmental Honours Course-II	MSC/DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	MSC3/ DHC3	Minor Specialization Course-III Departmental Honours Course-III	MSC/DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	BT-499	Training Seminar	PCC	2	0	2	0	0	0	100	-	-	-	-
		Total			14-22									
FOURTH YEAR (Spring)														
1.	BT-400B	B.Tech. Project	PCC	8	0	0	16	0	0	-	100	-	-	-
2.	BT-ELE5	Department Elective Course –V	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-ELE6	Department Elective Course -VI	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	MSC4/ DHC4	Minor Specialization Course-IV / Departmental Honours Course-IV	MSC/DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	MSC5/ DHC5	Minor Specialization Course-V / Departmental Honours Course-V	MSC/DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
		Total			16-24									

**DEPARTMENT OF BIOTECHNOLOGY  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

**List of Department Minor Specialization Courses:**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight ( % )				
S. No.	Subject Code	Course Title	Subject Area	Credit										
					L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	BT-490	Fundamentals of Biotechnology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-491	Biophotonics	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-492	Introduction to Computational Biology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	BT-493	Recombinant DNA Technology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	BT-494	Environmental Biotechnology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	BT-495	Fermentation Technology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
7.	BT-496	Fundamentals of Food Biotechnology	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
8.	BT-497	NMR Techniques	MSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-

**DEPARTMENT OF BIOTECHNOLOGY  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

**List of Department Honours Specialization Courses:**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	BT-471	Drug Discovery and Development	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-472	Stem Cell Technology	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-473	Phytomedicine	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	BT-474	Advanced Virology	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	BT-475	Enzyme Technology	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	BT-476	Protein Crystallography	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
7.	BT-477	Biomedical Optics and Biophotonics	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
8.	BT-478	Protein NMR	DHC	4	3	1	0	3	0	20-35	-	20-30	40-50	-



**DEPARTMENT OF BIOTECHNOLOGY  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

**List of Department Elective Course**

**Category-I**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight ( % )				
S. No.	Subject Code	Course Title	Subject Area	Credit										
					L	T	P	Theor y	Practi cal	CWS	PRS	MTE	ETE	PRE
Basket-1 (Cell and Molecular Biology)														
1.	BT-341	Gene Regulation	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-342	Food Biotechnology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-343	Virology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	BT-344	Nano- Bioengineering	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	BT- 345	Separation and Analysis of Biomolecules	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	BT-346	Drug Discovery	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
Basket-2 (Biological Engineering)														
7.	BT-347	Bioprocess Control	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
8.	BT-348	Bioprocess Modelling and Simulation	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
9.	BT-349	Biomechanics	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
Basket-3 (Structural and Computational Biology)														
10.	BT-350	Machine Learning and Deep Learning	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
11.	BT-351	Protein Engineering	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
12.	BT-352	Biophotonics	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-

**Category- II**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>Basket-1 (Cell and Molecular Biology)</b>														
1.	BT-441	Principles of Synthetic Biology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	BT-442	Environmental Biotechnology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3.	BT-443	Stem Cell Engineering	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4.	BT-444	Industrial Bioprocessing	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5.	BT-445	High Throughput Sequencing	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6.	BT-446	Chemical Genetics	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
7.	BT-447	Genetically Modified Organisms	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
8.	BT-448	Vaccine Biotechnology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
9.	BT-449	Cell and Tissue Engineering	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
<b>Basket-2 (Biological Engineering)</b>														
10.	BT-450	Bioreactor Design and Analysis	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
11.	BT-451	Bioprocess Optimization	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
12.	BT-452	Bioseparation Engineering	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
13.	BT-453	Bioelectronic Medical Devices	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-

Basket-3 (Structural and Computational Biology)														
14.	BT-454	Big Data Analytics	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
15.	BT-455	Biomolecular NMR	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
16.	BT-456	Biomolecular Modelling	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
17.	BT-457	Systems Biology	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
18.	BT-458	Molecular Biophysics	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
19.	BT-459	Biomolecular Interactions	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
20.	BT-460	Design and Analysis of Algorithms	PEC	4	3	1	0	3	0	20-35	-	20-30	40-50	-

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-101** Course Title: **Introduction to Biotechnology**
2. Contact Hours: **L: 2 T: 0 P: 0**
3. Examination Duration (Hrs.): **Theory: 2 Practical: 0**
4. Relative Weightage: **CWS: 0 PRS: 0 MTE: 0 ETE: 100 PRE: 0**
5. Credits: **2**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart the basic knowledge of various concepts in different areas of biotechnology

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction : Basic unit of life; macromolecules; prokaryotes; eukaryotes; cell components- sub-cellular organelles.	4
2	Microbial life and fermentation process: Bacteria, fungi and viruses; basic concept of microbial growth, bioprocess technology and enzymes.	5
3	Molecular biology concepts: Central dogma of molecular biology-replication, transcription and translation; recombinant DNA technology; basic concept of immune system, vaccines, GMOs.	6
4	Plant and Animal Biotechnology: Cell and tissue culture, transgenic plant and animals.	3
5	Medical Biotechnology: Introduction to biopharmaceuticals, herbal medicines, gene therapy, nanobiotechnology, bioinformatics and drug design, biosafety and bioethics.	5
6	Molecular techniques in Biotechnology: Introduction to microscopy, spectroscopy, electrophoresis, chromatography, centrifugation, , radioisotope technique, PCR, northern blotting, southern blotting, western blotting	5
<b>Total</b>		<b>28</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Walker, J.M. and Gingold, E.B., "Molecular Biology and Biotechnology", The Royal Society of Chemistry UK	1999
2	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry", 5 <sup>th</sup> edition, Cambridge University Press.	2000
3	Nelson, D.L. and Cox, M.M., "Lehninger's Principles of Biochemistry", 5 <sup>th</sup> edition, W.H. Freeman.	2009
4	Smith, J.E., "Biotechnology", Cambridge University Press, 5 <sup>th</sup> edition.	2009
5	Bernard R. G., Jack J. P., "Molecular Biotechnology : Principles and Applications of Recombinant DNA", ASM Press 4 <sup>th</sup> Edition.	2009
6	Murray, Moo-Young., "Comprehensive Biotechnology", 2nd edition ,University of Waterloo, Canada (Volumes 1, 4 and 5) Elsevier Press	2011

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BT-102** Course Title: **Biochemistry**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart knowledge of basic biochemistry concepts for understanding many important problems of biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Chemical basis of life; Water-properties of water, acid and base, pH, buffers, physiological buffers; Non-covalent interactions; Macromolecular assemblies	5
2	Proteins-classification, structure, function, dynamics, specificity, and basics of protein purification and analysis; Functional and structural proteins-Hemoglobin, myoglobin, collagen	9
3	Enzymes-introduction, classification, kinetics and catalysis; Enzyme inhibitors; Enzyme mechanisms and regulation	8
4	Nucleic acids-structure and properties of DNA and RNA, DNA double helical structure, A, B & Z DNA; Carbohydrates-Mono, di and polysaccharides, glycoproteins and glycolipids; Lipids-Classification, structure, function, lipid bilayer	5
5	Metabolism- basic concepts and design; Metabolism of carbohydrates-glycolysis & gluconeogenesis, citric acid cycle, electron transport chain and oxidative phosphorylation; Metabolism of lipid, amino acid and nucleotides	11
6	Integration of metabolism, coordinated control and regulation	4
	<b>Total</b>	<b>42</b>

S. No.	Practical course contents
1	Preparation of stock solutions and buffers.
2	Titration of a weak acid and a weak base.
3	Quantitative analysis of amino acid, sugars, fats
4	Protein estimation by spectroscopic, Biuret and Lowry's and Bradford methods.
5	Estimation of nucleic acids by absorbance at 260 nm
6	Purification of proteins using column chromatography and SDS-PAGE
7	Determination of Enzyme kinetic parameters

11. Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication /Reprint
1	Stryer, L., "Biochemistry" 7 <sup>th</sup> edition, W. H. Freeman.	2010
2	Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeour, R.S., "Principles of Biochemistry" 3 <sup>rd</sup> edition Prentice Hall,.	2001
3	Voet, D. and Voet, J. G., "Biochemistry" 3 <sup>rd</sup> edition, John Wiley and Sons.	2004
4	Nelson, D.L. and Cox, M.M., "Lehninger Principles of Biochemistry", 5 <sup>th</sup> edition, W.H. Freeman.	2009
5	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5 <sup>th</sup> edition, Cambridge University Press.	2000

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-103** Course Title: **Computer Programming**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE:0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart the basic knowledge of Computer System and Develop Basic skills in programming.
10. Details of Course:

S. No.	Contents	Contact Hours
1	<b>Basic Computer Fundamentals:</b> Introduction to computer systems; number system, integer, signed integer, fixed and floating point representations; IEEE standards, integer and floating point arithmetic; CPC organization, ALU, registers, memory, the idea of program execution at micro level.	7
2	<b>Basic Programming in C++:</b> Input/output; Constants, variables, expressions and operators; Naming conventions and styles; Conditions and selection statements; Looping and control structures (while, for, do-while, break and continue); File I/O, header files, string processing; Pre-processor directives such as #include#, #define, #ifdef, #ifndef; Compiling and linking.	8
3	<b>Programming through functional decomposition:</b> Functions (void and value returning), parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference; Design of functions and their interfaces (concept of functional decomposition), recursive functions; Function overloading and default arguments; Library functions; Matters of style, naming conventions, comments.	8
4	<b>Aggregate data-types:</b> Arrays and pointers; Structure; Dynamic data and pointers, dynamic arrays; Introduction to data structure, use of pointers in linked structures.	7
5	<b>Object Oriented Programming Concepts:</b> Data hiding, abstract data types, classes, access control; Class implementation-default constructor, constructors, copy constructor, destructor, operator overloading, friend functions; Object oriented design (an alternative to functional decomposition) inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.	12
	<b>Total</b>	<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Heller, Steve., 'Who's Afraid of C++', Academic Press.	1996
2	Koren, I., 'Computer Arithmetic Algorithms', A.K. Peters Ltd, 2 <sup>nd</sup> edition.	2001
3	Eckel, B., 'Thinking in C++ Volume 1 & 2', Prentice Hall, 2 <sup>nd</sup> edition.	2003
4	Oualline, S., 'Practical C++ Programming', O'Reilly Media, 2 <sup>nd</sup> edition.	2003
5	Prata, S., 'C++ Primer Plus', Sams, 5 <sup>th</sup> edition.	2004
6	Lippman, C.B., Lajoie J. & Moo. B.E., 'The C++ Primer. Addison', Wesley Professional, 4 <sup>th</sup> edition.	2005
7	Stallings, W., 'Computer Organisation and Architecture: Designing for Performance', Prentice-Hall, 7 <sup>th</sup> edition.	2005
8	Deitel, H.M. & Deitel, P.J., 'C++ How to Program', Prentice Hall, 8 <sup>th</sup> edition.	2011
9	Stroustrup, B., 'The C++ Programing Language', Addison-Wesley, 4th edition.	2013



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-104** Course Title: **Cell Biology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 03 Practical:0**
4. Relative Weightage: **CWS: 10-25 PRS:25 MTE: 15-25 ETE:30-40 PRE:0**
5. Credits: **4**
6. Semester: **Spring** 7. Pre-requisite: **Nil** 8. Subject Area: **PCC**
9. Objective: To give an overview of fundamental and advance knowledge on cell biology and its practical application to various regulatory processes.
10. Details of course:

S. No.	Contents	Contact Hours
1	<b>Cell structure and function:</b> Road map of the course, introduction to cell biology, cell theory, cell size and their components, microscopy, cell nutrition, eukaryotic and prokaryotic cell, difference between bacterial, plant, animal and fungal cells, structure and function of cellular organelles, origin of life and cell, cytoskeleton, transport across cell membrane,	14
2	<b>Cell division:</b> Mitosis and the phases of cell division, meiosis, cell cycle regulation and its checkpoints.	4
3	<b>Cell death:</b> significance of cell cycle regulation in connection to cell death by apoptosis and their regulation, intracellular trafficking,	4
4	<b>Cell Signaling:</b> Cell-cell interactions; important cell signaling mechanisms, cell receptors, ligands and trans-membrane signaling;	5
5	<b>Cancer:</b> Cell signaling pathways related to cancer, proto-oncogenes, oncogenes and tumour suppressor genes,	5
6	<b>Stem cells:</b> Cellular differentiation including early embryonal development, conditions of stem cells; application of stem cells; induced pluripotency	6
7	<b>Basics of in vitro cell culture:</b> Isolation of cells; various types of cell/ organs/ tissue cultures; stem cell cultures	3
8	<b>Basics of Tissue engineering:</b> Stem cells in tissue engineer; types of materials for tissue engineering	2
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Display of cell organelles and micro structures
2	Overview of light microscopy methods
3	Observation of distinguishing features of different eukaryotic cells.
4	Study of divisional stages in Mitosis.
5	Study of divisional stages in Meiosis
6	Introducing in vitro cell cultures for cell biology
7	Observation of growth and differentiation in single cells.
8	Isolation and estimation of chloroplasts and DNA.

11.Suggested Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Vunjak Novakovic, G., Freshney, I.A., "Culture of Cells for Tissue Engineering", John Wiley & Sons, Inc. ISBN:9780471741817	2006
2	Cell Biology: A Short Course, 3rd Edition Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White, Jeremy S. Hyams. ISBN: 978-0-470-52699-6	2011
3	Bruce Alberts, et al. Molecular biology of the cell. Garland Science, 2015. 6th edition.	2015
4	Slack, J.M.W., "The Science of Stem Cells" John Wiley & Sons, Inc. ISBN: 9781119235293	2018
5	Karp's Cell Biology, 8th Edition, Global Edition by Gerald Karp, Janet Iwasa, Wallace Marshall. ISBN: 978-1-119-45629-2	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT: **Department of Biotechnology**

1. Subject Code: **BT-106** Course Title: **Microbiology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the mechanistic features of the microbes to use them as a tool for various applications related to human health, industrial applications and environment.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Discovery of Microorganisms, Eukaryotic and Prokaryotic cells, Classification and nomenclature of microorganisms. Microscopy, Principles and applications- dark field, bright field, electron microscopy, TEM and SEM, Staining techniques. Control of Microorganisms-Sterilization, disinfection, antisepsis, Physical and chemical methods.	9
2	Morphological and structural organization of microbes- Bacteria, fungi, viruses. Cellular growth- Isolation, identification and cultivation of bacteria, fungi, viruses (lysis and lysogeny) and growth curve.	8
3	Microbial nutrition and metabolism- aerobic and anaerobic respiration, fermentation, bacterial photosynthesis. Food Microbiology-Preservation of food, Microbiological fermentation of food-products-cheese, yogurt, bread and other fermented foods.	12
4	Industrial Microbiology- Outline of production of ethanol, organic acids, vitamins, antibiotics, leaching of ores by microorganisms. Bacterial genome, recombination, mutations, diseases caused by bacteria, fungi, viruses; antibiotic resistance.	13
	<b>Total</b>	<b>42</b>

S. No.	Practical course contents
1	Preparation and sterilization of culture media.
2	Preparation of culture media plates by pouring
3	Growth of model microorganisms (E.coli) by streaking, pour plating and spread plating.
4	Isolation of bacteria from different sources (soil, water, air).
5	Characterization of the isolated bacteria obtained from different source samples.
6	Identification of isolated bacterial colonies using microscopic & staining techniques.
7	To plot a growth curve of isolated bacterial strain.
8	Determination of Minimum inhibitory concentration of a known antibiotic against reference bacterial strains-micro-broth dilution and disk diffusion assays.

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	William, M., O'Leary, "Practical handbook of microbiology", CRC Press.	1989
2	Talaron, K., Talaron, A., Pelczar, C. and Reid, A., "Foundations In Microbiology", W.C.Brown Publishers	2005
3	Pelczar, M.J., Chan, E.C.S. and Krein, N.R., "Microbiology", Tata McGraw Publication	2007
4	Goldman E., Lorrence, H. "Greenpractical handbook of microbiology", CRC Press.	2008
5	Prescott, L.M., Harley, J.P. and Klein, D.A., "Microbiology", W. C. Brown Publications	2012
6	Frazier and Westnoff, "Food Microbiology", Tata Mcgrawhill	2012

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code : **BT-201** Course Title: **Genetics and Developmental Biology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart fundamental knowledge of genetics and developmental biology in understanding the basis of inheritance, and structure and molecular mechanism of gene function and mechanism of development in animals and plants.

10. Details of Course:

S. No.	Content	Contact Hours
1	Introduction and history of genetics, Reproduction as the basis of heredity; Mendelian principles of genetics, Exceptions of Mendelian principles	5
2	Genetic recombination and prokaryotes and eukaryotes, Chromosomal basis of inheritance and linkage; genetic complementation, Construction of genetic and physical maps; genetic mapping in prokaryotes and eukaryotes	6
3	Mechanism of sex determination, Chromosomal aberration and gene mutations, types of mutations, cause and consequences of mutations	5
4	Cytoplasmic inheritance, Genetic disorders and genetic counseling: Applications of genetics in agriculture and medicine, eugenics	5
5	Fundamentals of development; Potency, Commitment, Specification, Competence, Cell fate and cell lineages, stem cells, homeotic transformation, Developmental mutants, Approaches to study development	4
6	Gametogenesis and fertilization in animals and plants, Embryogenesis in animals; Cleavage, Blastula formation, Gastrulation, Embryogenesis in plants; embryo sac development, establishment of shoot and root meristem	5
7	Morphogenesis and organogenesis in animals; Axes and pattern formation in <i>Drosophila</i> , vulva formation in <i>Caenorhabditis elegans</i> , Differentiation of neurons, Regeneration in vertebrates.	6
8	Morphogenesis and organogenesis in plants; organization of shoot and root apical meristem, transition to flowering, Floral organ development and determinacy, Lateral root development	6
<b>Total</b>		<b>42</b>

<b>S. No.</b>	<b>Practical</b>
1	Analyzing Mendelian genetic segregation of mutant phenotypes in plants
2	Observing tissue-specific expression pattern of developmental regulators in plants
3	Analyzing developmental defects in mutant plants
4	Observation of Sea urchin embryology by microscopic slides
5	Observation of Amphibian embryology by microscopic slides
6	Observation of Chicken embryology by microscopic slides
7	Isolation of Chicken embryo from fertilized and incubated egg

11. Suggested Books:

<b>S. No.</b>	<b>Author(s)/Title/Publisher</b>	<b>Year of Publication/ Reprint</b>
1	Snustad, S., "Principles of Genetics", John Wiley & Sons Inc. Hoboken.	2003
2	Leyser, O., Day S., Mechanisms in Plant Development, 1 <sup>st</sup> edition, Blackwell Science Ltd	2003
3	Klug, W.S. and Cummings, M.R., "Concepts of Genetics", Pearson Education Inc.	2004
4	Wolpert, L., Tickle, C., "Principles of Development", 4 <sup>th</sup> Edition, OUP Oxford Press	2011
5	Gilbert, S. F., Developmental Biology, Tenth Edition, Sinauer Associates, Inc.	2013
6	Taiz, L., Zeiger, E., Møller, I.M., Murphy, A., Plant Physiology and Development. Sixth edition, Sinauer Associates	2017

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Biotechnology Department**

1. Subject Code: **BT-202** Course Title: **Structural Biology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart an overview of basic concepts and principles of structural biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Overview of structural biology; Primary, secondary, tertiary and quaternary structure of protein; Motifs and domains of protein structures; Structure of RNA and DNA; Conformational analysis	4
2	Enzymes structure-function relationship and the basis of structure-based drug design	4
3	Folding and flexibility; Techniques for studying macromolecular structure	5
4	UV Visible Spectroscopy; Fluorescence Spectroscopy; Circular Dichroism Spectroscopy	8
5	Symmetry, Space group crystal lattices, Bragg's law in real & reciprocal space; Structure determination of macromolecules by Crystallography technique	10
6	Nuclear Magnetic Resonance, dynamics, engineering, and design of protein structures	8
7	Other methods such as cryo-electron microscopy, tomography and small angle X-ray scattering, Structure of some molecular machines and virus assembly	3
	<b>Total</b>	<b>42</b>

11. Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1	Wüthrich K "NMR of Proteins and Nucleic Acids" 2 <sup>nd</sup> edition, (Baker Lecture Series)/ John-Wiley.	1986
2	Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeour, R.S., "Principles of Biochemistry" 3 <sup>rd</sup> edition Prentice Hall,.	2001
3	Cavanagh, J., Fairbrother, W.J., Palmer III, A.J., Skelton, N.J., and Rance M. "Protein NMR Spectroscopy: Principles and Practice" 2 <sup>nd</sup> edition, Academic Press	2005
4	Gale Rhodes, Crystallography Made Crystal Clear - 3 <sup>rd</sup> edition, Academic Press	2006
5	Cantor, C. R. and Schimmel, P. "Biophysical Chemistry" Vol. I, II and III, W.H. Freeman and Company, New York, USA.	2010
6	Keeler J. "Understanding NMR Spectroscopy" 2 <sup>nd</sup> edition, Academic Press	2010
7	B.V Venkataram Prasad and Steve Ludtke, Advances in Protein Chemistry and Structural Biology – 1 <sup>st</sup> edition, Academic Press	2011

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BTN-203** Course Title: **Immunology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To give an overview of the basic concepts of immune system and immunobiology, and a complete understanding of the principles and applications of immunotechniques.

10. Details of course:

S. No.	Contents	Contact Hours
1	Introduction and overview of immune system, Types of immunity - innate and adaptive, Cells and organs of the immune system, Inflammation, Antigens – epitopes, antigenicity, factors influencing antigenicity	8
2	Immunoglobulins: Structure and types of Immunoglobulins, Biological activities. Polyclonal and monoclonal antibodies, Monoclonal antibodies- productions and applications, Complement System, Antibody-dependent protection mechanisms	6
3	Antigen receptors, BCR and TCR genes, Genetic mechanisms and molecular basis for generation of antibody diversity, Hypersensitivity,	6
4	Major Histocompatibility Complex (MHC) and its role. Antigen processing and Presentation. Cellular responses. B lymphocyte and T lymphocyte development, T-cell activation and Cytokines. Immune response to various classes of pathogens	8
5	Transplantation immunology, Allograft rejection, Tumor immunology, categories of tumor antigen, Autoimmunity, criteria and causes of autoimmune diseases, Immunotherapeutics, Vaccines, Engineering of immune cells	8
6	Applied immunology, generation and purification of antibodies, antigen and antibody interactions, affinity and avidity, agglutination and immunoprecipitation, immunoassays, Immunodiagnosics: principles and applications. RID Assays, ELISA, Western blotting, Immunofluorescence, Fluorescence activated cell sorting.	6
<b>Total</b>		<b>42</b>

Sl. No	Practical course contents
1	Affinity chromatography for Antibody purification
2	Immunodiffusion and/or Immunoprecipitation Assays
3	Giemsa staining of the peripheral blood smear
4	Immune cell isolation, counting with trypan blue staining and culture
5	Enzyme Linked Immunosorbent Assay (ELISA)
6	Western Blotting
7	Flow cytometry



11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	A.K. Chakravarty., "Immunology and Immunotechnology", Oxford University Press	2006
2	Peter J. Delves., Seamus J. Martin., Dennis R. Burton. and Ivan M. Roitt., "Immunology", John Wiley & Sons	2011
3	Kenneth Murphy., "Janeway's Immunobiology", Garland Science	2011
4	Kindt., Goldsby., Osborne. and Kuby., "Kuby Immunology", W.H. Freeman & Co.	2013

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-204** Course Title: **Physiology of Animals and Plants**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: The course emphasizes on the fundamentals of physiological systems in animals and plants understanding the mechanisms by which coordination and control system works.

10. Details of course:

S. No.	Contents	Contact Hours
1.	Introduction to animal physiology; Concept of metabolism in animals; Various physiological organ-systems and their importance to the integrative functions of the human body; Body fluid compartments; Intracellular and extracellular communication systems	6
2.	Motility, secretion, digestion, absorption in the gastrointestinal system; Structure and functions of the respiratory system; Gas transport in blood; Structure and functions of smooth muscle, including excitation-contraction coupling in smooth muscle	5
3.	Principles of hormone action; Structure and, mechanism of release from endocrine cell; Mode of transport in blood; Mechanism of action in target cells; Systemic effects of important hormones	5
4.	Organization structural and functional organization of the nervous system; Resting membrane and action potential and propagation along the axon; Chemical messenger molecules of the nervous system	5
5.	The organization of plants and plant cells; plant-water relations, uptake, transport and translocation of water and solutes, transpiration, mechanism of phloem loading and unloading. Engineering of plant physiological process.	5
6.	Photosynthesis; light and pigments, light reaction, dark reactions, carbon assimilation and allocation, C3, C4 and CAM cycles, photorespiration, Respiration; glycolysis, Krebs cycle, electron transport and ATP synthesis	6
7.	Growth and Development; cellular basis of growth and development, Seed dormancy and germination, primary and secondary growth, leaf development and phyllotaxy, light control of plant growth and development	5
8.	Plant growth regulators and phytohormones; biosynthesis, storage, breakdown, transport, signalling and their physiological effects, stress physiology	5
<b>Total</b>		<b>42</b>

11. Suggested Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Salisbury and Ross, Plant Physiology, third edition, Wadsworth Publishing	2010

	Company, 1985	
2.	Hill, R.W., Wyse, G.A., Andrson, M., “Animal Physiology, Third Edition 3rd Edition, Sinauer Associates, Inc.	2012
3.	Moves, C.D., Schulte, P.M., “Principles of Animal Physiology” 3rd Edition, Pearson Press.	2015
4.	Taiz, L., Zeiger, E., Møller, I.M., Murphy, A., Plant Physiology and Development. Sixth edition,Sinauer Associates	2017
5.	Fundamentals of Plant Physiology 1st Edition by Lincoln Taiz et al. Publisher: Sinauer Associates is an imprint of Oxford University Press; 1 edition (June 5, 2018), ISBN-13: 978-1605357904	2018
6.	Rastogi, S.C., “Essentials of Animal Physiology”, Fourth edition; New Age International.	2019

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-205** Course Title: **Bioinformatics**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To understand the functions of each gene and protein that is essential for creating knowledge database and its annotation.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction, database model, raw database and processed database, data mining, data storage and retrieval, querying in database and tools for querying-BLAST, FASTA.	7
2	Gene finding, Hidden Markov Models (HMM), annotation of protein sequences, prediction of co-regulated genes from sequences and sequence alignment-pairwise, substitution matrices, local, global, multiple sequence alignment, clustering, prediction.	8
3	Protein-ligand interaction, Protein-protein interaction, searching in databases, binding site prediction, phylogenetic tree analysis, structural database – protein structure database, homology modeling, comparison and superposition of structures.	7
4	Molecular visualization, structure comparison and alignment, searching for patterns and motifs. Evolution of protein structure and sequences by comparing different organisms.	12
5	Docking methods, ligand design and validating data sets in structural genomics era and molecular dynamics	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Gusfield, D., "Algorithm on Strings, Trees and Sequences: Computer Science and Computational Biology", Cambridge University Press.	1997
2	Attwood, T. and Pary-Smith, D., "Introduction to Bioinformatics", Prentice Hall.	1999
3	Mount, D.W., "Bioinformatics: Sequence and Genome analysis", Cold Spring Harbor Laboratory Press.	2001
4	Baxevanis, A.D. and Ouellette, B.F.F., "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", Wiley-Interscience.	2001
5	Sensen, C.W., "Essentials of Genomics and Bioinformatics", John Wiley and Sons.	2002

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-206** Course Title: **Transport Phenomenon in Biological System**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE:0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To provide the knowledge of advanced processes of energy and mass transfer in relation to food preservation, drying, bioreactor modeling and bioprocess modeling.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Equation of change and its application in non conventional systems, turbulence and boundary layer theory. Unsteady state heat transfer, chilling and freezing of food and biological material. Boundary layer flow and turbulence in heat transfer.	7
2	Mass transfer in suspension, diffusion and convection in chemical and biochemical reactions, numerical analysis. Heat transfer in various geometries in forced convection, heat exchangers, boiling and condensation.	12
3	Radiation heat transfer, in non Newtonian fluids, numerical analysis. Heat and mass transfer in evaporation, evaporators and condensers, evaporation of biological materials.	10
4	Drying equipments, drying curves, combined convection, radiation and conduction heat transfer, freeze drying for biological materials.	7
5	Membrane separation processes, gas permeation membranes derivation of equation for counter and co-current flow for gas separation, multicomponent mixtures, cross flow models.	6
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Sissom, L. S. and Pitts, D. R., "Elements of Transport phenomena", McGraw Hill	1983
2	Broodkey, R.S. and Hershey, H. C., "Transport Phenomena", McGraw Hill international	1988
3	Geankoplis, C. J., "Transport Processes and Separation Process Principles", 4 <sup>th</sup> Ed., Prentice-Hall of India Pvt. Ltd.	2003
4	Bird, R. B., Stewart, W. E. and Lightfoot, E. W., "Transport Phenomena", John Wiley	2006
5	Wilty, J. R., Wilson, R. W. and Wicks, C.W., "Fundamentals of Momentum Heat and Mass Transfer", 5th Ed, John Wiley	2010

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-207**                      Course Title: **Process Calculations**
2. Contact Hours:            **L: 3            T: 1            P: 0**
3. Examination Duration (Hrs.): **Theory: 3            Practical: 0**
4. Relative Weightage: **CWS: 20-35   PRS: 0    MTE: 20-30   ETE: 40-50   PRE:0**
5. Credits: **4**
6. Semester: **Autumn**                      7. Subject Area: **PCC**                      8. Pre-requisites: **Nil**
9. Objectives: To introduce the concepts of material and energy balance and its importance in analyzing biochemical process systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1	<b>Introduction:</b> Units and Dimensions in chemical process engineering, stoichiometric relations, degree of freedom and their dependence.	4
2	<b>Material Balance:</b> Selection of Basis, conservation of mass with and without chemical reactions, material balances involving gases, vapors, liquids and solids. Analysis of systems with recycles, bypass and purge with and without chemical reaction. Analysis of system with condensation and vaporization. Concept of humidity, dew point and saturation	14
3	<b>Energy Balance:</b> Conservation of energy with and without chemical reactions, Analysis of systems involving reversible processes. Heat of change of phase, heat of reaction, heat of combustion, heat of solution, heat of mixing, Temperature determination for adiabatic and non adiabatic processes.	12
4	<b>Simultaneous Mass and Energy Balance:</b> Degree of freedom, analysis of multicomponent systems, Steady state material and energy balance.	4
5	<b>Unsteady State Material and Energy Balance:</b> Transient material and energy balance with and without chemical reactions.	4
6	Degree of reductance, metabolic heat calculation, yield concepts for biochemical reactions	4
	<b>Total</b>	<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Bhatt B I and Vora S M: "Stoichiometry", 4 <sup>th</sup> Ed, Tata McGraw-Hill	2004
2	Felder R M and Rousseau R W: "Elementary Principles of Chemical Processes", 3 <sup>rd</sup> Ed, John Wiley	2005
3	Himmelblau, D.M. "Basic Principles and Calculations in Chemical Engineering", 7 <sup>th</sup> Ed Prentice Hall of India, New Delhi, India	2006
4	Lakshmi Kutty B and Narayan K V: "Stoichiometry and Process calculations", Printice Hall of India,	2010

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT: **Department of Biotechnology**

Subject Code: **BT-208**

Course Title: **Biomaterials and Devices**

2. Contact Hours: **L: 3 T: 1 P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**

4. Relative Weightage: **CWS: 15-30 PRS: 20 MTE: 15-25 ETE: 30-40 PRE:0**

5. Credits: **4**

6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**

9. Objective: To provide fundamental aspects of material properties as well as state-of-the-art techniques for fabrication, processing and application of materials in biomedical engineering.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to Biomaterials: Structure & Properties - Materials commonly used for biomedical application, such as their properties from a biocompatibility or medical device perspective. In addition, materials interactions with biological systems are examined from the molecular (e.g., protein), cellular, tissue and systemic (whole body) perspective.	9
2	Introduction to organic materials - Uses, structure, processing and properties of organic materials, including polymers, biomacromolecules and small molecule organic materials.	6
3	Clinic and Biomaterial interphase – Understanding the needs and unmet needs of the clinical problems and to critically evaluate potential solutions for clinical problems.	8
4	Biomedical Materials - Engineering biomaterials for biological environment, principles underlying use and design of medical implants and matrices/scaffolds. Biodegradable materials and their uses in prosthetics etc.	6
5	Biomaterials for Drug Delivery – basic principles of engineering controlled release systems, polymer chemistry and biomaterials.	7
6	Applications of Biomaterials – Tissue engineering, antibacterial material development, Biomimic designs.	6
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Characterization of Biomaterials
2	Interaction studies of Biological fluids and macromolecules with implantable devices (ASTM E2799-12)
3	Testing of disinfection efficacy against biofilm producing pathogens
4	Biomaterials for antibacterial activities: Generation and Testing

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Joon B. Park, Joseph D. Bronzino, "Biomaterials – Principles and Application", CRC Press	2002
2	Frederick H. Silver, David L. Christiansen, "Biomaterials Science and Biocompatibility", Springer Verlag New York	2018
3	Hasirci, Vasif, Hasirci, Nesrin, "Fundamentals of Biomaterials", Springer	2019



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code : **BT-210** Course Title: **Molecular Biology and Genetic Engineering**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart fundamental knowledge on genetics and molecular biology and genetic engineering.

10. Details of Course:

S. No.	Content	Contact Hours
1	Introduction and general background on molecular biology. Central dogma, DNA replication in prokaryote and eukaryotes, enzymes and accessory proteins, telomere replication. DNA repair, mutagenesis	8
2	Basic translation mechanism in prokaryote and eukaryotes and its control. Gene expression in prokaryote & eukaryote, operon model, genes silencing, transcription factors, antisense and ribozymes	6
3	Basic of genetic engineering. Molecular biology techniques used for gene manipulation: DNA cloning, restriction enzyme and its application, PCR, RT-PCR	4
4	Cloning vectors: plasmids, phages cosmids, phagemid, YAC, eukaryotic vectors. Gene targeting vector for plant and animal	4
5	Gene transfer in plant and animal cells, genetic manipulation in animal, generation of transgenic mice and its application	4
6	Transgenesis in plants: Agrobacterium tumefaciens, Ti-plasmid a T-DNA, Direct DNA transfer to plants.	8
7	Genetically modified (transgenic): Resistance to herbicides, Resistance to insect pests, Value added Transgenic crops, Tolerance to abiotic stresses.	8
	<b>Total</b>	<b>42</b>

S. No.	Practical course contents
1.	Preparation of competent cells and determination of transformation efficiency using plasmid DNA (pUC19)
2.	Plasmid DNA isolation
3.	Restriction Enzyme digestion of plasmid DNA
4.	Vector and Insert Ligation
5.	Polymerase Chain Reaction and analysis by agarose gel electrophoresis
6.	Confirmation of the insert by Colony PCR and Restriction mapping

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Watson J, "Molecular Biology of the Gene", Seventh Edition, Pearson.	2013
2	Primrose SB, "Principles of Gene Manipulation and Genomics, Seventh edition, Wiley Blackwell	2014
3	Alberts B, "Molecular Biology of the Cell", Sixth Edition, Garland Science.	2015
4	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications.	2017
5	Rup Lal., "Genetic Engineering of Plants for Crop Improvement"	2017

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-301** Course Title: **Bioprocess Engineering**
2. Contact Hours: **L: 3 T: 1 P: 2/2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 15-30 PRS: 20 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objectives: To impart the knowledge of kinetics of microbial growth, product formation and its role in various modes of bioreactor operation.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Microbial kinetics, Monod's equation, substrate inhibition, double substrate equations	5
2	Structured and unstructured models, substrate & product inhibition models, cybernetic models, segregated models, maintenance coefficient	8
3	Media and air sterilization, sterilization kinetics, batch and continuous sterilization	4
4	Agitation and aeration in bioreactor, different types of impellers, power requirements, $k_{La}$ determination, mixing, multiphase reaction	8
5	Types of bioreactor operation, batch, fed-batch, continuous, cell recycle and cascade mode, calculation of productivity, yield and reactor sizing	8
6	Extractive fermentation, high cell density culture, Scale-up and scale down of bioreactor	4
7.	Heterogenous enzyme kinetics, first order, zero order, Thiele modulus, Effectiveness factor	5
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Study of batch sterilization kinetics and parameters estimation
2	Operation of fermentor and sterilization
3	Batch growth kinetics and estimation of growth parameters
4	Immobilization of enzyme and parameter estimation
5	Determination of volumetric oxygen mass transfer coefficient by dynamic method
6	Analytical methods for estimation of metabolites using HPLC and yield calculation

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Bailey, J.E. and Ollis, D.F., "Biochemical Engineering Fundamentals", McGraw Hill	1986
2	James, M. Lee, "Biochemical Engineering", Prentice Hall	1991
3	Shuler, M.L. and Kargi, F., "Bioprocess Engineering", Prentice Hall	2002
4	Nielsen, J., Villadsen, J. and Gunnar Liden, "Bioreaction Engineering Principles", 3 <sup>rd</sup> edition Springer	2011
5	Doran, P.M., "Bioprocess Engineering Principles", 2 <sup>nd</sup> Edition Academic Press	2013

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-302** Course Title: **Genomics, Proteomics and Metabolomics**
2. Contact Hours: **L: 3 T: 1 P: 2/2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 15-30 PRS: 20 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: The focus of the subject is to introduce novel analytical methodologies (genomics, proteomics and metabolomics) with application in pre-clinical, clinical trials, cell models and plant experiments.
10. Details of course:

S. No.	Contents	Contact Hours
1	<b>Genomics:</b> Genome evolution and organization in prokary and eukaryotes, Genome sequencing, basics, strategies and methodology, databases and sequence comparisons, Comparative genomics, functional genomics, expression sequence tags (ESTs), serial analysis of gene expression (SAGE) and targeting induced local lesions in genome (TILLING), Microarrays technology: Principles and applications, transcriptome analysis and SNPs determination, RNA seq expression analysis: methods and applications	14
2	<b>Proteomics:</b> Isolation of proteins from different sources (e.g., plants, animals and humans) and biofluids (e.g., saliva, blood, urine and milk). Extraction proteins by different precipitation methods (e.g., TCA and acetone precipitation). Estimation of protein concentration by different assays (BCA and Bradford). Separation of proteins by gel electrophoresis (1D and 2D PAGE). Pros and cons of different stains (e.g., Coomassie, Silver stain, Sypro Ruby stain). Quantification of protein expression (e.g. 2-DIGE). Sample preparation for mass spectrometry (e.g., in-solution and in-gel methods). Qualitative analysis by MS (e.g. MALDI and LC-ESI MS). Quantitative analysis by MS – Label free quantitation by AUC and spectral counts ; Labeled quantitation by iTRAQ and TMT. Database and search engines.	14
3	<b>Metabolomics:</b> Introduction to metabolomics, statistical aspects both before and after design and implementation of experiments. Sample preparation for metabolomics study, analytical methods in metabolomics (with special focus on mass spectrometry), identification tools for metabolites, raw data analysis to study the metabolome using mass spectroscopy, data processing using univariate and multivariate statistical analysis, annotation, VIP score, pathway analyses. Structural elucidation of new compounds using mass spectrometry, inclusion of metabolites into biosynthetic pathways, examples of metabolomics studies using plant models. Access tool for important public metabolomics database and search engine for mass-spectrum based identification of metabolites and network analysis of metabolite-metabolite interactions ("interactomics").	14
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Identification of an unknown nucleotide sequence by database search and BLAST (BLASTN, BLASTP etc.)
2	Analysis of ESTs from different organisms.
3	Comparative genomics for identification of related genes from different organisms.
4	Phylogenetic analysis
5	Gel electrophoresis, Protein staining, in-solution and in-gel trypsin digestion.
6	Generation of peptide mass fingerprint, MSMS and data analysis
7	GC-MS metabolomics of sugar, amino acid, fatty acids and secondary metabolites
8	Identification of an unknown metabolites using mass spectrometry
9	Multivariate analyses of practical metabolomics data and normalization process

#### 11.Suggested Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	PLANT metabolomics : methods and protocols / edited by Nigel W. Hardy, Robert D. Hall. – New York : Humana Press : Springer, cop. 2012. – XIII, 340 str. ISBN 978-1-61779-593-0	2012
2	Mass Spectrometry Data Analysis in Proteomics by Rune Matthiesen. 2 <sup>nd</sup> Edition	2013
3	METABOLOMICS in practice: successful strategies to generate and analyze metabolic data / edited by Michael Lämmerhofer and Wolfram Weckwerth. – Weinheim : Wiley-VCH, ISBN 978-3-527-65589-2	2013
4	Genomes 4 by T. A. Brown, Garland Science publication, 4 <sup>th</sup> edi.	2017
5	PROTEOMICS: Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 8 <sup>th</sup> Edition	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-303** Course Title: **Animal and Plant Tissue Culture**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the most recent techniques used in animal cell and tissue culture practices and its link to animal biotechnology and their applications to animal husbandry and biomedical field.

10. Details of course:

S. No.	Contents	Contact Hours
1	Introduction to animal tissue culture; applications; culture environment; cell adhesion; cell proliferation; differentiation; Animal cell culture facility	5
2	Animal cell culture media; Isolation of tissue; Steps involved in primary cell culture; Immortalization of cell lines; Routine maintenance; Cryopreservation and cell banks	6
3	Characterization of cell lines; Chromosome analysis; DNA content; Cytotoxicity and viability assays, Cell separation techniques, Flow cytometry and fluorescence associated cell sorting	5
4	In situ hybridization; Hybridoma technology; Industrial products of animal cell culture; Role of enzymes / isozymes in culture	5
5	Introduction to Plant Tissue culture, Terms and definitions, Historical background, laboratory organization, methods of sterilization. laboratory contaminants- it's control and measures. Role of micro and macro nutrients, explants selection, sterilization and inoculation; various media preparations; MS, B5, LS.	5
6	Induction and growth parameters; culture initiation, callus culture, cell suspension culture, micropropagation, protoplast fusion, somaclonal variation, hairy root culture.	6
7	Plant cell culture as production platform for value added products. Engineering of plant cell and cell cultures (precursor feeding, biotransformation, elicitor treatment, cell encapsulation, <i>trans</i> -genic and <i>cis</i> -genic cell lines) for targeted production of values added products. Isolation and commercial production strategies for value added products using plant cell culture (phytomedicine and food supplements). Technologies to generate transgenic plants	10
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Introduction to laboratory manuals for animal and plant tissue culture
2	Sterilization techniques for animal and plant tissue culture
3	Media preparation for animal cell culture
4	Practical introduction to animal cell cultures
5	Media and growth regulator preparations for plant tissue culture
6	Development of plant callus culture and cell culture
7	Isolation of value added natural products from plant cell culture
8	Development of plant hairy root cultures

## 11. Suggested Books:

S. No.	Name of Books/Authors/publisher	Year of Publication
1	S. M. Bhatt, Animal Cell Culture - Concept and Application, Narosa Publishing House.	2009
2	J. P. Matcher., P. E. Roberts., Introduction to Cell and Tissue Culture. Plenum Press, New York and London.	2010
3	I. A. Freshney, Culture of Animal Cells, Academic Press	2010
4	S. B., Primerose, Molecular Biotechnology. Blackwell Scientific Publication	1993
5	Plant Cell and Tissue Culture – A Tool in Biotechnology Basics and Application. Authors: Neumann, Karl-Hermann, Kumar, Ashwani, Imani, Jafargholi. ISBN 978-3-030-49096-6	2020
6	Razdan, M. K. (2003). <i>Introduction to Plant Tissue Culture</i> . Enfield, NH: Science.	2003
7	Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). <i>Biochemistry &amp; Molecular Biology of Plants</i> . Chichester, West Sussex: John Wiley & Sons.	2015
8	Plant Biotechnology by B D Singh. ISBN-13: 978-9327211801, Kalyani publication.	2014
9	Introduction To Plant Biotechnology 3Ed by CHAWLA H S; OXFORD & IBH PUBLISHING; 3rd Revised edition (2020); ISBN-13: 978-8120417328	2020



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT : **Department of Biotechnology**

1. Subject Code: **BT-304** Course Title: **Molecular Diagnostics**
2. Contact Hours: **L: 3 T: 1 P: 2/2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 15-30 PRS: 20 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Spring** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the basics and advanced concepts of diagnostic methods and their application to environment, food and healthcare sector.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario.	3
2	Infectious diseases and diagnosis: Microbial pathogenesis, diagnostic pathology, immune pathology, and immunohistopathology. Detection & differentiation of pathogens – bacterial, viral, fungal, zoonotic, protozoan, Drug susceptibility testing, drug resistance testing.	8
3	Clinical Biochemistry in Diagnostics: Laboratory diagnostics – routine blood & urine analysis, enzyme assays - liver function tests, cell free biopsies, non-invasive testing. Point of care testing, Cellular and functional genomics in diagnostics.	7
4	Nucleic acids: Principle and methods, Genomic DNA isolation, Plasmid isolation, Restriction digestion, DNA ligation, and agarose gel electrophoresis, quantification, RNA isolation and purification methods	5
5	Nucleic acid analysis technologies: PCR Principle, procedure, types and applications. cDNA synthesis and cloning, DNA primers, linkers, adapters, DNA finger printing, PCR-RFLP, RAPD, Micro satellites, SCAR (Sequence characterized amplified region). Role of NGS in diagnostics.	5
6	Diagnostics meets Nano – Role of nanoparticles in nanodiagnostics, Molecular recognition elements, Conjugation of MREs to Nanoparticles for diagnostics.	6
7	Molecular Diagnostics and the future – Diagnostic market analysis – major players, their platforms, role of AI and ML in diagnostics, Futuristic ideas in diagnostic field.	3
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1	Single Nucleotide Polymorphism Diagnostics using Allele Specific – PCR methods
2	Real time PCR for pathogen detection
3	Clinical Biochemistry – Widal test, lateral flow tests for antigen screening (Pathology Lab)
4	GFP – based diagnostic methods for rare diseases, pollutants and xenobiotics

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	David bruns, Edward Ashwood, carl Burtis, "Fundamentals of Molecular Diagnostics", Saunders Press	2007
2	Bruce Alberts, "Molecular Biology of the Cell", Taylor & Francis Group	2012
3	Nader Rifai, A. Rita Horvath, Carl T. Wittwer, Jason Park, "Principles and Applications of Molecular Diagnostics", Elsevier Science	2018
4	Anthony Warford, NadegePresneau, "Molecular Diagnostics: Fundamentals of Biomedical Science", Oxford University Press	2019

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT-305** Course Title: **Computational Biology**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**
5. Credits: **4**
6. Semester: **Autumn** 7. Subject Area: **PCC** 8. Pre-requisites: **Nil**
9. Objective: The course provides exposure to the vast field of computational biology, methodologies and techniques used in the field. The course discusses about various topics in depth around published research.
10. Details of course:

S. No.	Contents	Contact Hours
1.	Introduction to computational biology, basic introduction to cell, genome, rna, protein, cell biology and big picture of research problems in computational biology	4
2.	Genomic analysis and whole sequence assembly, exact string matching and approximate string-matching algorithms, sequence alignment, genome structure, constraint-based optimization	10
3.	RNA folding, RNA-sequence analysis, various algorithms used in the field.	6
4.	Protein: protein folding, protein sequence matching, proteomics, integrative structural modeling, drug designing	10
5.	Metabolomic pathway analysis, metabolomics, microbiome analysis, metagenomics	7
6.	Whole-cell modeling, various whole cell modeling methods developed, introduction to big consortiums (4D Nucleosome Project, Pancreatic Beta Cell Consortium, Human Atlas, Allen Institute, Cancer Systems Biology Consortium, etc.)	5
<b>Total</b>		<b>42</b>

S. No.	Practical course contents
1.	BLAST search and FASTA search; its different types; observing the effect of change in various parameters in the search; comparison of the result between BLAST and FASTA
2.	Whole genome sequence alignment
3.	Comparison of distance matrices, searching for patterns and motifs.
4.	Prediction of protein structure -homology based, protein threading/fold recognition, ab-initio modelling, template recognition, model generation, loop modelling, model validation
5.	Phylogenetic analysis
6.	Designing a small molecule; binding-site prediction in protein; protein-small molecule docking

11.Recommended Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	"Algorithms on Strings, Trees and Sequences" by Dan Gusfield	1997
2.	Pierre Baldi and Soren Brunak, "Bioinformatics: The Machine Learning Approach" 2 <sup>nd</sup> Edition (The MIT Press)	2001

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-490** Course Title: **Fundamentals of Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: To provide understanding of the basics of biotechnology

10. Detail of Course:

S.No.	Content	Contact Hours
1	<b>Introduction to Biotechnology:</b> Basic unit of life; Biomolecules, Prokaryotes, Eukaryotes, Cell components, Sub-cellular organelles	5
2	<b>Microbial life and fermentation process:</b> Bacteria, fungi and viruses, Basic concept of microbial growth and bioprocess technology	5
3	<b>Molecular biology concepts:</b> Central Dogma of molecular biology, Replication, Transcription, Translation, Gene mutations, Recombinant DNA Technology, Cell fusion technology-hybridoma technology, basic concept of immune system	8
4	<b>Vectors used in biotechnology:</b> Restriction and modifying enzymes, cloning vectors: Plasmids, phage cosmids, phasmid, YAC, eukaryotic vectors	2
5	<b>Plant and Animal Biotechnology:</b> Transgenic Plants and Animals	2
6	<b>Medical Biotechnology:</b> Introduction to - Biopharmaceuticals, Gene therapy, Vaccines, Nanobiotechnology, Bioinformatics and Drug design	7
7	<b>Environmental technology:</b> Pollution and human health, waste treatment, bioremediation, Biofuels	4
8	<b>Analytical techniques in Biotechnology:</b> Introduction to microscopy, radioisotope technique, electrophoresis, chromatography, centrifugation, spectroscopy, PCR, Northern blotting, Southern blotting, Western blotting, Sequencing techniques. Biosafety and Bioethics	9
Total		42

11. Suggested Books:

S. No	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Stryer, L., "Biochemistry", 4th Ed., WH Freeman & Co. 2000	2000
2.	Old, R. W. and Primrose, S. B., "Principles Of Gene Manipulation: An Introduction To Genetic Engineering", Blackwell Science. Publications.	2001
3.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science Ltd.	2001
4.	Watson, J.D., "Molecular Biology of The Cell", Taylor & Francis	2002
5.	Sambrook, J. and Russel, D.W., "Molecular Cloning: A laboratory Manual", Cold Spring Harbor Laboratory Press.	2011

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 491** Course Title: **Biophotonics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: To impart knowledge about the emerging field of biophotonics and the application of optical based technologies in the field of biosensing, imaging etc.

**10. Detail of Course:**

S. No.	Contents	Contact Hours
1	Light and matter: - Fundamental nature of light, Basics of structure and function of living materials, Process of light interaction with matter, Types of light sources, Basic optics for light transmission.	5
2	Interaction of light with cells and tissues- Components that interact with light, light absorption in cells, light induced cellular processes, Interaction of light with tissues- absorption, scattering, tissue optical properties, light induced processes in tissue, radiative transport theory	7
3	Optical Spectroscopy: Fluorescence spectroscopy, Raman spectroscopy, CARS, fluorescence detection and quantification of nucleic acids, proteins and cells, Optical activity and circular dichroism.	6
4	Basic principles of lasers, Lasers relevant to biophotonics, Time resolved studies.	5
5	Optical imaging- Background and need for optical imaging, Different optical imaging techniques, Microscopy –Simple, compound, , Fluorescence microscopy, confocal microscopy, Optical coherence tomography, Spectral and time resolved imaging- fluorescence resonance energy transfer (FRET), fluorescence life time imaging (FLIM).	8
6.	Applications of Bioimaging- endogenous and exogenous fluorophores, tissue imaging, in vivo imaging. Optical biosensing- principle, fiber optic biosensors, surface Plasmon resonance biosensors	4
7	Microarray technology for analysing bio samples, flow cytometry-optical diagnostic technique, Light for therapy and treatment, optical tweezer, laser scissor.	5
8	Bio nanophotonics - major areas of nanophotonics, semiconductor quantum dots for bioimaging.	2
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	T. Vo-Dinh ed., "Biomedical Photonics Handbook", CRC Press Optics, E. Hecht, Addison-Wesley	2002

<b>2</b>	Paras N. Prasad, "Introduction to Biophotonics", Wiley & Sons	<b>2003</b>
<b>3</b>	Joseph R Lakowicz , "Principles of fluorescence spectroscopy", Springer	<b>2006</b>
<b>4</b>	Splinter R, and Hooper BA, "An Introduction to Biomedical Optics", CRC Press, Taylor and Francis Group, Boca Raton	<b>2007</b>
<b>5</b>	Bahaa Saleh and Malvin Teich, "Fundamentals of Photonics", Wiley & Sons	<b>2007</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 492** Course Title: **Introduction to Computational Biology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: To understand the structure and function of macromolecules by computational approach.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Process of Molecular Visualization, Molecular Models, Visualization Programs	5
2	Protein Structure Evolution, Structure Comparison and Alignment.	5
3	CATH domain structure, Similarity and Evolutionary relationship in CATH, Classifying close homologues, Structure based methods for identifying structural homologues and related folds, Population of super-families and families	6
4	Algorithms for identifying structural domains in proteins: Insight into history and methodology, in-depth analysis, evaluating automatic methods, Domain prediction based on sequence information, SCOP Database	6
5	Protein function from Structure: Inferring function from structure, Structural Genomics (High –throughput function prediction).	6
6	Structural annotation of genome, Methodologies for identifying Structural protein domains in genomes, Structural genomics	5
7	Evolutionary Studies using Protein structure: structures as evolutionary units, phylogeny by protein domain content, Evolutionary history of Protein Domain	4
8	Homology Modeling, Ligand Designing and Docking Methods	5
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Attwood, T. and Pary-Smith, D., "Introduction to Bioinformatics", Prentice Hall.	1999
2	Carl Branden, John Tooze, "Introduction to Protein Structures", Routledge publishers, 2 <sup>nd</sup> Edition	1999
3	Mount, D.W., "Bioinformatics: Sequence and Genome analysis", Cold Spring Harbor Laboratory Press.	2001
4	Sensen, C.W., "Essentials of Genomics and Bioinformatics", John Wiley and Sons.	2002
5	Jenny Gu, Philip E. Bourne, "Structural Bioinformatics" John Wiley & Sons.	2009



## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Biotechnology**

1. Subject Code : **BT-493** Course Title: **Recombinant DNA Technology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**

9. Objective: The course intends to offer students the opportunity to gain a theoretical knowledge and understanding of basic techniques of recombinant DNA technologies, and their applications.

### 10. Details of course

S.No.	Contents	Contact Hours
1	Introduction to Recombinant DNA Technology:- Establishment, development and history	2
2	Introduction to vectors as cloning vehicles:- Plasmids, Cosmids, Viral vectors, Ti and Ri plasmids, BAC, YAC expression vectors, Shuttle vectors, Transposons; Vector preparation; Genomic DNA preparation; DNA quantification; DNA labeling and detection; Electrophoresis; Blotting techniques and applications; Southern Blotting and Northern Blotting; In situ hybridization.	6
3	Enzymes technology:- Exonucleases, Endonucleases, Restriction Endonucleases, Ligases, Topoisomerase, DNA polymerases, RNA polymerases, Reverse transcriptase, DNA and RNA Modifying enzymes:- Methylase, Alkaline phosphatase, Terminal deoxynucleoside acyltransferase, T4 polynucleotide kinase etc	8
4	Primer designing, Polymerase chain reaction (PCR), Site directed mutagenesis, Gene Cloning:- Ligation independent cloning; Selection of cloned genes – Antibiotics, Gene expression analysis, Reporter genes; Replicons; Recombinant protein production; Bacterial expression system, Eukaryotic expression system, Cell free expression system.	10
5	Gene transfer techniques - Gun shooting methods, Transformation, Transduction and Conjugation; Transformation:- Competence preparation, Heat shock method; Transfection methods, Electroporation, Viral methods, Chemical based transfection.	5
6	Genomic library; Genomic library construction; cDNA library construction; Genome mapping; DNA finger printing; Restriction fragment length polymorphism (RFLP); Random amplified polymorphic DNA (RAPD); DNA foot printing.	5
7	Transgenic plants:- Herbicide tolerance, Fruit ripening - resistance to viruses, Pests, Fungi and bacteria; Transgenic animals, Applications in agriculture, medicine and industry.	6
<b>Total</b>		<b>42</b>

### 11. Suggested books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/
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		<b>Reprint</b>
<b>1</b>	James D. Watson, Watson and Michael Gilman., "Recombinant DNA", Publisher W.H. Freeman & Company	<b>1992</b>
<b>2</b>	Bernard R. Glick , Jack J. Pasternak and Cheryl L. Patten., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM press	<b>2009</b>
<b>3</b>	Sandy B. Primrose and Richard Twyman., "Principles of Gene Manipulation and Genomics", John Wiley & Sons	<b>2013</b>
<b>4</b>	TA brown., "Gene cloning and DNA analysis: An Introduction", Wiley- Blackwell	<b>2010</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 494** Course Title: **Environmental Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective of Course: To impart the knowledge of biotechnological applications in waste treatment and biodegradation of various xenobiotic compounds using microorganisms.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Introduction, pollution monitoring, biotechnological treatment of waste, Microorganisms and nutrient cycle in aquatic environments, Waterborne infectious agents, detection and control of pathogenic microbes in water, sewage & sludge	8
2	Wastewater treatment-activated sludge processes, wastewater treatment efficiency assessment, Microorganisms in the soil environment, Phyllosphere, Rhizosphere and Rhizoplane microorganisms	12
3	Sampling and analysis of Airborne microorganisms- fungi and mycotoxins, Airborne viruses, Biotransformation and biodegradation of pollutants, methods for determining biodegradability	10
4	Biodegradation of lignocelluloses, PAH, agricultural chemicals, Microbial Leaching, Molecular biological techniques in the characterization of environmental populations of microorganisms, Emerging Technologies - bioreporters, biosensors and microprobes	12
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Pickup R.W and Saunders J.R., "Molecular approaches to environmental microbiology", Ellis Horwood Limited, First Edition, UK.	1996
2	Scragg, A., "Environmental Biotechnology", First Edition, Pearson Education Limited, UK.	1999
3	Hurst, C.J., Crawford, R.L., Knudsen, G.R., MacInerney, M.J., Stetzenbach, L.D., "Manual of Environmental Microbiology", ASM press, Washington, DC, Second edition.	2002
4	Evans, G.M., Furlong, J C., "Environmental Biotechnology - Theory and application", John Wiley & Sons, Ltd, USA.	2003
5	Metcalf & Eddy, INC, "Wastewater Engineering- Treatment, Disposal and Reuse, 5 <sup>th</sup> Edition, Tata MacGraw-Hill publishing company Limited, New Delhi.	2005

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT - 495** Course Title: **Fermentation Technology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: This course is designed with objective of introducing the basic concepts of bioprocess engineering to non-biologist.
10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction to microbial growth,Basics of growth kinetics, growth of animal cell, enzyme kinetics	6
2.	Microbial nutrient, media design, mass balance, air and media sterilization techniques	7
3.	Modes of fermentation: batch, continuous and fed-batch fermentation	5
4.	Types of bioreactors: Stirred tank reactor, packed bed reactor, solid state bioreactor, membrane bioreactor, photo-bioreactor	6
5.	Animal and plant cell culture techniques	3
6.	Mass and heat transfers in bioreactor, scale-up of bioreactor	6
7.	Purification of bio-products: chromatography, membrane separation, purity requirements, examples of primary and secondary metabolites production, recombinant product	9
	<b>Total</b>	<b>42</b>

## 11. Suggested Books:

S.No.	Author(s)/ Title/Publisher	Year of Publication/ Reprint
1	Shuler, M.L., and Kargi, F. Bioprocess engineering:Basic concepts 2 <sup>nd</sup> Edition, Prentice Hall	2001
2	Stanbury, P.F., Hall, S. and Whitaker A.,“Principles of Fermentation Technology” Second Edition Macmillian	2009
3	Bailey, J. and Ollis, D., “Biochemical Engineering Fundamentals”, McGraw-Hill	2010
4	Doran, P.M., “Bioprocess engineering Principles” 2 <sup>nd</sup> Edition Academic press	2012

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 496** Course Title: **Fundamentals of Food Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: This course will introduce the students to the concept of biotechnological processes in food industry, natural microflora of fermented foods, bio-preservation, contaminants in food and their detection, potential use of microorganisms and nanotechnologies in food & food products.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to biotechnology and microbiology, factors affecting the growth & survival of microorganisms. Methods of gene engineering of microbes for food industry	8
2	Microbial spoilage of food- milk, meat, plant products, food borne diseases. Bacterial agents of food borne illness- Clostridium, Listeria, Salmonella, Shigella, Staphylococcus, Vibrio Yersini.	13
3	Non-bacterial agents of food borne illness- helminthes and protozoa, toxigenic algae, toxigenic fungi, food borne viruses. Fermented and microbial foods- fermented milk, cheese, sauerkraut, fermented meat, beer, vinegar, mould fermentation	9
4	Microbiological examination of foods- direct examination, culture techniques, MPN count, and dye reduction assay; Immunological methods, advance techniques	5
5	Microbiology of food preservation- biological based preservation systems – acid and antibacterial peptides. Future applications- Nanobiotechnology for food industry – preservation, smart packaging and functional foods	7
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1	Adams, M.R. and Moss-Food, M.O., "Microbiology", Royal Society of Chemistry.	2000
2	James, M. J., "Modern Food Microbiology", Aspen Publications.	2000
3	Michael, P. D., Larry, R.B. and Thomas, J., "Montville. Food Microbiology- Fundamentals and Frontiers", ASM press.	2001
4	Perry Johnson-Green, "Introduction to Food Biotechnology". Publisher; CRC Press.	2002

<b>5</b>	Richard, K. R., Carl, A. B., "Encyclopedia of Food Microbiology",ASM Press.	<b>2014</b>
<b>6</b>	Frazier, W.C. and Westhoff, D.C. Food Microbiology. 5 <sup>th</sup> Edition. Tata McGraw- Hill	<b>2017</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT - 497** Course Title: **NMR Techniques**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **MSC** 8. Pre-requisite: **Nil**
9. Objective: To impart the concepts of nuclear magnetic resonance and its applications in biology.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to NMR – Angular momentum and nuclear magnetism, Precession, resonance frequencies, classical and quantum mechanical principles	4
2	Continuous and pulsed NMR, Fourier transformation, rotating frame of reference, Bloch equation, free induction decay, one dimensional NMR, measurement of parameters-chemical shift, intensity	6
3	Spin-spin coupling, multiplet pattern, karplus relation, spin systems, Relaxation times T <sub>1</sub> and T <sub>2</sub> measurement of relaxation times, structure based on chemicals shift and coupling constant, dipolar coupling, nuclear overhauser effect	8
4	Instrumentation, nmr probes, sensitivity, resolution, solvent effects, effect of pulses, Population and coherence, polarization transfer, INEPT, DEPT, chemical exchange, kinetics, rotational motion, multinuclear NMR	12
5	Two dimensional NMR-principle and techniques, homonuclear and heteronuclear techniques, applications	4
6	Determination of three dimensional structure, distance geometry and restrained molecular dynamics, of NMR derived Structure – Energy calculation and minimization, Restrained molecular dynamics, solid state NMR, magic angle spinning cross polarization, application. Magnetic resonance imaging, principle, applications	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	P.J.Hore, "Nuclear Magnetic Resonance", Oxford Chemistry Primers.	1995
2	Evans, J.N.S., "Biomolecular NMR spectroscopy", Oxford University Press.	1995
3	Gunther H., NMR Spectroscopy: Basic principles, Concepts and Applications in Chemistry, Wiley.	1995
4.	Pavia, D.L., Lampman G.M., Kriz G.S., Vyvyan J.A., "Introduction to Spectroscopy", Brookes Cole.	2008

5.	K.V.R. Chary and Grijesh Govil, "NMR of biological Systems", Springer.	2008
6.	James Keeler, "Understanding NMR spectroscopy", 2 <sup>nd</sup> Edition, Wiley.	2010



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 471** Course Title: **Drug Discovery and Development**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE:0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **DHC** 8. Pre-requisites: **Nil**
9. Objective: To provide understanding of the discovery and development of therapeutics and why they fail in the market

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Introduction to Drugs, Classification of drug targets – Nucleic acids, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors, small molecule receptors, transporters.	8
2	Physiochemical properties of drugs- Molecular properties, geometries, Stereochemistry, Medicinal chemistry,	5
3	Synthetic small molecules and natural products High throughput screening, Target discovery and validation strategies, Combinatorial chemistry.	5
4	Molecular mechanism of Drug action- characterization, drugability, drug targets, drug receptor theories, and enzyme targets.	4
5	Structure activity relationships-SAR, efficacy and toxicity, pharmacokinetics and pharmacodynamic parameters of drugs, pre-clinical and clinical trials	8
6	Patent issues in drug development, Technology transfer, Commercialization	5
7	Setbacks in global drug market- development of drug resistance, efflux mechanisms, enzymatic modifications, multiple drug resistance in pathogens, strategies to overcome drug resistance.	7
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Christopher Walsh, "Antibiotics: Actions, Origins, Resistance"	2003
2	Silverman, R.B., "The organic chemistry of drug design and action", Elsevier, New York	2004
3	Brahmankar, D.M. and Jaiswal, S.B., "Biopharmaceutics and Pharmacokinetics", Second Edition	2009
4	Benjamin E. Blass, "Basic Principles of Drug Discovery and Development"	2015
5	Bayya Subba Rao, P. V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", Second Edition	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 472** Course Title: **Stem Cell Technology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **DHC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the most recent techniques used in understanding the basics of stem cells and their applications in cure and management of various human diseases.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Developmental Biology: principles and applications of developmental biology, early embryonic development, types of cleavage and mechanisms, gastrulation; cell fate determination.	6
2	Concepts of stem cells: basic concepts and properties; totipotency; Pluripotency; embryonic stem (ES) cells; germinal stem cells; adult stem cells; tumor stem cells; stem cell plasticity; general methods of characterization of stem cells.	6
3	ES cells: isolation of ES cells; salient features and application of ES cells; human and mouse ES cells; differentiation of ES cell; maintenance of ES in undifferentiated state.	6
4	Stem cells and cloning: therapeutic and reproductive cloning; nuclear transfer methods; applications of nuclear transfer in ES cells; safety of nuclear transfer in ES cells.	6
5	Hematopoietic, mesenchymal and neural Stem Cell (HSC) (MSC) and (NSC): identification and characterization of HSCs, MSCs and NSC; sources of HSC; mouse assay of HSC; HSC in leukemia and lymphoma; Clinical use of HSC; embryonic origin of MSC's, harvesting; isolation and characterization; Differentiation; NSC and Neural crest stem cell.	6
6	Stem cell therapy and future of stem cell research: potential of stem cell therapy for various diseases like AIDS/HIV; alzheimer's disease; anaemia; multiple sclerosis; Parkinson disease; rheumatoid arthritis; injuries; cancer	6
7	Tissue Engineering: introduction; structural and organization of various tissues like epithelial and connective; vascularity and angiogenesis; basic wound healing; cell migration; use in therapeutic and in-vitro testing, scaffold and transplant -Engineering biomaterials; degradable materials; porosity; mechanical strength; 3-D architecture and cell incorporation; engineered tissues for replacing bone, cartilage, tendons, ligaments, skin, liver, pancreas.	6
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
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<b>1</b>	Lanza, R.P., Langer, R. and Vacanti, J., "Principles of Tissue Engineering", Academic Press.	<b>2007</b>
<b>2</b>	Lanza R., "Essentials of Stem Cell Biology", 2nd Edition. Academic Press	<b>2009</b>
<b>3</b>	I. A. Freshney., "Culture of Animal Cells", Academic Press	<b>2010</b>
<b>4</b>	Atala, A., Lanza R., Thomson J. A., "Principles of Regenerative Medicine", Elsevier Inc.	<b>2010</b>

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 473** Course Title: **Phytomedicine**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE:0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **DHC** 8. Pre-requisites: **Nil**

9. Objective: To impart knowledge of plant based medicine, emerging technologies and case studies on the subject of phytomedicine.

10. Details of Course:

S. No.	Contents	Contact Hours
1	History of phytomedicine. Taxonomy, Morphology and Ecology of Medicinal plants: a botanical perspective. Economic value of phytomedicine.	5
2	Bioactive compounds in phytomedicine. Role of plant-derived compounds in drug development. Different classes of plant Secondary metabolites as a source of phytomedicine.	7
3	Selecting medicinal plants for development of phytomedicine and use in primary health care; bioactive phytocompounds and products traditionally used in India and Asia. Recent developments in drug discovery from plants. Examples of plant-derived compounds currently involved in clinical trials Phytomedicine: India's contribution.	5
4	Medicinal plant: molecular biology and Biotechnology approaches. Breeding and cultivation of medicinal plants, quality issues of current herbal medicines.	5
5	Development of phytomedicine; extraction, sample preparation, application of all available modern, high-tech methods to standardize phytomedicines before going for systematic pharmacological investigations and clinical studies. Quality control, screening, toxicity, and regulation of herbal drugs.	8
6	Application of phytomedicine in modern drug development. Molecular modes of action of some successful molecules used in phytomedicine, phyto-complexes versus single-entity drug, bioavailability issue. Drug delivery system for herbal-based therapeutics	5
7	Methods for testing the anti-microbial, anti-cancer, anti-HIV, anti-diabetic, and neuroprotective activities of plant extracts. Reverse pharmacology approach for Phytomedicine development.	7
Total		42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Iqbal Ahmad, Farrukh Aqil, Mohammad Owais: Modern Phytomedicine: Turning Medicinal Plants into Drugs. (Wiley)	2006
2	Leland J. Cseke; Ara Kirakosyan, Peter B. Kaufman, Sara Warber; James A. Duke; Harry L. Brielmann: Natural Products from Plants, 2 <sup>nd</sup> edition; (CRC Press)	2006
3	Naturally Occurring Bioactive Compounds, 1st Edition (Advances in Phytomedicine vol 3). Edited by Rai & Carpinella. Publisher: Elsevier Science; 1 edition (December 2, 2006)	2006
4	Stephen Neidle, Antony D Buss, Mark S Butler: Natural Product Chemistry for Drug Discovery; 1 <sup>st</sup> Edition; (Royal Society of Chemistry).	2009
5	Chemistry and Pharmacology of Naturally Occurring Bioactive Compounds. Editor, Goutam Brahmachari. Publisher: CRC Press; 1 edition (February 20, 2013)	2013

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 474** Course Title: **Advanced Virology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE:0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **DHC**      8. Pre-requisites: **Nil**
9. Objective: To impart knowledge of the principles and applications of virology, their role in disease pathogenesis, antivirals, vaccines and applications of viruses.

10. Details of course:

S. No.	Contents	Contact Hours
1	<b>Introduction:</b> History and origin of viruses. General characteristics and structural components of virus: viral proteins, nucleic acids, lipids, carbohydrates and genome	3
2	<b>Viral Taxonomy:</b> Classification and nomenclature of different groups of viruses infecting microbes, plants and animals	3
3	<b>Animal viruses:</b> DNA virus transcription and replication, Positive-strand RNA virus replication, Negative-strand RNA virus replication, dsRNA viruses, Regulation of retrovirus replication	6
4	<b>Bacteriophages:</b> Replication and regulation, classification, lytic and lysogenic phages (lambda and P1 phage), regulation of transcription in lambda phage and applications of bacteriophages. Plant viruses. Insect viruses: Baculoviruses	5
5	<b>Oncogenic viruses:</b> DNA and RNA tumor viruses. Oncogenes, protooncogenes and tumor suppressor genes. Molecular mechanisms of activation of proto-oncogenes	3
6	<b>Viral multiplication and replication strategies:</b> Attachment, penetration, uncoating, replication, assembly, maturation and release of virions. Replication strategies of viruses	6
7	<b>Viral diseases:</b> Prevention and control, antiviral compounds, interferons, structure based drug designing and screening for antivirals, mechanisms of action, replicons, vaccines, pseudoviruses, chimericviruses, antiviral libraries, antiretrovirals—mechanism of action, drug resistance.	7
8	<b>Applications of Virology:</b> Uses of viral vectors: recombinant DNA technology, gene therapy and development of vaccines, viral nanoparticles, drug delivery, biological warfare.	9
<b>Total</b>		<b>42</b>

11. Books suggested:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Fundamental Virology: Fields and Knipe, ed. Raven Press	1991
2	Flint, S.J., Enquest, L.W., Krug, R. M., Racaniello, V. R., and Skalka, A. M., "Principles of Virology: Molecular Biology, Pathogenesis and Control", ASM Press.	2000
3	Strauss, E. G. and Strauss, J. H., "Viruses and Human Disease", Academic Press	2002
4	Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Elsevier Health Sciences.	2003
5	Paul F. Torrence., (Editor), "Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats", Wiley, John & Sons, Incorporated	2005
6	Matthews., "Plant Virology", Academic Press	2013

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 475** Course Title: **Enzyme Technology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE:0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **DHC**      8. Pre-requisites: **Nil**
9. Objectives: This course is designed for familiarising students with basic idea of enzyme kinetics, immobilization kinetics, immobilized reactor and varied applications of enzymes

**10. Details of Course:**

S.No.	Contents	Contact Hours
1.	Introduction to enzyme catalysis, nomenclature, class, specificity, Single substrate enzyme kinetics, effects of environmental parameters, inhibition	9
2.	Bi-substrate enzyme kinetics, enzyme co-operativity, allosteric inhibition, various co-operativity models	9
3.	Interfacial enzyme kinetics, Metabolic regulation and control analysis	10
4.	Immobilization techniques and kinetics, Immobilized reactors	8
5.	Applications of enzymes in process industry, enzymes in organic solvents, extremozymes	6
	<b>Total</b>	<b>42</b>

**11. Suggested Books :**

S.No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Palmer, T., "Understanding Enzymes" 4 <sup>th</sup> Edition Prentice Hall	1995
2	Shuler, M.L., and Kargi, F. Bioprocess engineering: Basic concepts 2 <sup>nd</sup> Edition, Prentice Hall	2001
3	Marangoni, A., J., "Enzyme kinetics : A Modern Approach" Wiley & Sons	2003
4	Doran, P.M., "Bioprocess engineering Principles" 2 <sup>nd</sup> Edition Academic press	2012



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT- 476** Course Title: **Protein Crystallography**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **DHC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of macromolecules crystallization, X-ray crystallography and tools for solving the three dimensional structures of macromolecules by X-ray crystallography.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of macromolecular crystallography, principles of macromolecules crystallization	4
2.	Crystallization techniques and crystal preparation	3
3.	X-ray sources and detectors, X-ray diffraction by a crystal, scattering, reciprocal lattice and Ewald construction	7
4.	Crystal symmetry, point groups, crystal system and Bravais lattices, space group determination	6
5.	Crystal mounting and data collection, crystal orientation matrix, indexing and data reduction	6
6.	Data processing: AutoMar, HKL2000 and MOSFLM software packages	4
7.	Fourier transforms, phase problem and structure determination	6
8.	CCP4, MOLREP, PHASER, PHENIX, PYMOL and COOT software packages	6
	<b>TOTAL</b>	<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1.	McPherson, A., "Crystallization of Biological Macromolecules, first edition", Cold Spring Harbor Laboratory Press.	1999
2.	Ducruixand, A., Gieg'e,R., "Crystallization of Nucleic Acids and Proteins: A Practical Approach", 2 <sup>nd</sup> edition,Oxford University Press, USA.	2000
3.	Drenth, J., "Principles of Protein X-ray Crystallography", II edition, Springer.	2000
4.	Rhodes, G., "Crystallography made crystal clear". II <sup>nd</sup> edition, Academic	2000

	Press, Inc. USA.	
5.	McPherson, A., "Introduction to Macromolecular Crystallography", Wiley-Liss,	2002

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 477** Course Title: **Biomedical Optics and Biophotonics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **DHC** 8. Pre-requisites: **Nil**
9. Objective: To impart knowledge about the emerging field of biophotonics and the application of optical based technologies in the field of biosensing, imaging etc.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Light – matter interaction, fundamental nature of light, Basics of structure and function of living materials, Process of light interaction with matter, Types of light sources	5
2	Interaction of light with cells and tissues- Components that interact with light, light absorption in cells, light induced cellular processes, Interaction of light with tissues- absorption, scattering, tissue optical properties, light induced processes in tissue, radiative transport theory	7
3	Optical Spectroscopy: Fluorescence spectroscopy, Raman spectroscopy, CARS, fluorescence detection and quantification of nucleic acids, proteins and cells, Optical activity and circular dichroism	6
4	Basic principles of lasers, Lasers relevant to biophotonics, Time resolved studies	5
5	Optical imaging- Background and need for optical imaging, Different optical imaging techniques, Microscopy –Simple, compound, Fluorescence microscopy, confocal microscopy, Optical tomography, Spectral and time resolved imaging- fluorescence resonance energy transfer (FRET), fluorescence life time imaging (FLIM)	8
6	Optical biosensing- principle, fiber optic biosensors, , surface Plasmon resonance biosensors, Applications of Bioimaging- endogenous and exogenous fluorophores, tissue imaging, in vivo imaging. Microarray technology for analysing bio samples, flow cytometry-optical diagnostic technique, Light for therapy and treatment, optical tweezer, laser scissor	9
7	Bio nanophotonics - major areas of nanophotonics, semiconductor quantum dots for bioimaging	2
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	T. Vo-Dinh ed., "Biomedical Photonics Handbook", CRC Press Optics	2002
2	E. Hecht, "Optics", Addison-Wesley	2002
3	Paras N. Prasad, "Introduction to Biophotonics", Wiley & Sons.	2003
4	Joseph R Lakowicz , "Principles of fluorescence spectroscopy", Springer	2006
5	Bahaa Saleh and Malvin Teich, "Fundamentals of Photonics", Wiley & Sons	2007
6	Splinter R, and Hooper BA, "An Introduction to Biomedical Optics", CRC Press, Taylor and Francis	2007

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 478** Course Title: **Protein NMR**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **DHC**      8. Pre-requisites: **Nil**
9. Objective: To impart in depth knowledge of NMR methodologies that are essential to unravel protein structure-dynamics-folding-function paradigms.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Basic concepts of solution NMR spectroscopy and NMR spectrometer, Principles of 1D and 2D homonuclear and heteronuclear protein NMR and insights into basic structural characteristics of proteins	9
2	Labeling strategies for producing isotopically enriched proteins using bacterial cell cultures.	4
3	Theory and applications of solution state NMR Triple resonance (3-Dimensional/4-Dimensional) experiments for protein backbone, side chain assignment and structure determination of proteins and their complexes	9
4	Principles of NMR relaxation measurements, understanding protein dynamics and allostery using solution state NMR	6
5	NMR analysis of protein folding energy landscapes, stability, kinetics and thermodynamics of protein-ligand interactions.	6
6	TROSY based NMR methodologies for studying structure and dynamics of large proteins/macromolecular complexes. In-vivo protein NMR and solid state protein NMR	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Wüthrich K "NMR of Proteins and Nucleic Acids" 2 <sup>nd</sup> edition, (Baker Lecture Series)/ John-Wiley.	1986
2	James, T.L., Dotsch, V., and Schmitz, V. Nuclear Magnetic Resonance of Biological Macromolecules, Part B, Volume 339: Methods in Enzymology. Elsevier	2001
3	Cavanagh, J., Fairbrother, W.J., Palmer III, A.J., Skelton, N.J., and Rance M. "Protein NMR Spectroscopy: Principles and Practice" 2 <sup>nd</sup> edition, Academic Press	2005
4	James, T.L. "Nuclear Magnetic Resonance of Biological Macromolecules" Part C, Volume 394: Methods in Enzymology. Elsevier/Academic Press	2005
5	Rama Krishna, N., and Berliner, L.J., "Protein NMR for the Millennium (Biological Magnetic Resonance)", Springer, 2003 edition	2007
6	Keeler J. "Understanding NMR Spectroscopy" 2 <sup>nd</sup> edition, Academic Press	2010

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE :Department of Biotechnology**

1. Subject Code: **BT- 341** Course Title: **Gene Regulation**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To provide information about the various mechanisms of gene regulation in bacteriophages, prokaryotes and eukaryotes.
10. Details of Course:

S. No.	Particulars	Contact Hours
1	Introduction to gene, genome and different concepts and aspects of gene regulation process, brief introduction about gene expression in prokaryotes and eukaryotes, cis- and trans-regulatory elements and regulatory factors	5
2	To understand the difference between prokaryotic and eukaryotic genetic material, types of genes and other organelle genomes, Tissue specific expression of messenger RNAs and proteins	5
3	Transcriptional regulation in Bacteria; Operon concept, Riboswitches, Translational and post-translational regulation in bacteria	6
4	Viral gene regulation with special emphasis on bacteriophage life cycle	4
5	Gene regulation at transcription in eukaryotes; chromatin structure, DNA sequence elements, transcriptional factors, riboswitches	6
6	Post-transcriptional regulation in eukaryotes, alternative splicing, miRNAs, siRNAs	6
7	Gene regulation at translation; regulation at 5' Cap, Cap-independent translation and gene regulation, post-translational protein modifications and proteolysis	5
8	Current research activities and methods in the study of gene regulation, Application and future prospects of gene regulation studies	5
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication / Reprint
1	Latchman, D. S., "Gene Regulation: An Eukaryotic Perspective", 4th, Ed., Chapman and Hall.	2003
2	Jun, M.A., "Gene Expression and Regulation", Springer Verlag.	2005
3	Jeffery, W., "Post Transcriptional Gene Regulation", Humana Press.	2008
4	Lewin's GENES XII by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick	2017

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 342** Course Title: **Food Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To provide comprehensive picture of applications and basics of biotechnology in food sector.

**10. DETAILS OF COURSE:**

S. No.	Contents	Contact Hours
1.	Introduction, general background (History and evolution of food biotechnology) Compositional, nutritional and technological aspects of plant, animal foods	3
2.	Background, status of nutraceuticals and functional food market, definitions, difference between nutraceuticals and functional foods, types of nutraceutical compounds and their health benefits, current scenario Nutraceuticals. Types of nutraceutical compounds – Phytochemicals, peptides and proteins, carbohydrates, prebiotics, probiotics and synbiotics, their sources and role in promoting human health.	8
3.	Fermented foods – Food Fermentations, Fermentation – definition and types, Microorganisms used in food fermentations, Dairy Fermentations Probiotic properties, their health benefits and role in conditions like cardiovascular diseases, hypertension, diabetes etc. Future prospects of functional foods and nutraceuticals and their potential for use in improving health, Food spoilage: (a) By pathogens (b) By oxidation. Food as a substrate for microorganism, factors affecting growth of microbes, Types of foodborne infections, foodborne toxins.	8
4.	Types of food processing: Refining and Milling, Canning, Concentration, Freezing, Drying, Pasteurization and sterilization, Fermentation, Irradiation, Packaging, Ethnic Fermented Foods – types, examples, Classical and Modern methods to study ethnic fermented food microbiology. Food preservatives	7
5.	Food packaging: Objectives of packaging, flexible packaging, properties of the packaging materials, Smart packaging. Antimicrobial food packaging. Role of nanotechnology in food packaging.	6
6.	Food Biotechnology market, innovation and upcoming trends in food industry. Major global and country players in food sector. Food safety, food laws and Standards – FSSAI and FDA regulations.	6
7.	Recent concerns - New and Emerging Pathogens, Genetically modified foods \ Transgenics, Organic foods, Newer approaches to food safety	4
<b>Total</b>		<b>42</b>



11. Suggested Books:

S.No.	Book Title	Year of Publication / Reprint
1	B. Srilakshmi, Food science, New Age Publishers,2002	2002
2	Frazier WC and Westhoff DC, Food Microbiology, TMH Publication, New Delhi, 2004	2004
3	Ramaswamy H and Marcott M,Food Processing Principles and Applications CRC Press,2006	2006
4	Forsythe,S.J.The Microbiology of Safe Food , second edition, Willey-Blackwell,U.K.,2010	2010
5	Roday,S. Food Science, Oxford publication, 2011.	2011
6	Nanotechnology Applications in Food -1st Edition, Flavor, Stability, Nutrition and Safety- Editors: Alexandru Grumezescu Alexandra Oprea. Academic Press	2017
7	Food Microbiology and Biotechnology – Ed-uadalupe Virginia Nevárez-Moorillón, Arely Prado-Barragan, et al.CRC Press.	2020

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT - 343** Course Title: **Virology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To emphasize understanding of the basic concepts of virology, a rapidly developing and important subject from biomedical technology perspectives. The course gives comprehensive introduction to the fundamentals of virology.

10. Details of course:

S. No.	Contents	Contact Hours
1	Introduction to basic virology, Brief history and recent outbreaks of viral pandemics and epidemics; Basic strategies to prevent, control and combat viral diseases;	3
2	DNA viruses: ds DNA and ss DNA; Their replication strategies eg	6
3	RNA viruses: ds RNA viruses, +ss RNA viruses, -ss RNA viruses; +SS RNA via DNA viruses: replication strategies of each eg	12
4	Viral pathogenesis and transmission: Virus-host interactions, Host range and tissue tropism; Acellular antiviral response, immune response, host signaling and molecular-interaction networks, and the role of host genetics in determining disease outcome.	5
5	Virological methods: Cultivation of viruses in cell culture and animals; Quantification of viruses, virus purification strategies. Virus like particles, Chimeric viruses, Pseudo viruses, Mini viral genomes, Purification of viral replication complexes and viral proteins.	6
6	Viral disease diagnostics: virus neutralization assays, western blot, RIPA, flowcytometry and immunohistochemistry, viral genome based diagnosis; Electron microscopy; Biosafety levels for viruses, risk groups for viruses, handling and transport of clinical samples containing infectious viruses and handling of viruses etc	4
7	Antiviral targets and antivirals; immunotherapies and viral vaccines Structural biology and computational biology: development of antiviral therapeutics	4
<b>Total</b>		<b>42</b>

11. Books suggested:

S. No.	Author(s)/ Title/ Publisher	Year of Publication / Reprint
1	Concepts in Viral Pathogenesis; Editors A. L. Notkins; M. B. A. Oldstone; Copyright 1984; Publisher Springer-Verlag New York	1984
2	Fundamental Virology: Fields and Knipe, ed. Raven Press	1986
3	Basic Virology, 3rd Edition; Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini ISBN: 978-1-405-14715-6; Wiley-Blackwell	2007
4	Principles of Virology Authors: S. J. Flint, L. W. Enquist, V. R. Racaniello, A. M. Skalka, Edition: Third Edition Publisher: ASM Press ISBN-13: 978-1555814434	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE:**Department of Biotechnology

1. Subject Code: **BT- 344** Course Title: **Nano-Bioengineering**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge about nanoscale physical and biological systems and their applications in biology and medicine.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to nanotechnology and nanobiotechnology	3
2	Introduction to Nanostructures: Carbon Nanotubes (CNT), Fullerenes (C60, C300), Quantum Dots and Semiconductor Nanoparticles, Metal-based Nanostructures (Iron Oxide Nanoparticles), Nanowires, Polymer-based Nanostructures (Dendrimers), Biogenic Nanoparticles	8
3	Introduction to Nanostructures: Gold and Silver Nanostructures: (Nanorods, Nanocages, Nanoshells), Protein-based Nanostructures: Nanomotors: Bacterial (E.coli)	7
4	Nanobiosensors: Science of Self-assembly -From Natural to Artificial Structures	5
5	Nanoparticles in Biological Labeling and Cellular Imaging: Science of Nanoparticles Functionalization	5
6	Nanotechnology Meets Detection: Rapid diagnostics with nanoparticles, molecular beacons	6
7	Medical and food Applications: Nanoparticles' Cytotoxicity	3
8	Applications of Nanostructures in Drug: Discovery, Delivery, and Controlled Release, Nanostructures in Cancer Research: examples of Nanostructures in Research and Therapy.	5
	<b>Total</b>	<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Christof M. Niemeyer, Chad A. Mirkin, "Nanobiotechnology: Concepts, Applications and Perspectives", VCH Verlag GmbH & Co.	2004
2	Chad A. Mirkin, Christof M. Niemeyer, "Nanobiotechnology II: More Concepts and Applications", VCH Verlag GmbH & Co.	2007
3	Nanobiotechnology : NPTEL Course (IIT Roorkee) <a href="http://nptel.ac.in/courses/118/107/118107015">http://nptel.ac.in/courses/118/107/118107015</a> Co-ordinators: Dr. N K Navani and Dr. R P Singh	2013
4	Nanobiotechnology : NPTEL Course (IIT Madras) <a href="http://nptel.ac.in/courses/118/106/118106019">http://nptel.ac.in/courses/118/106/118106019</a> Co-ordinators: Dr. K. Uma Maheshwari	2013
5	Clive Jarvis, "Nanobiotechnology: An Introduction", Larsen and Keller Education Publishers	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BTN-345** Course Title: **Separation and Analysis of Biomolecules**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To emphasize and give knowledge of techniques used for isolation and purification and characterization of nucleic acid and proteins.

10. Details of course:

S.No	Contents	Contact Hours
1	Brief introduction to Biomolecules, Chemical properties of biomolecules, native conformation of proteins, application of purified molecules	3
2	Sedimentation, centrifugation, preparative centrifugation, density gradient separation: discontinuous, continuous; analytical ultracentrifugation, suspension and disruption methods	7
4	Precipitation methods: precipitation with salts, organic solvents, Non-ionic hydrophilic polymers, polyelectrolytes, isoelectric point precipitation, immuno-precipitation,	5
5	Electrophoresis methods: gel electrophoresis, agarose, PAGE, vertical electrophoresis, horizontal Electrophoresis, 2D gel electrophoresis, denaturing, non-denaturing and reducing gels, immuno-electrophoresis, pulse field electrophoresis, isoelectric focusing, isotachopheresis affinity electrophoresis, capillary electrophoresis, electroblotting, methods for staining and visualization of molecules, Silver staining of biomolecules.	10
6	Principles and applications of chromatography: gelfiltration chromatography, ion-exchange chromatography, hydrophobic interaction chromatography, affinity chromatography, immuno affinity chromatography, affinity tags and applications, IMAC chromatography, HPLC, gas chromatography, paper and thin layer chromatography.	10
7	High throughput purification and application in structural genomics	4
8	Filtration, membrane filtration, ultrafiltration, dialysis, evaporation, crystallization, Methods of protein, DNA, RNA concentration.	3
<b>Total</b>		<b>42</b>

11. Books suggested:

S No.	Author(s)/ Title /Publisher	Year of Publication/ Reprint
1	Willard H.H., Merritt L.L., Dean J.A. and Settle F. A., "Instrumental Methods of Analysis", Wadsworth Publishing Co USA	1986
2	Dechow F., "Separation and Purification Techniques in Biotechnology", Elsevier	1989
3	Schweitzer P. A., "Handbook of Separation Techniques for Chemical Engineers", McGraw-Hill Professional	1996
4	Wilson K. and Walker J., "Practical biochemistry: Principles and Techniques", Publisher Cambridge University Press	2000
5	Scopes R. K., "Protein purification: Principles and practice", Springer	2005

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-346** Course Title: **Drug Discovery**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To provide basic understanding of the principles of design and discovery of drugs using various disciplines of biotechnology

10. Details of Course:

S. No.	Contents	Contact Hours
1	Drug target classification – DNA, RNA, post- translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors, small molecule receptors, transporters.	8
2	Molecular basis of Drug discovery- Molecular properties, geometries, Stereochemistry, Medicinal chemistry, natural products, small molecules and High throughput screening, Target discovery and validation strategies, Combinatorial chemistry.	9
3	Molecular basis of Drug action- Drugability, drug targets, receptor targets, drug receptor theories, and enzyme targets.	8
4	Structure activity relationship, toxicity, efficacy, pharmacokinetics and pharmacodynamic parameters of drugs, pre-clinical trials, clinical trials	9
5	Drug discovery in global market- development of drug resistance, efflux mechanisms, enzymatic modifications, multiple drug resistance in pathogens, strategies to overcome drug resistance.	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Christopher Walsh, "Antibiotics: Actions, Origins, Resistance"	2003
2	Silverman, R.B., " The organic chemistry of drug design and action", Elsevier, New York	2004
3	Brahmankar, D.M. and Jaiswal, S.B. (2009) Biopharmaceutics and Pharmacokinetics. 2nd Edition	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 347** Course Title: **Bioprocess Control**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objectives: To impart the knowledge of the control aspects of the process engineering and integrating various process schemes and control loop interactions.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Laplace transformation, transformation of standard function, open loop systems, first order systems, transient response, input functions, linearization, first and second order system and dynamics, transfer functions of bioreactor and dynamics.	8
2.	Closed loop control system, block diagram, servo and regulator problem, Transfer functions for controllers. Transient response, lag, closed loop control	8
3	State space model: Introduction, state variables, matrix algebra, transfer function matrix, multivariable control	6
4	Controller mechanism, proportional controller, PI, PD and PID controller. Introduction to advanced control system, feed forward control, introduction to microprocessor and computer control of bioprocesses, application in bioprocess control.	8
5	Stability: Concept, definition of stability, stability criterion, Routh test for stability	4
6	Frequency response closed loop systems, design by frequency, Bode diagram, stability criterion, Nyquist diagram. Tuning.	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Luyben, W.L., "Process Modeling, Simulation and Control for Chemical Engineers", 2 <sup>nd</sup> Ed, Mc.Graw-Hill International	1990
2.	George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd	1990
3.	Eckman, D.P., "Industrial Instrumentation", Wiley Publications	2004
4.	Coughanowr D.R., "Process System Analysis and Control", 3 <sup>rd</sup> Ed., McGraw Hill.	2017

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE:**Department of Biotechnology

1. Subject Code: **BT- 348** Course Title: **Bioprocess Modeling and Simulation**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage : **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the concepts of mathematical modeling of bioprocesses and thereby parameter estimation, testing and model validation.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Introduction, dimensionless models. General form of linear systems of equations, nonlinear function	3
2	State space models for linear and nonlinear models, solution of general state-space form, solving homogeneous, linear ODEs with distinct and repeated Eigenvalues, solving non-homogeneous equation with time varying parameter, Routh	8
3	Transfer function, lead-lag models, transfer function analysis of higher order systems, pole location, padé approximation for dead time, converting transfer function model to state space form	7
4	Block diagrams , system in series, pole-zero cancellation, block in parallel, feedback system, Routh stability criterion transfer functions, discrete time models and parameter estimation, phase plane analysis, nonlinear system, nonlinear dynamics, cobweb diagram, bifurcation and orbit diagram, stability cascade of period doubling	12
5	Case studies, stirred tank heaters, developing the dynamic model, steady state condition, state space model, dynamic model, steady state analysis, isothermal continuous stirred tank chemical reactors, biochemical reactors: model equation, Steady-state function, dynamic behavior, linearization, phase analysis, multiple steady state, bifurcation behavior	12
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Luyben, W. L., "Process Modeling, Simulation and Control for Chemical Engineers", 2 <sup>nd</sup> ed., McGraw-Hill international	1990

<b>2</b>	Wayne Bequette, B., "process Dynamics, Modeling, Analysis and Simulation", Prentice Hall	<b>1998</b>
<b>3</b>	Schugerl, K. and Bellgardt, K.H., "bioreaction Engineering, Modeling and Control", Springer-Verlag	<b>2000</b>
<b>4</b>	Nielsen, J. and Villadsen, J., "Bioreaction Engineering Principles", 2 <sup>nd</sup> Ed., Kluwer Academic/ Plenum publisher	<b>2003</b>



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT- 349** Course Title: **Biomechanics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objectives of Course : To impart knowledge of basic concepts and broad overview of biomechanics with applications in areas of musculoskeletal, cardiovascular, sports, injury, and cellular biomechanics, biomedical engineering.
10. Details of Course:

S. No.	Particulars	Contact Hours
1	<b>Introduction to Biomechanical Analysis:</b> Mathematical overview, Forces and moments, Statics, Kinematics and kinetics, Levers and fulcrum	03
2	<b>Fundamentals of Solid Mechanics:</b> Stress and strain, Material properties, loading of axial bars, Tension, Compression, Shear, Material testing and fracture, Effect of bending and torsion, Buckling of column, Measurement of Kinematics and Kinetics of motion, Experimental techniques to characterize motion of biological tissues	06
3	<b>Biomechanics of Joints:</b> Classification and structure of human joints, Joint motion mechanics, Factors influencing joint motion.	04
4	<b>Biomechanics of Hard Tissues - Bone:</b> Introduction to bone biology and structure, Mechanical properties of bone, Change in mechanical properties with age and activity, Constitutive relations - elastic, plastic.	05
5	<b>Biomechanics of Soft Tissues - Skeletal Muscle, Cartilage, Tendons and Ligaments:</b> Structure of Muscle, Cartilage, Tendons and Ligaments, Functionality of soft tissues in movements, Mechanical properties of soft tissues, Constitutive relations for soft tissues (Hyperelastic and viscoelastic), Effect on body movements.	05
6.	<b>Cell Biomechanics:</b> Cell mechanics and its role in human disease diagnosis, adhesion, mechanotransduction, and mechanobiology, cellular contractility and extracellular vesicles, cell motility, interaction with microenvironment, computational and experimental methods in cellular mechanics	06
7	<b>FEM: Tool for Biomechanics Analysis:</b> Introduction to Finite Element Analysis, Basic mathematical formulation, Application of FEA, Introduction of commercial software for FEA.	06
8	<b>Case Study:</b> Musculoskeletal, cardiovascular, Sports, Injury, Cellular Biomechanics, Tissue Engineering, Biomechanics in nature (e.g., flight mechanics in birds, plant biomechanics), Biomimetics	06
9	<b>Biomechanical analysis using computational or experimental mechanics:</b> Short projects assigned to small group of students. Presentation to be attended by the whole class.	-
<b>Total</b>		<b>42</b>

11. Suggested Books:

<b>S. No.</b>	<b>Name of Books / Authors / Publisher</b>	<b>Year of Publication</b>
<b>1</b>	Y.C. Fung, Biomechanics: Mechanical Properties of Living Tissues, Springer	1993
<b>2</b>	D J Schneck, J D Bronzino: Biomechanics – Principles and Applications, CRC Press	2003
<b>3</b>	C A Oatis, Kinesiology: The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins	2004
<b>4</b>	J N Reddy, An Introduction to the Finite Element Method, Tata McGraw Hill publishing Company Limited	2005
<b>5</b>	F P Beer, E R Johnston, J T DeWolf and D F Mazurek, Mechanics of Materials, Tata McGraw Hill publishing Company Limited	2014

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE:**Department of Biotechnology

1. Subject Code: **BT- 350** Course Title: **Machine Learning and Deep Learning**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **3**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart knowledge of Machine Learning and Deep learning algorithms, hands-on experience with using Python and exposure to applications in computational biology and bioinformatics by discussion around published research.
10. Details of course:

S. No.	Contents	Contact Hours
1.	Introductio to Machine Learning. Python Foundation: Python Basics, handling data using numpy, pandas. Introduction to package sklearn, Data visualization in Python	3
2.	Supervised Machine Learning: Classification (kNN), Handling data for building models, train/validation/test data split, model evaluation, Cost Function, Model Evaluation	4
3.	Supervised learning techniques: Linear Regression, Decision trees, Random Forest, Support Vector Machines, Applications in computational biology and bioinformatics	6
4.	Neural Networks: Basic Intuition, representation, learning (back propagation), Some basic neural networks and their use in Biology	6
5.	Introduction to Fully Connected Networks, Convolutional Neural Networks	6
6.	Practical Aspects of Deep Learning, Optimization algorithms and Hyperparameter tuning, Using Python package (keras) to develop basic networks to have hand on experience with neural networks, Real world deep learning examples, Recurrent Neural Networks	6
7.	Unsupervised Machine Leaning: Clustering Methods (k-means, Hierarchical, DBSCAN)	4
8.	Dimension Reduction: PCA, t-SNE, Autoencoders and Decoders	4
9.	Relevant algorithms: GANs, Hidden Markov Models. Paper examples using various algorithms discussed in the course.	3
<b>Total</b>		<b>42</b>

11.Recommended Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Tom M. Mitchell, "Machine Learning" (McGraw-Hill)	1997
2.	Pierre Baldi and Soren Brunak, "Bioinformatics: The Machine Learning Approach" 2 <sup>nd</sup> Edition (The MIT Press)	2001

3.	Christopher M. Bishop “Pattern Recognition and Machine Learning” Springer	2006
4.	Kevin Murphy, “Machine Learning: A Probabilistic Approach” 1 <sup>st</sup> Edition (The MIT Press)	2012
5.	Ian Goodfellow, YoshuaBengio and Aaron Courville, deeplearningbook.org (MIT Press)	Online book

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT- 351** Course Title: **Protein Engineering**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objectives: To impart the knowledge of recent advantage in protein folding and function, chemical synthesis of peptides and proteins, site- directed mutagenesis, de novo protein design and protein engineering.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Protein synthesis, protein structure, protein function and structure-function relationships.	4
2.	Identification of putative enzymes in sequence databases, bioinformatic analysis.	4
3.	Isolation of genes from host organisms, cloning, preparation of recombinant proteins, host organisms, protein expression and protein purification.	6
4.	Structural characterization of proteins, an overview of spectroscopic techniques for the analysis of protein secondary and tertiary structure; an overview of techniques for analysis of protein quaternary structure.	8
5.	Enzymes, enzyme catalysis, factors influencing the speed of enzymatic reaction, Enzyme applications, targets of protein engineering, protein engineering approaches, advantages and limitations.	8
6.	Rational design, prediction of the structure of enzyme variant, evaluation of the effect of mutations on enzyme structure and function, Directed evolution, screening of mutants	6
7.	Examples of application of protein engineering to improve- enzyme catalytic efficiency, enzyme stability, enzyme enantioselectivity.	6

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Moody, P.C.E, and Wilkison, A.J., "Protein Engineering", IRL, Press	1990
2	Braden, C. and Trooze, J., "Introduction to protein structure", Galland Publishing.	1999
3	Voet, D. and Voet, G., "Biochemistry", John Wiley Sons.	2001
4	Park S. J. and Cochran J.R., "Protein Engineering and Design" CRC Press, 1 <sup>st</sup> Edition	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT – 352** Course Title: **Biophotonics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart knowledge about the emerging field of biophotonics and the application of optical based technologies in the field of biosensing, imaging etc.

**10. Detail of Course:**

S. No.	Contents	Contact Hours
1	Light and matter: - Fundamental nature of light, Basics of structure and function of living materials, Process of light interaction with matter, Types of light sources, Basic optics for light transmission.	5
2	Interaction of light with cells and tissues- Components that interact with light, light absorption in cells, light induced cellular processes, Interaction of light with tissues- absorption, scattering, tissue optical properties, light induced processes in tissue, radiative transport theory	7
3	Optical Spectroscopy: Fluorescence spectroscopy, Raman spectroscopy, CARS, fluorescence detection and quantification of nucleic acids, proteins and cells, Optical activity and circular dichroism.	6
4	Basic principles of lasers, Lasers relevant to biophotonics, Time resolved studies.	5
5	Optical imaging- Background and need for optical imaging, Different optical imaging techniques, Microscopy –Simple, compound, , Fluorescence microscopy, confocal microscopy, Optical coherence tomography, Spectral and time resolved imaging- fluorescence resonance energy transfer (FRET), fluorescence life time imaging (FLIM).	8
6.	Applications of Bioimaging- endogenous and exogenous fluorophores, tissue imaging, in vivo imaging. Optical biosensing- principle, fiber optic biosensors, , surface Plasmon resonance biosensors	4
7.	Microarray technology for analysing bio samples, flow cytometry-optical diagnostic technique, Light for therapy and treatment, optical tweezer, laser scissor. Bio nanophotonics - major areas of nanophotonics, semiconductor quantum dots for bioimaging.	7
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	T. Vo-Dinh ed., "Biomedical Photonics Handbook", CRC Press Optics, E. Hecht, Addison-Wesley	2002

<b>2</b>	Paras N. Prasad, "Introduction to Biophotonics", Wiley & Sons	<b>2003</b>
<b>3</b>	Joseph R Lakowicz , "Principles of fluorescence spectroscopy", Springer	<b>2006</b>
<b>4</b>	Bahaa Saleh and Malvin Teich, "Fundamentals of Photonics", Wiley & Sons	<b>2007</b>
<b>5</b>	Splinter R, and Hooper BA, "An Introduction to Biomedical Optics", CRC Press, Taylor and Francis Group, Boca Raton	<b>2007</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT- 441** Course Title: **Principles of Synthetic Biology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the key technologies and their applications in the field of synthetic biotechnology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Biotechnology and Synthetic Biology – Structure of Nucleic acids, basic functions of nucleic acids, Synthesis of nucleic acids in-vitro. Introduction to iGEM community.	6
2.	Basics of Recombinant DNA technology and Genomics – rDNA technology and its application overview. Introduction to genetic circuits in natural systems; engineering principles in biology; BioBricks and standardization of biological components.	8
3.	Protein design/expression in prokaryotic cells – Basics of protein design, expressing foreign proteins in cells, overview of various expression systems. Use of synthetic biology in evolving proteins with customized functions.	8
4.	Synthetic biology: Biological components and circuits, novel organisms.	6
5.	Synthetic biology in microbial biotechnology – Synthetic regulatory elements, riboswitches, Design and selection of artificial gene switches.	6
6.	Application of synthetic DNA switches, toggles in therapeutics, environmental diagnostics, etc.	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1.	R. W. Old, S. B. Primrose, "Principles of Gene Manipulation: An introduction to Genetic Engineering", Blackwell Scientific Publication	1980
2.	J. Craig Venter, "Life at the Speed of Light: From the Double Helix to the Dawn of Digital Life", Penguin Books, New York	2014
3.	George M. Church, Ed Regis, "Regenesi: How Synthetic Biology will Reinvent Naure and Ourselves", Basic Books	2014
4.	Jamie A. Davies, "Synthetic Biology: A very Short Introduction", Oxford Press	2018



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 442** Course Title: **Environmental Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the biotechnological applications in waste treatment and biodegradation of various xenobiotic compounds using microorganisms.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Introduction, pollution monitoring, biotechnological treatment of waste, microorganisms and nutrient cycle in aquatic environments, waterborne infectious agents, detection and control of pathogenic microbes in water, sewage & sludge	8
2.	Wastewater treatment-activated sludge processes, wastewater treatment efficiency assessment	6
3.	Microorganisms in the soil environment, Phyllosphere, Rhizosphere and Rhizoplane microorganisms	6
4.	Sampling and analysis of Airborne microorganisms- fungi and mycotoxins, Airborne viruses	4
5.	Biotransformation and biodegradation of pollutants, methods for determining biodegradability	6
6.	Biodegradation of lignocelluloses, PAH, agricultural chemicals, Microbial Leaching	6
7.	Molecular biological techniques in the characterization of environmental populations of microorganisms, Emerging Technologies - bioreporters, biosensors and microprobes	6
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Metcalf & Eddy, INC, "Wastewater Engineering- Treatment, Disposal and Reuse, 3 <sup>rd</sup> Edition, Tata MacGraw-Hill publishing company Limited, New Delhi.	1995
2	Pickup R.W and Saunders J.R., "Molecular approaches to environmental microbiology", Ellis Horwood Limited, First Edition, UK.	1996
3	Scrugg, A," Environmental Biotechnology", First Edition, Pearson Education Limited,UK.	1999
4	Hurst, C.J., Crawford, R.L., Knudsen, G.R., MacInerney, M.J., Stetzenbach, L.D., "Manual of Environmental Microbiology", ASM press, Washington, DC, Second edition.	2002
5	Evans, G.M., Furlong, J C., " Environmental Biotechnology- Theory and application", John Wiley & Sons, Ltd, USA.	2003

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 443** Course Title: **Stem Cell Engineering**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of the most recent techniques used in understanding the basics of stem cells and their applications in cure and management of various human diseases.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Developmental Biology: principles and applications of developmental biology, early embryonic development, types of cleavage and mechanisms, gastrulation; cell fate determination.	6
2.	Concepts of stem cells: basic concepts and properties; totipotency; Pluripotency; embryonic stem (ES) cells; germinal stem cells; adult stem cells; tumor stem cells; stem cell plasticity; general methods of characterization of stem cells.	6
3.	ES cells: isolation of ES cells; salient features and application of ES cells; human and mouse ES cells; differentiation of ES cell; maintenance of ES in undifferentiated state.	6
4.	Stem cells and cloning: therapeutic and reproductive cloning; nuclear transfer methods; applications of nuclear transfer in ES cells; safety of nuclear transfer in ES cells.	6
5.	Hematopoietic, mesenchymal and neural Stem Cell (HSC) (MSC) and (NSC): identification and characterization of HSCs, MSCs and NSC; sources of HSC; mouse assay of HSC; HSC in leukemia and lymphoma; Clinical use of HSC; embryonic origin of MSC's, harvesting; isolation and characterization; Differentiation; NSC and Neural crest stem cell.	6
6.	Stem cell therapy and future of stem cell research: potential of stem cell therapy for various diseases like AIDS/HIV; alzheimer's disease; anaemia; multiple sclerosis; Parkinson disease; rheumatoid arthritis; injuries; cancer	6
7.	Tissue Engineering: introduction; structural and organization of various tissues like epithelial and connective; vascularity and angiogenesis; basic wound healing; cell migration; use in therapeutic and in-vitro testing, scaffold and transplant - Engineering biomaterials; degradable materials; porosity; mechanical strength; 3-D architecture and cell incorporation; engineered tissues for replacing bone, cartilage, tendons, ligaments, skin, liver, pancreas.	6
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Name of Books/Authors/publisher	Year of Publication/ Reprint
1.	Lanza, R.P., Langer, R. and Vacanti, J., "Principles of Tissue Engineering", Academic Press.	2007
2.	Lanza R., "Essentials of Stem Cell Biology" 2nd Edition. Academic Press	2009
3.	I. A. Freshney, Culture of Animal Cells, Academic Press	2010
4.	Atala, A., Lanza R., Thomson J. A., "Principles of Regenerative Medicine" Elsevier Inc.	2010

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT-444** Course Title: **Industrial Bioprocessing**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To provide the knowledge of scientific and industrial principles for the bioconversion of raw materials into value added products using microorganisms.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Selection of microorganism, screening for metabolites, strain improvement, industrial microorganisms	5
2.	Fermentation, raw materials for fermentation, submerged, surface and solid-state systems, bioreactor	6
3.	Production of organic acids and amino acids	6
4.	Production of antibiotics, polysaccharides, biosurfactants and applications	7
5.	Biofuels-butanol, ethanol, biodiesel and hydrogen; production process and factors regulating production.	6
6.	Production of enzymes from microbial sources, immobilized enzymes, industrial enzymes and applications	5
7.	Metabolic engineering, molecular approaches for improved and economical production of metabolites, downstream processing, economics, legislative and safety aspects	7
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication / Reprint
1.	Rehm, H. J. and Reed, G., "Biotechnology", VCH Publ.	1996
2.	Lee, S.Y. and Papoutsakis, E.T., "Metabolic Engineering", CRC press	1999
3.	Crueger, W. and Crueger, A., "Biotechnology: A Textbook of Industrial Microbiology", R. Oldenbourg Publ.	2000
4.	Ratledge, C. and Kristiansen, B., "Basic Biotechnology", Cambridge Univ Press	2003
5.	Okajor, N., "Modern Industrial Microbiology and Biotechnology" Science pull	2007
6.	Rhodes, A. and Fletcher, D.L., "Principals of Industrial Microbiology", Pergamon Press	2008

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT - 445** Course Title: **High Throughput Sequencing**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objectives: This course will provide details on next generation sequencing technology and its application in human health and disease.

10. Details of Course:

S. No.	Contents	Contact Hours
1	<b>Genome sequencing technology:</b> Introduction to high throughput biology, concept on next generation sequencing, brief overview to select and prepare samples for next generation sequencing.	4
2	<b>Platform used for high throughput sequencing:</b> Library constructions for Illumina, HiSeq and MiSeq next generation sequencing platform, single read, paired-end read, mate-pair, targeted resequencing technology.	6
3	<b>Genome sequencing project:</b> Overview on Human, Mouse, Drosophila and Arabidopsis genome sequence.	6
4	<b>RNA sequencing:</b> Preparation of mRNA library for sequencing. Removal of rRNA from samples. Isolation of small RNA (miRNA and piRNA ) from animal cells, small RNA sequencing and exome sequencing.	6
5	<b>Gene expression studies:</b> Multiplexed gene expression, miRNA expression, and copy number variation analysis. Genome wide association study, single nucleotide polymorphism. ChIP-seq, third generation sequencing.	8
6	<b>Protein sequencing:</b> Isolation and preparation of protein samples for sequencing. Comparative proteomics. Stable isotope labeling by amino acids in cell culture (SILAC) and isobaric tags for relative and absolute quantification (iTRAQ) method in proteomic research.	8
7	<b>Metagenomics:</b> Bacterial genome sequencing, Microbiome 16S rRNA sequencing, and barcode multiplexing.	4
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Campbell M., Heyer L. J., Discovering Genomics, Proteomics and Bioinformatics (2 <sup>nd</sup> Edition)", Benjamin/Cummings.	2006

<b>2</b>	Brown S.M., “Essential of Medical Genomics (2 <sup>nd</sup> edition)”, Wiley-Blackwell.	<b>2009</b>
<b>3</b>	Brown S.M., “Next-Generation DNA Sequencing Informatics”, Cold Spring Harbor Laboratory Press.	<b>2013</b>
<b>4</b>	Gorodkin J., Ruzzo W.L., “RNA Sequence-Structure and Function: Computational And Bioinformatic Methods”, Springer.	<b>2014</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 446** Course Title: **Chemical Genetics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart knowledge in the upcoming area of chemical genetics and synthetic biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to genetics, Forward genetics, Reverse genetics, Phenotypes, Target identification, biochemical methods. Introduction to Chemical genetics, Forward chemical genetics, Reverse chemical genetics	7
2.	Forward chemical genetics -Chemical libraries: target-oriented synthesis and diversity oriented synthesis. High throughput screening, Phenotype based screens. Target identification, biochemical approaches; 3-hybrid screens. Chemical approaches, labelling of small molecules, pull-down and cross-linking.	10
3.	Reverse chemical genetics- Relationship to "classical" drug discovery. Lead discovery; fragment based approaches. Diversity oriented synthesis. High throughput screening, high content screening, Small molecules, Small molecules as probes of cellular physiology	8
4.	Synthetic biology- Structure of operons, gene regulation in prokaryotes, promoters, Natural and synthetic promoters; attenuation and termination. Codon usage, RBS, small RNA, Principles of genome engineering.	9
5.	Functional nucleic acids - ribozymes, DNAzymes, aptamers, riboswitches and applications, small RNA and ribolocks, Assembly of synthetic genomes.	8
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Kubinyi, et al., ed., " Chemogenomics in drug discovery: A medicinal chemistry perspective". John Wiley and sons	2004
2.	Hisashi, K., "Reverse chemical genetics – methods and protocols", Springer protocols, Humana Press., ISBN 978-1-60761-231-5	2009
3.	Marechal, E., Roy, S., Lafanechere, L., " Chemogenomics and Chemical Genetics", Springer-Verlag Berlin and Heidelberg GmbH & Co. KG., ISBN: 9783642196140	2011
4.	George Church and Ed Regis "Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves" Basic Books; 1st edition, ISBN-10: 0465021751	2012
5.	Paul S. Freemont (Editor), Richard I. Kitney (Editor), "Synthetic Biology - A Primer", World Scientific Publishing; 1 edition, ISBN-10: 1848168632	2012

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 447** Course Title: **Genetically Modified Organism**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart in-depth knowledge about various genetically modified organisms engineered for improvement of resistance against biotic and abiotic stresses, nutritional quality and shelf life, production of pharmaceutical and industrial products.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	History of recombinant DNA and guidelines for research. Methods of Gene cloning and cloned genes, selectable markers and reporter genes.	9
2.	Promoters and transformation cassettes, transformation methods.	6
3.	Characterization of GMOs, toxicological and allergenicity assessment. Regulatory agencies and commercialization.	8
4.	GMOs for resistance against abiotic stresses, resistance against biotic stresses, improved nutritional quality and shelf life, engineered enzymes, proteins and pathways, pharmaceutical proteins.	12
5.	Gene therapy for congenital and other diseases. Risk assessment, IPRs and ethical issues.	7
	<b>Total</b>	<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Old, R.W. and primrose, S.B., "Principles of Gene Manipulation: An Introduction To Genetic Engineering", Blackwell Science Publications	1993
2	Sambrook, J. and Russel, D.W., "Molecular Cloning : A laboratory Manual", Cold Spring Harbor Laboratory Press	2001
3	Brown, T.A., "Gene cloning and DNA Analysis", Blackwell Science Ltd.	2001
4	Curiel, D.T. and Douglas, J.T., "Adenoviral Vectors for Gene Therapy", Academic Press	2002

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT-448** Course Title: **Vaccine Biotechnology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of various aspects of pathogens and the approaches used for the development of vaccines.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction - Basic concepts of antigen and antibody, Lymphoid organs, humoral and cell-mediated immunity, primary and secondary immune response, immunological memory	7
2	Vaccine – concepts and features of an ideal vaccine, conventional vaccines-live attenuated and non-living vaccines, modern vaccine technologies-recombinant live vaccines, subunit vaccines, peptide and nucleic acid vaccines.	8
3	Vaccine for Viral pathogens I - Hepatitis B virus, Influenza and swine flu virus and Polio virus: structure, mechanism of pathogenesis, treatment, approaches for designing of the vaccines	8
4	Vaccine for Viral pathogens II - HIV, Herpes simplex virus: structure of the pathogen, genome organization, pathogenesis, approaches for designing of vaccines	7
5	Pertussis toxin – structural and molecular features, chemical toxoids, recombinant DNA toxoids; Cholera toxin –molecular structure, pathogenesis and designing of the vaccine; Streptococcal and Rickettsial infections	6
6	Pharmaceutical aspects – production, formulation, characterization and storage of vaccines; regulatory and clinical aspects – phase I, II and III trials; safety and economics of vaccine production	6
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Bittle, J.A. and Murphy, F.L., "Vaccine Biotechnology", Academic Press	1989
2	Manuel, J.T.C., Griffiths, B. and Jose, L.P.M., "Animal cell Technology: From Vaccines to Genetic Medicine", Springer	1996
3	Ellis R.W., "Combination Vaccines: Development, Clinical Research and Approval", Humana Press	1999
4	Bloom, B., Bloom, B. R., Lambert, P.H., (2002 ) The Vaccine Book, Academic Press	2002



	Strategies”, Caister Academic Press	
<b>6</b>	Plotkin S.A., Orenstein W.A., Offit P.A., “Vaccines”, Saunders-publ.	<b>2012</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT- 449** Course Title: **Cell and Tissue Engineering**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of tissue engineering with special emphasis on the molecular basis of cellular function and interactions.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to tissue engineering, biomaterials for tissue engineering, biological study of different cell types, tissue structures, tissue modifications	10
2	Principles and practice gene therapy, musculoskeletal tissue engineering, scaffolds, their various physicochemical properties	8
3	Modification of tissues ring, tissue structure, tissues as scaffolds, classification of scaffolds, manufacture and processing of scaffolds	10
4	Receptor ligand interaction, receptor structures, types of receptors, biological functions of receptors	6
5	Development of artificial tissues, transplantation biology, immuno-rejection ,tissue grafting, tissue typing	8
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	Morgan, J.R. and Yarmush,M.L., "Tissue Enginerig Methods and Protocols", Humana Press	2000
2	Atala, A.,and Lanza, R., "Methods of Tissue Engineering", Academic Press	2001
3	Lanza, R.P.,Langer,R. and Vacanti,J., "Principles of Tissue Engineering", Academic Press	2007
4	Palsson, B.O. and Bhatia, S.N., "Tissue Engineering", Pearson Press.	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE:**Department of Biotechnology

1. Subject Code: **BT-450** Course Title: **Bioreactor Design and Analysis**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart the concept of various types of bioreactors, analysis, non-ideality and uses in microbial bioprocesses

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Bioreactor models, CSTR, plug flow, physical processes in the reactors, ideal CSTR, bubble column and air-lift tower loop reactor, description and physical processes.	5
2	Gas-liquid flow in stirred tank reactor, single phase flow, Transport equations, simulation with experimental observations, multiple impellers, interfacial forces, turbulence model; Non-ideal behavior of bioreactor and its analysis with RTD analysis, basic models for non-ideal reactors.	9
3	Bioprocess control, disturbances, stability and its analysis, dynamic models, feedback, proportional action, integral action, linear and non-linear control Heat transfer effects in bioreactors, reactor dynamics, CFD approach for simulation.	8
4	Bubble column bioreactors, basic equation of motion, fundamental laws of fluid motion ,two fluid model, dynamics of the dispersed gas phase, mass transfer and chemical reaction ,mixing due to bubble ,fluidized bed; trickle bed bioreactor, photobioreactor.	9
5	Models for $k_L a$ , interfacial area and bubble behavior, mass transfer correlations gas-liquid oxygen and other mass transfer, design and operation of aseptic and aerobic fermentation process.	6
6	Scale-up, of bioreactor, basic requirement and reactor type, CSTR, mixing, power consumption heat transfer, scale-up related effect on mass transfer, rheology of fermentation broth.	5
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1	James, E.Bailey and David,F. ollis, "Biochemical Engineering Fundamentals", McGraw Hill	1986
2	Doran, P.M., "Bioprocess Engineering principles", Academic Press	1995

<b>3</b>	Schugerl, K. and Bellgardt, K.H.(editors), "Bioreaction Engineering : Modeling and Control" Springer-Verlag	<b>2000</b>
<b>4</b>	Shuler ,M.L. and Kargi, F., "Bioprocess Engineering", Prentice Hall	<b>2002</b>
<b>5</b>	Nielsen, J., Villadsen, J. and Liden, G., "Bioreaction Engineering Principles", 2 <sup>nd</sup> ED. Kluwer Academics/Plenum Publisher	<b>2003</b>

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-451** Course Title: **Bioprocess Optimization**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To introduce various techniques of optimization and their application to bioprocesses.

10. Details of Course:

S. No.	Contents	Contact Hours
1	<b>Introduction:</b> Basic concepts, essential features of optimization, few examples and obstacles of optimization. Various mathematical tools and methods for optimization.	5
2	<b>Fitting of Models:</b> Classification of Models, fitting function to empirical data, various methods of fitting data. Development of objective function. Numerical methods, one-dimensional and multidimensional search methods.	6
3	<b>Multivariable Optimization:</b> Direct methods e.g. Random search. Grid search, simplex method, conjugate search. Indirect methods e.g. Gradient method, Newton's method, movement in search direction. Secant methods.	7
4	<b>Linear and Non-Linear Programming:</b> Basic concepts in linear programming, simplex methods, standard LP form, revised simplex methods. Unconstrained –univariate method, Powell's method, simplex method, rotating coordinate method, steepest descent method, Fletcher Reeves method, Newton's method, Marquardt's method and variable metric (DFP and BFGS) methods; Constrained-complex method and augmented Lagrange multiplier method.	9
5	<b>Dynamic Programming:</b> Multistage processes- acyclic and cyclic, sub optimization, principle of optimality and applications.	4
6	<b>Geometric Programming (GP):</b> Differential calculus and Arithmetic-Geometric inequality approach to unconstrained GP; Constrained GP minimization; GP with mixed inequality constraints and complementary GP.	6
7	<b>Emerging Optimization Techniques:</b> Genetic algorithm, simulated annealing, particle swarm and ant colony optimization.	5
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Beveridge G.S.G. and Schechter R.S., "Optimization: Theory and Practice", McGraw Hill.	1970
2	Edgar T.F., Himmelblau D.M. and Ladson L.S., "Optimization of Chemical Processes", 2 <sup>nd</sup> Ed., McGraw Hall.	2001
3	Rao S.S., "Engineering Optimization	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-452** Course Title: **Bioseparation Engineering**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objectives: To provide the knowledge of various separation techniques used in the purification of biological materials from the fermentation broth and complex mixture.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1	Characteristics of fermentation broth and bioproducts, sedimentation and centrifugation, different type of centrifuges and their theory	6
2	Theory of filtration, Darcy's law, derivation, filtration of biological fluids and fermentation broth. Relationship between filtration rate and pressure difference, membrane filtration theory, cross flow system, filtration rate	8
3	Cell disruption, mechanical, chemical and biological methods, precipitation of protein by solvent and ammonium salt, thermodynamic principles, solvent extraction, super critical fluid extraction and aqueous two phase extraction and adsorption	8
4	Principles of various liquid chromatography: Gel Chromatography, Ion-Exchange, Affinity chromatography, Hydrophobic interaction chromatography, Adsorption, Isotherms of adsorption, scale-up of liquid chromatography	8
5	Membrane based separation techniques: micro and ultrafiltration, tangential filtration	6
6	Crystallization, drying, mass and heat transfer, rate of drying	6
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication / Reprint
1.	Belter, P.A., Cussler, E.L. and Wei-Shou Hu., "Bioseparation: Downstream Processing for Biotechnology", Wiley Interscience	1988
2.	Asenjo, J.A. and Merchuk, J.C., "Bioreactor System Design", Marcel Dekker Inc.	1995
3.	Garcia, A.A., "Bioseparation Science", Blackwell Science.	1999
4.	Ghosh. R., "Principles of Bioseparations engineering" World scientific publishing co ltd.	2006

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

DEPTT./CENTR: **Department of Biotechnology**

1. Subject Code: **BT-453** Course Title: **Bioelectronic Medical Devices**
2. Contact Hours:      **L: 3**              **T: 1**              **P: 0**
3. Examination Duration (Hrs.): **Theory: 3**              **Practical: 0**
4. Relative Weightage: **CWS: 20-35**              **PRS: 0**              **MTE: 20-30**              **ETE: 40-50**      **PRE: 0**
5. Credits: **4**
6. Semester: **Both**              7. Subject Area: **PEC**              8. Pre-requisites: **Nil**
9. Objective: To introduce fundamentals of algorithms, their analysis and complexity issues.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Basic Bio-electronics Concepts and Methods: Hydrophobic and Hydration Forces, Electrochemical Gradients and Ion Distributions Across Membranes, Osmotic Properties of Cells, Electrical Properties of Cells. Membrane Equilibrium Potentials, Nernst Potential and Nernst Equation, Membrane Action Potential, Channel Conductance, The Voltage Clamp, Electrokinetic Effects.	9
2	Electrochemical Principles and Electrode Reactions: The Beer-Lambert Law, Impedance Spectroscopy, Electrochemical Cells and Electrode Reactions, Electrical Control of Electron Transfer Reactions, Reference Electrodes, Electrochemical Impedance Spectroscopy (EIS)	9
3	Bioelectronic Instrumentation and Electrochemical Sensor Interfaces: Transducer Basics, Signal Amplification, The Operational Amplifier, Basics of Electrochemical , Impedance and FET Based applications in bioelectronics. Transducer Technology for Neuroscience and Medicine.	12
4	Neural sensors and actuators: Microelectrode arrays, neural implants, Implantable medical devices: Biofouling, materials and regulation, Wireless sensor interfaces: Sensor networks and wireless power	12
Total		42

### 11. Suggested References/Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1	Introductory Bioelectronics, Ronald R. Pethig, Stewart Smith, Wiley,	2012
2	Biomedical Instruments - Theory and Design"; W. Welkowitz, S. Deutsch, M. Akay; Academic Press Inc.	2012
3	Introduction to Biosensors, Yoon, Jeong-Yeol, Springer,	2015

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE: Department of Biotechnology**

1. Subject Code: **BT-454** Course Title: **Big Data Analytics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**

9. Objective: The course provides exposure to the vast field of computational biology, methodologies and techniques used in the field. Discusses various topics in depth by discussion around published research.

10. Details of course:

S. No.	Contents	Contact Hours
1.	Introduction to Big Data And Hadoop Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.	8
2.	HDFS(Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	12
3.	Map Reduce Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	6
4.	Hadoop Eco System Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction	8
5.	Data Analytics with R Machine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	8
<b>Total</b>		<b>42</b>

11. Recommended Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters- A Beginner's Guide to R, Springer.	2009
2.	Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch , James Giles, David Corrigan- Harness the Power of Big Data The IBM Big Data Platform , Tata McGraw Hill Publications	2012
3.	Shui Qing Ye- Big Data Analysis for Bioinformatics and Biomedical Discoveries, CRC Press	2015
4.	Ka-Chun Wong- Big Data Analytics in Genomics, Springer	2016



## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 455** Course Title: **Biomolecular NMR**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of modern concepts of bio-molecular nuclear magnetic resonance

### 10. DETAILS OF THE COURSE:

S. No.	Contents	Contact Hours
1.	Magnetic moments, Principles of Nuclear Magnetic Resonance (NMR)- classical and quantum mechanical, Understanding NMR spectrometer, Fourier transformation, Resolution, sensitivity, NMR Probes, NMR Pulses, Gradients, etc	8
2.	Theory of Chemical Shifts, Spin- spin coupling, dipolar coupling, longitudinal, transverse and cross relaxation parameters, polarization transfer, homonuclear and heteronuclear two-dimensional NMR, Product operator formalism.	12
3.	Basic structural characteristics of proteins, Isotopic labeling strategies, Theory and applications of solution state NMR Triple resonance (3-Dimensional) experiments for protein backbone, side chain assignment. NMR analysis of protein dynamics and stabilities	8
4.	Nucleic acid structural analysis, strategies and assignment, sugar conformation, Experimental restraints, Restrained Molecular Dynamics (rMD) based structure. NMR of protein-DNA/carbohydrate/membrane interactions, Characterizing binding surfaces and affinities	8
5.	Solid state NMR: Magic Angle Spinning (MAS), Cross Polarization (CP), CP-MAS, and biomolecular applications. Advanced NMR concepts: In-vivo NMR and Magnetic Resonance Imaging	6
	<b>Total</b>	<b>42</b>

### 11. Suggested books:

S. No.	Author(s)/Title/Publisher	Year of Publication
1.	Wuthrich, K., "NMR of protein acid", John Wiley & Sons.	1986
2.	Derome, A.E., "Modern NMR Techniques for Chemistry Research", Pergamon Press	1987
3.	Evan, J.N.S., "Biomolecular NMR spectroscopy", Oxford University Press	1995
4.	Evan, J.N.S., "Biomolecular NMR spectroscopy", Oxford University Press	1995
5.	Cavanagh, J., Fairbrother, W.J., Palmer III, A.J., Skelton, N.J., and Rance M. "Protein NMR Spectroscopy: Principles and Practice" 2 <sup>nd</sup> edition, Academic Press	2005
6.	Keeler J. "Understanding NMR Spectroscopy" 2 <sup>nd</sup> edition, Academic Press	2010
7.	P.J. Hore, "Nuclear Magnetic Resonance" Oxford University Press	2015

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT-456** Course Title: **Biomolecular Modeling**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: To impart the knowledge of molecular modeling, computer-based technology to identify and design molecules for new medications for the discovery phase of drug development.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Quantum mechanics & concepts in molecular modeling : Introduction – coordinate systems – potential energy surfaces – introduction to quantum mechanics – postulates – Schrodinger wave equation – hydrogen molecule – Born-Oppenheimer approximation.	6
2.	Molecular mechanics and energy minimization: Empirical force field models – Bond stretching – angle bending – torsional term – nonbonding interactions – thermodynamics properties using a forcefield – derived and non derived energy minimization method – simplex – sequential univariate method – steepest descent method – conjugate gradient method- Newton-Rapson method.	6
3.	Molecular Dynamics and Monte Carlo simulation : ) Introduction – Using single Model – time steps – Multiple steps – Setting up MD – energy conservation in MD Simulation Examples – Monte Carlo – Random number generation – Difference in MD & MC.	8
4.	Homology modeling: Comparative modeling of proteins – comparison of 3D structure – Homology – steps in homology modeling – tools – databases – side chain modeling – loop modeling.	6
5.	Drug design: General approach to discovery of new drugs - lead discovery – lead modification – physiochemical principles of drug action – drug stereo chemistry – drug action - 3D database search – computer aided drug design	8
6.	Understanding of docking tools- molecular modeling in drug design – pharmacophores - QSAR. Molecular visualization tools	8

**11. Suggested Books:**

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1.	A. R. Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications,	1996
2.	Baxivannis and Foulette - Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiely Indian Edition.	2001
3.	Valerie Daggett-Protein Simulations, 1st edition, Volume 66 - Academic Press	2003
4.	Philip E. Bourne-Structural Bioinformatics, 2nd edition,	2009

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT- 457** Course Title: **Systems Biology**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both**      7. Subject Area: **PEC**      8. Pre-requisites: **Nil**
9. Objective: Systems Biology is an integrated approach to the study of biology through experiment and the use of computer models with both predictive power

10. Details of course:

S. No.	Contents	Contact Hours
1.	Introduction to systems biology and metabolism: Components of Biological systems (DNA, RNA, Protein, Metabolites), their properties and function. Overview of cellular metabolism, enzyme kinetics and metabolic pathways	6
2.	Biological network: Biological networks and their significance – at the level of genome, transcriptome, proteome, and metabolome. Omics - applications and its role in systems biology. Analytical methods for detecting and quantifying metabolites. General work flow and Statistical methods in omics. Pathway and omics databases.	12
3.	Modelling and Analysis of networks (MAN): The module focuses on mathematical and statistical methods used to evaluate and analyse large-scale data sets. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making.	10
4.	Large biological data analyses: Differential gene expression analysis of transcriptome data, 16S rRNA based phylogenetic profiling, phylogenetic tree, introduction to Gene Ontology, KEGG, EcoCyc databases, Automated pathway mapping and annotation of proteins and metabolites, Metabolic network reconstruction, Genome scale model analysis.	12
<b>Total</b>		<b>42</b>

11. Suggested Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	A Practical Approach to Microarray Data Analysis (Hardcover) by Daniel P. Berrar (Editor), Werner Dubitzky (Editor), Martin Granzow (Editor)	2003
2.	System Biology: Computational Systems Biology (Hardcover) by Andres Kriete (Editor), Roland Eils (Editor)	2005
3.	Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide By: Helen Causton (Imperial College), J Quackenbush and Alvis Brazma (The European Bioinformatics Institute)	2009
4.	Stochastic Modelling for Systems Biology. ISBN-10 1-58488-540-8 and ISBN-13 978-158488-540-5	2018

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT- 458** Course Title: **Molecular Biophysics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objectives: To teach the concepts of energetic for structure-stability-conformational transitions in biological molecules.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Levels of structure of biomacromolecules-- random coils, proteins, nucleic acids, polysaccharides, biological membranes, computer aided simulations	7
2.	Polypeptide chain geometry, Ramachandran Map, Estimate of potential Energy – nonbonded and dipolar terms, intrinsic torsional potential, Conformational energy of peptide residues, Hydrogen bonding, Hydrophobic and Electrostatic Interactions, Disulfide bonds, applications to protein structure	6
3.	Conformation of Sugar, Glycosidic bond and Backbone torsional angles, Base Pairing and Stacking Interactions, Thermodynamic parameters, Conformation of A, B, Z DNA, transfer RNA, Triple helix and DNA Quadruplexes	6
4.	Helix to Coil Transitions, Molecular mechanism, Simple and Statistical thermodynamic treatment, Zipper model, Host-guest experiment	5
5.	Reverse Folding of proteins, Equilibrium studies, Kinetics, Experimental observations	4
6.	Ligand-Macromolecule Interactions, phase transitions in biopolymers and aggregates	7
7.	Transport of ions across biological membranes, electron transfer in bioenergetics	7
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/ Reprint
1.	Van Holde, K. E., Johnson, W. C., Ho P. S., 'Principles of Physical Biochemistry, Prentice Hall Intl.	1998
2.	Cantor, C. R., and Schimmel, P.R., 'Biophysical Chemistry, Part-I and Part III', W H Freeman & Co.	2008
3.	Atkins, P., and De Paula J., 'Physical Chemistry for the Life Sciences'. Second Edition	2011
4.	Atkins, P., De Paula, J., and Keeler, J., 'Atkin's Physical Chemistry'. International Edition	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE : Department of Biotechnology**

1. Subject Code: **BT - 459** Course Title: **Biomolecular Interactions**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To impart in depth knowledge of biomolecular interactions to execute structure based drug design.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of biomolecules; primary, secondary, tertiary/ quaternary structure of proteins, RNA and DNA, carbohydrates, lipids/membranes. structural properties of biological macromolecules. Motifs and domains of protein structures.	4
2.	Structural and energetic principles governing the biomolecular interactions. Role of electrostatics/surface potentials, hydrogen bonding and hydrophobicity. Cooperativity and allostery in mediating the macromolecular recognition	6
3.	Molecular Recognition: Recognition of proteins, Recognition of DNA/RNA, Recognition of foreign molecules by immune system, Thermodynamics of Binding, Binding Energetics, Specificity of macromolecular recognition	6
4.	Biochemical methods for characterization of biomolecular interactions: Size Exclusion Chromatography, Ala-screening, GST-pull down assays, Co-Immunoprecipitation, Biotin-Avidin, Native PAGE, protein-protein interactions in living cells, Gel-shift assays etc	5
5.	Biophysical approaches to elucidate biomolecular interactions and binding kinetics: Nuclear Magnetic Resonance Spectroscopy, X-ray diffraction, Isothermal calorimetry, Surface Plasmon resonance, Fluorescence Spectroscopy, Analytical ultracentrifugation, Dynamic light scattering, Small angle x-ray scattering (SAXS), CD etc	12
6.	Computation biology methods and tools for identification and characterization of biomolecular interactions	4
7.	Biomolecular interactions as drug targets; Ligand binding thermodynamics in drug discovery, Biomolecular interactions and rational drug design, Binding affinity of monoclonal antibodies to molecular engineering of antibodies with improved stability and affinity.	5
<b>Total</b>		<b>42</b>

11. Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Introduction to Protein Structure. 2e, Carl Branden and John Tooze, Garland Science	1999
2.	Serdyuk, I.N., Zaccai, N.R., Zaccai, J., "Methods in Molecular Biophysics-Structure, Dynamics, Function", Cambridge University Press	2007
3	Rice, P.A. and Correll C.C., " Protein-Nucleic Acid Interactions: Structural Biology " 1 <sup>nd</sup> edition, RSC Biomolecular Sciences	2008
4.	Giralt, E., Peczuh, M.W., Salvatella, X., "Protein Surface Recognition-Approaches for Drug Discovery", 1 <sup>st</sup> edition, Wiley.	2010
5.	Cantor, C. R. and Schimmel, P. " Biophysical Chemistry" Vol. I, II and III, W.H. Freeman and Company, New York, USA.	2010
6.	The Molecules of Life: Physical and Chemical Principles, John Kuriyan, Boyana Konforti, David Wemmer, Garland Science (2012)	2012

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPTT. /CENTRE:**Department of Biotechnology

1. Subject Code: **BT-460** Course Title: **Design and Analysis of Algorithms**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**
4. Relative Weightage: **CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0**
5. Credits: **4**
6. Semester: **Both** 7. Subject Area: **PEC** 8. Pre-requisites: **Nil**
9. Objective: To introduce fundamentals of algorithms, their analysis and complexity issues.

**10. Details of Course:**

S. No.	Contents	Contact Hours
1.	Notion of algorithm, pseudo code conventions, Performance analysis, Time and space complexities, Asymptotic notation, Big oh notation, omega notation, theta notation, Average and worst case analysis, Probabilistic analysis, Amortized analysis.	5
2.	Recurrence relations, Divide and conquer relations, Solving of recurrences by iteration method and substitution method, Master theorem, Binary search algorithm, Merger sort, Quick sort, Strassen's matrix multiplication method	9
3.	Greedy strategy, Huffman coding algorithm, Data structures of disjoint sets, Complexity analysis of Depth first search, Breadth first search, Prim's algorithm, Kruskal's algorithm, Dijkstra's and Bellman-Ford algorithms, Knapsack problem, Warshall's and Floyd's algorithms.	12
4.	Introduction to dynamic programming, Principle of optimality, Optimal binary search trees, Matrix-chain multiplication, Longest common subsequence.	7
5.	String matching, The naive string matching algorithm, The Rabin-Karp algorithm	3
6.	Introduction to computability, Reducibility, Polynomial-time verification, NP-completeness, NP-complete problems.	6
Total		42

**11. Suggested References/Books:**

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Aho A. V., Hopcroft J. E. and Ullman J. D., "The Design and Analysis of Computer Algorithms", Pearson Education	2002
2.	Levitin A., "Introduction to the Design and Analysis of Algorithm", (2 <sup>nd</sup> edition) Pearson Education	2003
3.	Cormen T. H., Leiserson C. E., Rivest R. L. and Stein C., "Introduction to Algorithms", Prentice Hall India, (3 <sup>rd</sup> Edition)	2004
4.	Horowitz E., Sahni S. and Rajasekaran S., "Fundamentals of Computer Algorithms", Orient Longman	2006
5.	Kleinberg J. and Tardos E., "Algorithm Design", Pearson Education	2008

**Item No. 86.6: To consider the proposal of Department of Architecture & Planning to include Minor Specialization and Departmental Honours Courses (MSC/DHC) in the existing B. Arch curriculum.**

As per the existing framework, the Minor Specialization (MSC) and Departmental Honours Courses (DHC) are applicable to all UG programmes excluding B. Arch. Based on the proposal received from the Department of Architecture and Planning, the IAPC in its 95<sup>th</sup> meeting held on 09.12.2020 recommended the proposal to include MSCs and DHCs in B. Arch. with minor modifications. The modified proposal is given at **Appendix-A.**

The above is submitted for consideration and approval of the Senate.



Date 4<sup>th</sup> November 2020  
Revised 18 November 2020  
(Options A, B, C rearranged, DHC courses added)  
Revised after IAPC held on 11th December  
(corrections/suggestions incorporated)

## **Proposal for Introduction of Minor Specialisation in B. Arch Curriculum**

### **Background**

At IITR, students can take up and complete at least 18-20 credits (in addition to the own departmental credit) of courses of their interests from a pool of courses offered by a specific department to obtain a Minor Specialisation along with their majors. All the other departments already have the above option for UG students except Architecture and Planning.

### **The context and the need**

In recent times, the field of Architecture has become multifaceted. The diverse job market of architecture is no longer limited to architectural design and construction of buildings. Instead, the application of multidisciplinary knowledge has emerged due to the increasing complexity of the design, management, and construction of buildings. A few of those aspects are material science, digital fabrication, mathematical modeling, civil Infrastructure development, coding, and development design-related software, building automation, security systems etc. (An indicative full list in Annexure 1). Naturally, there is a growing enthusiasm among the architecture students to pursue such minor specializations. Architects graduating from IITR can develop such skills from the sister department if the minor specialization is allowed.

On the other hand, many graduating engineers from the department like civil engineering, electrical, mechanical, computer science, mathematics, and materials science can avail MSC in architecture. Minor specialization in Architecture will provide them an edge to deliver good results. Therefore the minor specialization in Architecture is the need for the hour.

### **Process**

Based on the student's requests, the DAPC, in its meeting dated 22nd October and 4th November, deliberated the matter at length and proposed the addition of MSC in the curriculum. For a better consolidation, all the faculty involved in B. Arch teaching were invited to the extended DAPC meeting on 4th November. Besides, officials from the academic section were consulted for clarification and guidance.

### **Challenges**

MSC courses of 18 to 20 credits are distributed in 6<sup>th</sup>, 7<sup>th</sup>, and 8<sup>th</sup> semesters of four years B. Tech and in 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> and 10<sup>th</sup> semesters in five years IDD/MSc course. B. Arch is a five-year course with a training component for a full 8<sup>th</sup> semester. Therefore MSC courses have to be distributed in spring and autumn semesters during the 6<sup>th</sup> to 10<sup>th</sup> semester except for the 8<sup>th</sup> like a typical five-year program.

**Department of Architecture and Planning  
Indian Institute of Technology Roorkee**

**Existing B. Arch Curriculum**

Semester	Number of courses	Credit	Remarks
1 <sup>st</sup>	8	25	
2 <sup>nd</sup>	7	25	
3 <sup>rd</sup>	7	23	
4 <sup>th</sup>	7	24	
5 <sup>th</sup>	6	21	
6 <sup>th</sup>	6	20	
7 <sup>th</sup>	6	20	
8 <sup>th</sup>	1	10	Six-month Training
9 <sup>th</sup>	6	20	
10 <sup>th</sup>	3	22	Including a Thesis project
Total		210	

**The proposed addition of MSC courses in B. Arch Curriculum**

Based on students' preference, input from the academic sections, and faculty deliberations, following distribution of slots for MSC courses across semesters are proposed:

Semester	Number of courses	Existing Credit	Proposed credit including MSC	Remarks
			No change	
2 <sup>nd</sup>	7	25	No change	
3 <sup>rd</sup>	7	23	No change	
4 <sup>th</sup>	7	24	No change	
5 <sup>th</sup>	6	21	No change	
6 <sup>th</sup>	6	20	20+ 6/8*	
7 <sup>th</sup>	6	20	20+ 3/4*	
8 <sup>th</sup>	1	10	No change	Six-month Training
9 <sup>th</sup>	6	20	20+ 3/4*	
10 <sup>th</sup>	3	22	22+ 3/4*	Including Thesis project
Total		210	210 without MSC	
			228-230 With MSC	

\*Credit for MSC courses, shaded cells contains revisions

The above additions of MSC courses are proposed to be applicable for the present B. Arch-II (2018) and B. Arch-I (2019) students and new students (2020) in the current B. Arch Program

## Department of Architecture and Planning Indian Institute of Technology Roorkee

### MSC courses proposed to be offered in the department of Architecture

A combination of 10-12 spring and autumn semester courses are proposed so that non-architecture students can opt for the courses at their convenience.

Sl no.	Category	Code	Course	Semester	Credit
1	DCC	AR-104	Introduction to Building Materials & Construction-I	Spring	3
2	DCC	AR-108	Climatology in Architecture	Spring	3
3	DCC	AR-204	Building Construction-III	Spring	4
4	DCC	AR-205	History of Architecture-I	Autumn	3
5	DCC	AR-209	Structure and Architecture	Autumn	3
6	DCC	AR-211	Principles of Architecture	Autumn	3
7	DCC	AR-206	History of Architecture -II	Spring	3
8	DCC	AR-210	Modern World Architecture	Spring	3
9	DCC	AR-212	Landscape Design and Site Development	Spring	3
10	DCC	AR-403	Urban Design	Autumn	4
11	DCC	AR-405	Sustainable Architecture	Autumn	4
12	DCC	AR-505	Urban Planning	Autumn	4
13	DCC	AR-502	Professional Practice, Valuation & Arbitration	Spring	4

### Departmental Honours courses proposed to be offered

- A. Elective course/s from B. Arch over and above the minimum  
B. Any of the following courses from M. Arch/MURP basket

Sl no.	Category	Code	Course	Semester	Credit
1	PCC	AR-603	Contemporary Architecture- Theories and Trends	Autumn	3
2	PCC	AR-605	Urban Design	Autumn	3
3	PCC	AR-607	Advanced Building Technologies	Autumn	3
4	PCC	AR-655	Ecology and Sustainable Development	Autumn	3
5	PCC	AR-657	Planning Theory and Techniques	Autumn	3
6	PCC	AR-659	Housing	Autumn	3
7	PCC	AR-661	Planning Legislation and Governance	Autumn	3
8	PCC	AR-604	Sustainable Built Environment	Spring	4
9	PCC	AR-606	Megastructures	Spring	3
10	PCC	AR-654	Infrastructure Planning	Spring	4
11	PCC	AR-656	Rural Planning and Development	Spring	3

- C. NPTEL/MOOC courses recommended by the department as DHC time to time

On behalf of DAPC, APD

*Uttam Roy*

Dr. Uttam K. Roy, DAPC Chair

**Department of Architecture and Planning  
Indian Institute of Technology Roorkee**

**Annexure I:**

Multidisciplinary areas of specializations linked to Architecture

**CIVIL ENGINEERING IN ARCHITECTURE:**

Construction engineering; Earthquake resistant techniques; Environmental engineering; Geophysical aspects in building; safely and economically design foundations, retaining walls; Surveying; Structural engineering; Material Sciences; elements of hydrology, environmental science etc.

**ELECTRICAL ENGINEERING IN ARCHITECTURE:**

Lighting Fixture performance specifications and arrangements, Emergency Lighting, Exit Lighting, Lighting Control and circuiting; lighting automation, large scale electrical installations in the campuses; Standardization, integration and promulgation of smart grid technology, smart power distribution system, smart metering, smart peak load demand controls, smart building management systems etc.

**MECHANICAL ENGINEERING IN ARCHITECTURE:**

Heating, ventilation and air conditioning (HVAC), plumbing, and rainwater systems; Materials Properties in-depth analysis; horizontal & vertical transportation systems; integrating mechanics and designing; humidity control or air Filtration systems etc.

**COMPUTER SCIENCE ENGINEERING IN ARCHITECTURE:**

Virtual Reality, new softwares in the Climatology require intensive skills with coding; Augmented Reality in designing and building analysis; automating different small tasks in BIM; Using Machine learning to understand client tastes etc.

**APPLIED MATHEMATICS IN ARCHITECTURE:**

Algorithms and mathematics help in artificial intelligence in Architecture; designing efficient structures; AI analysing the structures etc.

**DOMS COURSES IN ARCHITECTURE:**

Studying Marketing; Understanding the market trends; identifying target audience; selling our product; integrating economics into designing; proper Costing-Estimation of structure

**Item No. 86.7: To consider the proposal to introduce M. Tech in Dam Safety and Rehabilitation programme.**

The IAPC in its 96<sup>th</sup> and 97<sup>th</sup> meeting held on 28.12.2020 and 11.01.2021, respectively recommended the proposal to introduce M. Tech in Dam Safety and Rehabilitation programme along with its structure and syllabi with minor modifications.

The proposal along with modified structure and syllabi is given at **Appendix-A**.

The above is submitted for consideration and approval of the Senate.

**M. TECH. IN DAM SAFETY AND REHABILITATION**

(After incorporating suggestions of the IAPC meeting held on December 28, 2020 and suggestions of associated faculty)

**BACKGROUND**

India has 5334 large dams in operation and about 411 large dams are under construction. In addition to the large dams, there are more than 90,000 small and medium dams in the country. These dams have been built to ensure water safety, which in turn, is essential for the food and energy security of the country. The recorded history of dam construction in the country dates back to the 11<sup>th</sup> century when Veeranam dam was constructed in Central India and since then the dams are being built for the storage of water. In addition to this, there are numerous dams all over the world. IIT Roorkee is playing a major role in the design and execution of these dams since its inception in 1847.

The safety of these dams is of utmost importance. Many of the existing dams are very old and need rehabilitation. Keeping these concerns in view, Ministry of Water Resources, River Development & Ganga Rejuvenation through Central Water Commission initiated the DRIP project in April 2012 with the assistance of World Bank. IIT Roorkee is the academic partner in this programme and has entered in MoU with Central Water Commission in September 2017. This project is coming to an end in March 2021.

Keeping the importance of the dams in view and to cover more number of dams in the project, phase II and phase III of the DRIP programme have been approved by Ministry of Jal Shakti, Government of India on October 29, 2020.

Dam Safety Bill 2019 was introduced in Lok Sabha on July 29, 2019, and was passed on August 2, 2019. The bill provides for the surveillance, inspection, operation, and maintenance of all specified dams across the country. The bill is likely to be passed by Rajya Sabha soon.

During the concurrence of the Dam Safety Bill, Government India desired that apex institutions in the country should be approached to start a regular course in the dam safety management at the post-graduation level. Accordingly, in pursuance to this, Secretary, DoWR, RD&GR requested

Secretary, Department of Higher Education, Ministry of HRD for this. The Chairman, CWC also requested to the academic partners of DRIP in June 2019.

IIT Roorkee kept a close eye on these developments and constituted a 4-member committee, consisting of Prof N.K. Goel, Prof. M.L. Sharma, Prof. Zulfequar Ahmad, and Prof. M.L. Kansal, in December 2019 to draft the proposal for the establishment of the International Centre for Dams at IIT Roorkee and start a M. Tech. programme in Dam Safety and Rehabilitation with effect from July 2021.

A meeting through video conferencing was held on May 27, 2020, under the Chairmanship of the Additional Secretary, D/o WR, RD & GR, Ministry of Jal Shakti to discuss about the matters related to the experience of IIT Roorkee with ongoing DRIP, plan for the introduction of Postgraduate programme in Dam Safety Management and establishment of a Centre of Excellence (CoE) in Dam Engineering. This meeting was attended by Director, IIT Roorkee and Prof. N.K. Goel. The intent of IIT Roorkee to establish the Centre for dams and start of the M. Tech. programme on Dam safety and Rehabilitation was reiterated in the meeting.

The committee had a series of meetings and after receiving the inputs from Central Water Commission finalised its proposal for the establishment of the 'International Centre for the dams' at IIT Roorkee and start of M. Tech programme in Dam safety and Rehabilitation and sent it to the Departments of Civil Engineering, Hydrology, Earthquake and WRDM for consideration and inputs for the M. Tech. Programme. The proposal for the Establishment of the Centre was also sent to the CWC and the World Bank for consideration and providing inputs for the finalisation of the proposal in October 2020.

A number of suggestions were received from the Departments of Civil, EQ, Hydrology and WRDM. The present proposal incorporates the suggestions received till date. The requirements, structure and the syllabus of different subjects of the programme are given in the next section.

### **Who can Attend the Programme**

Initially, the programme will be meant only for the sponsored officers of state implementing agencies of DRIP programme.

**Eligibility**

1. Graduation/ Post Graduation degree in Civil/ Mechanical/Earthquake/ Hydrology/ Water Resources Engineering/ equivalent;
2. Post-graduation degree in Physics/ Mathematics/ Geology/ Geophysics; Environmental Engineering/ equivalent;
3. Any other degree acceptable to the State Implementing agencies for regular appointment in the dam safety wings

**Experience:**

2- year relevant experience.

**Number of seats:**

30;

**Faculty**

The programme will be jointly delivered by the faculty members of IIT Roorkee and the national and international experts. The national and International experts have been proposed with the delivery of the programme as the number of subjects proposed to be dealt with are new and the faculty members of IIT Roorkee need to develop the expertise of delivering the programme independently over a period of next five years through continuous interaction with international experts and exposure visits.

**Financial Support:**

The programme shall be supported by Ministry of Jal Shakti under DRIP phase II and III and the World Bank.

**Reference Material:**

A number of guidelines have been prepared by CPMU of CWC in consultation with National and International subject matter specialists during the last 6 years. These guidelines document the best National and International practices in the area. The M. Tech. programme will give the participants



enough exposure to follow these guidelines and implement the best practices in the field. So far, the following 14 guidelines have been prepared and are available online.

1. Guidelines for developing Emergency action plans for dams, February 2016;
2. Guidelines for safety inspections of dams, January 2018;
3. Guidelines for instrumentation of large dams, January 2018;
4. Guidelines for preparing operation and maintenance manual for dams, January 2018;
5. Guidelines for mapping flood risks associated with dams, January 2018;
6. Manual for rehabilitation of large dams, January 2018;
7. Inspection Manual for Dam Field Engineers After Seismic Events, Ichari Dam, Uttarakhand, January 2018;
8. Technical Specifications of Hydro-meteorological, Geodetic, Geotechnical and Seismic Instruments, January 2018;
9. Guidelines for Assessing and Managing Risks Associated with Dams; February 2019;
10. Handbook for Assessing and Managing Reservoir Sedimentation, February 2019;
11. Inspection Manual for Dam Field Engineers after Seismic Events, Maithon Dam, Damodar Valley Corporation, Jharkhand, February 2019;
12. Guidelines for Classifying the Hazard Potential of Dams, November 2020;
13. Operational Procedures for Assessing and Managing Environmental Impacts in Existing Dam Projects, November 2020;
14. Manual for Assessing Structural Safety of Existing Dams, November 2020.

Apart from the above guidelines, few more guidelines have been prepared by other organisations:

1. Guidelines for community-based ecotourism development, WWF International, 2001;
2. Guidelines for maintaining longitudinal connectivity through dams, 2017;
3. ICOLD, “Selecting Seismic Parameters for Large Dams, Guidelines”, Bulletin 148 Committee on Seismic Aspects of Dam Design, International Commission on Large Dams (ICOLD), Paris, 2014;
4. National Disaster Management Guidelines, 2007;

## **COURSE OBJECTIVES, STRUCTURE AND THE SYLLABUS**

### **Course Objectives**

The course objective is to train the sponsored officers to deal with the complete life cycle of the dam and take up the challenges of safety and rehabilitation of the older dams and the design of new dams. To develop analytical, operational, and sectoral understanding, M. Tech. students will be exposed to a plethora of courses related to dam safety which would enhance the qualitative and quantitative research methodology, policy aspects, and skills to device appropriate solutions.

**INTERNATIONAL CENTRE FOR DAMS  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

Program Code: XXX M.Tech. (Dam Safety and Rehabilitation)

Department: \_\_\_\_\_

Year: I \_\_\_\_\_

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>Semester-I (Autumn)</b>														
1.	DS-501	Assessing and Managing Risks Associated with Dams	PCC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
2.	DS-502	Basics of Disaster Management and its Implementation Concepts	PCC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
3.	DS-503	Hydrologic Safety Evaluation of dams	PCC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
4.		Programme Elective Course -I	PEC	4										
5.		Programme Elective Course -II	PEC	4										
		Total		20										
<b>Semester-II (Spring)</b>														
1.	DS-504	Sediment Management in Reservoirs	PCC	4	3	1	-	3	-	20-35	-	20-30	40-50	0
2.	DS-505	Dam Safety Surveillance, Instrumentation and Monitoring	PCC	4	2	1	2/2	3	-	15-30	20	15-25	30-40	0
3.	DS-701	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
4.		Programme Elective Course -I	PEC	4										
5.		Programme Elective Course -II	PEC	4										
6.		Programme Elective Course -III	PEC	4										
		Total		22										

\*Credit requirement for PG Diploma/ 1<sup>st</sup> year M. Tech is 42 credits.

**INTERNATIONAL CENTRE FOR DAMS  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

Program Code: XXX M.Tech. (Dam Safety and Rehabilitation)

Department: \_\_\_\_\_

Year: II

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>Semester-I (Autumn)</b>														
1.	DS-701A	Dissertation Stage-I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
<b>Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.</b>														
<b>Semester-II (Spring)</b>														
1.	DS-701B	Dissertation Stage-II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester	1	2	3	4
Semester-wise Total Credits	20	22	12	18
Total Credits	72			

**List of Program Elective Courses**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	DS-511	Seepage through Dams	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
2.	DS-512	Assessment and Management of Environmental issues in Reservoirs	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
3.	DS-513	Earthquake Geotechnical Engineering	PEC	4	2	1	2/2	3	-	15-30	20	15-25	30-40	-
4.	DS-514	Study tour/ Case studies	PEC	4	2	1	2/2	3	-	15-30	20	15-25	30-40	-
5.	DS-515	Geo-Mechanics	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
6.	DS- 516	Geospatial Technology for Monitoring of Dams	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
7.	DS- 517	Hydraulic and structural design of dams, spillways and energy dissipators	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
8.	DS-518	Ground Improvement and Geo-synthetics	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
9.	DS-519	Contract and Financial Management	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
10.	DS-520	Sustainable Tourism around Dams	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
11.	DS-521	Earth Retaining Structures and Dams (Concrete, RCC, CFRD, Arch, Earth, Rockfill dams & Barrages)	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
12.	DS- 522	Seismic Safety of Embankment Dams	PEC	4	2	1	2/2	3	-	15-30	20	15-25	30-40	-
13.	DS-523	Concepts of Planning & Design of Hydro-Mechanical Components in Dams	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-
14.	DS-524	Engineering Seismology and Hazard Assessment for dams	PEC	4	3	1	-	3	-	20-35	-	20-30	40-50	-

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-501      **Course Title:** Assessing and Managing Risks Associated with Dams
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35      **PRS:** 0      **MTE:** 20-30      **ETE:** 40-50      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Autumn                      7. **Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide necessary background about the various risk associated with dams and the techniques for dam safety assessment and management.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Overview of Dams Risk Assessment and Management:</b> Smart Governance and risk management, Risk analysis Formal Framework, Risk-informed decision-making and its importance in an integral Dam Safety Management Program, Dam Safety Program Fundamentals in USA, Spain, Argentina, Brazil etc.	4
2.	<b>Basis for a Risk-Informed Dam Safety Management Program for India:</b> Dam failure risks worldwide, Dam failure risks in India, Lessons learnt from Risk Assessment and Management worldwide.	6
3.	<b>Initial Risk-Based Screening:</b> Purpose of a risk-based screening tool, elements of the risk-based screening tool, brief reference to the Hazard Classification in India, dam safety inspections reports and DHARMA. Practical workshop or hands-on exercise.	5
4.	<b>Identification of Failure Modes:</b> PFMA (Potential Failure Mode Analysis), types of failure modes and loading scenarios, the purpose of the failure mode identification, Identification and classification of Failure Modes, Identification of investigation and surveillance needs, Proposal of risk reduction actions. Practical workshop or hands-on exercise.	5
5.	<b>Semi-Quantitative Risk Analysis:</b> Introduction, scope, and limitations of a semi-quantitative risk analysis (Failure probability categories Vs. Consequences categories), Prioritization of new studies or instrumentation. Practical workshop or hands-on exercise.	4
6.	<b>Quantitative Risk Assessment:</b> Introduction, scope and limitations. Incremental Risk Concept, Failure modes structure, Risk model input data, Levels of Detail in Risk Calculation input data, Event tree concept and calculation examples, Common Cause Adjustment, Risk Calculation in dam systems, Risk Representation (FN and FD Graphs). Uncertainty analysis in risk calculations. Practical workshop or hands-on exercise.	6
7.	<b>Risk Evaluation (Quantitative Risk Assessment):</b> Introduction, scope and limitations on Risk Evaluation process. Tolerability Guidelines Worldwide (ANCOLD, USBR, USACE, other countries/agencies), Proposal and justification of Tolerability Guidelines for India, Definition and prioritization	5

	of risk reduction actions, Risk reduction principles, Relation between quantitative risk models and DRIP Guidelines. Practical workshop or hands-on exercise.	
8.	<b>Portfolio Risk Management:</b> Introduction, Risk-informed decision-making inputs, risk-informed decision-making process (conditioning aspects). Structure of Reports on Dam Safety Risk Assessment. Practical workshop or hands-on exercise.	3
9.	<b>Risk Governance:</b> Introduction, Capacity building, Risk Communication, Overall Regulatory Framework, Review and quality assurance, Other Factors Affecting Decision Making- Climate Change, Inter-State Issues etc. <b>Institutional Framework in Dam Safety:</b> Perspective of Institutional framework in Switzerland, USA, Australia; Existing Dam Safety Monitoring Mechanism in India-Dam Safety Organization (DSO), National Committee on Dam Safety (NCDS), National Committee on Seismic Design Parameters (NCSDP); Dam Safety Legislation in India-Historical Development, Important Provisions of the Dam Safety Bill 2019.	4
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Zhang L., Peng M., Chang D. and Xu Y., “Dam Failure Mechanisms and Risk Assessment”, John Wiley & Sons	1976
2.	Hartford D. N. and Baecher G. B., “Risk and Uncertainty in Dam Safety”, Thomas Telford, Ltd	2004
3.	Raftery J., Loosemore M. and Reilly C., “Risk Management in Projects”, United Kingdom: Taylor & Francis	2006
4.	Rodríguez Valladares M., “Overview of Credit Risk Portfolio Management”, (n.p.): FT Press Delivers	2011
5.	“Risk Analysis, Dam Safety, Dam Security and Critical Infrastructure Management”. Netherlands: CRC Press	2011
6.	Solozhentsev E., “Risk Management Technologies: With Logic and Probabilistic Models”, Netherlands: Springer Netherlands	2012
7.	“Hydrology of Disasters”, Netherlands: Springer Netherlands	2012
8.	Iverson D., “Strategic Risk Management: A Practical Guide to Portfolio Risk Management”, Germany: Wiley	2013
9.	Wagner R., “The Handbook of Project Portfolio Management”, United Kingdom: Taylor & Francis	2018
10.	“Guidelines Assessing and Managing Risks Associated with Dams”, DRIP, DoWR, MoJ, GoI, New Delhi	2019

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-502 **Course Title:** Basics of Disaster Management and its Implementation Concepts
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Autumn **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the basics of disaster management and implementation of various concepts to the dam by various modelling and mapping etc.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Overview of Disaster Management and Flood Mapping:</b> Disaster management cycle, Disaster Management Policies in India. Potential Uses of Flood Mapping in brief, Tiered Flood Modelling and Mapping Approach in India.	4
2.	<b>Flood Risk Associated with Dams:</b> Types of Dams, Dam Failure concept, Estimation of consequences.	8
3.	<b>Disaster Mitigation:</b> Warning and evacuation, do's and don'ts about disaster, damage survey for designing aid package, detailed survey for reconstruction, repair and retrofitting, post disaster survey, long term measures, codal practices.	5
4.	<b>Remote Sensing and Geographic Information Systems (GIS) applied to Emergency Preparedness and flood Mapping:</b> Techniques, uses, importance, Planning the Mapping Process, Geographical Information System (GIS), GIS Software, Practical workshop or hands-on exercises	5
5.	<b>Dam Hazard Classification Framework in India:</b> CWC Guidelines; Assessment of the Area Affected by Dam break; Failure Scenarios, Classification of the Dams in India Based on Hazard Potential; Potential Consequences Index Definition and Calculation Process (Additive-weighting scheme), Potential Implications of Hazard Potential Classification; Requirement for Emergency Action Plans (EAP) and their revision. Practical workshop or hands-on exercises.	4
6.	<b>Emergency Action Plans Preparation:</b> Emergency management Organisation (Stakeholders), Relationship of the EAP document and the O&M manual. Establishment of emergency response protocols/procedures, Notification Flowcharts, levels of alerts and associated thresholds, preparedness actions/protocols, local evacuation plan [shelters, evacuation	8



	routes, warning time], communications networks, emergency resources and equipment. Practical workshop or hands-on exercises.	
7.	<b>Emergency Action Plans Implementation:</b> Stakeholder's Consultation Meeting (discussion-based exercise), mock-drill or table top exercise for EAP testing and improvement. Design of an incident management system, types, and design process of a warning system network in the flood plain. Integration of the Dam EAP with the District/State Disaster Management Plan. Practical workshop or hands-on exercises.	5
8.	<b>Environmental Management:</b> Introduction; Existing Policies and Legal Framework; Procedure for Environment, Forest and Wildlife Clearances; EIA Procedure; Environmental Management and Control; External Funding Agency's Policy and Requirements on Environmental and Social Safeguards	3
<b>Total</b>		<b>42</b>

### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	"National Disaster Management Guidelines", Government of India	2007
2.	Baas S., "Disaster Risk Management Systems Analysis: A Guide Book", Italy: Food and Agriculture Organization of the United Nations	2008
3.	"Swaziland Disaster Risk Reduction National Action Plan", 2008 to 2015. Eswatini: Swaziland Government	2008
4.	MacDonald W. and Ritchie L. A., "Enhancing Disaster and Emergency Preparedness, Response, and Recovery Through Evaluation: New Directions for Evaluation", Number 126, United Kingdom: Wiley	2010
5.	Dwivedi O., "India's Environmental Policies, Programmes and Stewardship". United Kingdom: Palgrave Macmillan UK	2016
6.	Huggel C. and Singh R., "Climate Change, Extreme Events and Disaster Risk Reduction: Towards Sustainable Development Goals", Germany: Springer International Publishing	2017
7.	"Environmental Modelling with GIS and Remote Sensing", United Kingdom: Taylor & Francis	2017
8.	Esmail M., and Abdalla R., "WebGIS for Disaster Management and Emergency Response", Germany: Springer International Publishing	2018
9.	"Emergency and Disaster Management: Concepts, Methodologies, Tools, and Applications", United States: IGI Global	2018
10.	Mondal D. and Basu D., "Disaster Management Concepts and Approaches", CBS Publishers and Distributors	2020

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-503                      **Course Title:** Hydrologic Safety Evaluation of Dams
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:** CWS: 20-35                      PRS: 0                      MTE: 20-30                      ETE: 40-50                      PRE: 0
5. **Credits:** 4                      6. **Semester:** Autumn                      7. **Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the knowledge and aspects of Hydrologic Evaluations for dam safety.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	<b>Design Flood Analysis:</b> Design flood estimation by Hydro-meteorological approach: Concept of Unit hydrograph, design storm, depth estimation from PMP Atlas, clock hour correction, areal reduction factor, Storm transposition, Location Adjustment Factor (LAF), Barrier Adjustment Factor (BAF), Transposition Adjustment Factor (TAF), Moisture Maximization Factor (MMF), loss rate, base flow, time distribution coefficient, HEC-HMS model	8
2.	<b>Design flood estimation by flood frequency approach:</b> Statistical tests on flood data, stationary and non-stationary flood frequency analysis, computation of return period floods, Goodness of fit tests	8
3.	<b>Channel routing:</b> Hydrological and hydraulic channel routing	4
4.	<b>Reservoir routing:</b> Modified Pul's and other applicable methods	3
5.	<b>Dam Breach Modelling:</b> Parameters estimation methodologies, Breach outflow routing (Upstream Flood Routing methodologies, Downstream Flood Routing methodologies, two-dimensional depth averaged models, one-dimensional models and coupled 2D-1D models, Modelling Software available), Practical workshop or hands-on exercises for three different levels of detail in dam breach modelling (Tier I, II and III)	8
6.	<b>Reservoir Rule Curve:</b> Consistency check of inflow data, computation of percentile and dependable flow, derivation of rule curve, conservation rule curve, upper rule curve, testing of rule curve for different dependable flows	5
7.	<b>Hydrological safety under changing climate:</b> Climate change, Changes in precipitation domain and its impact of inflows.	6
<b>Total</b>		<b>42</b>

# 11. Suggested Books:

S.No.	Contents	Contact hours
1.	“Statistical Distributions for Flood Frequency Analysis”, WMO operational hydrology report no. 33.	1989
2.	“Design Flood Estimation Manual”, Central Water Commission, New Delhi	2000
3.	Haan C. T., “Statistical Methods in Hydrology”, Wiley Publication, 378 pages	2002
4.	Hosking, J.R.M. and Wallice J.R. “Regional Frequency Analysis- An Approach Based on L-Moments”, Cambridge University Press.	2005
5.	“Guide to hydrological practices”, World Meteorological Organization (WMO)	2008
6.	Boes R. M. and Schleiss A. J., “Dams and Reservoirs Under Changing Challenges”, Netherlands: CRC Press	2011
7.	AghaKouchak A., Easterling D., Hsu K., Schubert S. and Sorooshian S. (Eds.), “Extremes in a changing climate: detection, analysis and uncertainty (Vol. 65)”, Springer Science & Business Media	2012
8.	Beven, K.J. “Rainfall-Runoff Modelling: The Primer”, 2nd Edition, Wiley-Blackwell	2012
9.	Zhang J., Zhang L. and Wang R., “Dam Breach Modelling and Risk Disposal: Proceedings of the First International Conference on Embankment Dams (ICED 2020)”, Germany: Springer International Publishing	2020
10.	Xu Y., Zhang L., Chang D. and Peng M., “Dam Failure Mechanisms and Risk Assessment”, Singapore: Wiley	2016
11.	“Flood Evaluation and Dam Safety”, United States: CRC Press	2018

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-504                      **Course Title:** Sediment Management in Reservoirs
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Spring                      7. **Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the background of sedimentation in reservoirs, its assessment and measurement, various options to manage sedimentation of the reservoir.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Sediment Management; Magnitude of the Problem	2
2.	<b>Erosion and Sedimentation in Drainage Basins:</b> Weathering and Erosion Processes, sediment properties, modes of sediment transport, mathematical models, Sediment Delivery Ratio, Rates of Erosion and Delivery, Human Impact on Sediment Yield, Impact of Natural Events, Measurement of Sediment Load	8
3.	<b>Reservoir Sedimentation Process:</b> Hydrological and Hydraulic Processes, Erosion, Transport and Sedimentation, Sources and Processes, Morphological Processes, Sediment Size, Entrainment, Suspension, Suspended Material Load, Bed Material Load, Unit Weight of Deposits, Delta Formation	5
4.	<b>Reservoir sedimentation:</b> Computation of sediment yield, trap efficiency, distribution of sediment in reservoir, new zero elevation	5
5.	<b>Predictive Methods for Reservoir Sedimentation:</b> Measurement and Monitoring Techniques, Empirical and Analytical Methods, Physical Modelling, Satellite, UAV and USV, Post-Processing and Analysis Tools for Topo-Bathymetric Data, Computational Modelling	6
6.	<b>Mitigation of Reservoir Siltation:</b> Erosion and Sedimentation Control, Sediment Routing, Sediment Removal, Structural and Non-Structural Adaptive Measures, Watershed Management, Check Dams, Sediment Bypassing, Sediment Flushing, Sediment Sluicing, Density Current venting, Sediment Dredging	6
7.	<b>Reservoir Sedimentation in India:</b> National Records and Regulation of Dams in India, Indian Standard Code, Guidelines and Compendium on Reservoir Sedimentation, Reservoir Sediment Management in India, Sedimentation Data and Observation in Selected Reservoirs, Sediment	6

	Management in Indian Reservoirs: Good Practices and Problems, published Indian case studies from journals	
8.	Reservoir sedimentation- International Practices	4
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Annandale G.W., "Reservoir sedimentation", Elsevier, New York	1987
2.	Morris G. L. and Fan J., "Reservoir sedimentation handbook: design and management of dams, reservoirs, and watersheds for sustainable use", McGraw Hill Professional	1998
3.	Garde R.J. and Raju K., "Mechanics of Sediment Transportation and Alluvial Streams Problems", Taylor & Francis	2006
4.	"Reservoir Sediment Management Hardcover"-Illustrated, CRC Press, 1st edition	2011
5.	Tigrek S. and Aras T., "Reservoir sediment management", CRC Press, Taylor & Francis Group, Boca Raton	2012
6.	Bhattacharyya K. and Singh V. P., "Reservoir Sedimentation: Assessment and Environmental Controls", CRC Press, Taylor & Francis Group, Boca Raton	2019
7.	"Handbook for Assessing and Managing Reservoir Sedimentation", DRIP, DoWR, MoJ, GoI	2019

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-505                      **Course Title:** Dam Safety Surveillance Instrumentation and Monitoring
2. **Contact Hours:**                      **L:** 2                      **T:** 1                      **P:** 2/2
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 15-30                      **PRS:** 20                      **MTE:** 15-25                      **ETE:** 30-40                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Spring                      7. **Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the concepts of dam inspection, monitoring etc. and explore the theory and practical knowledge for the dam safety surveillance instrumentation.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Dam Safety Inspection Program:</b> Types, preparing for an Inspection, Inspecting Embankment Dams, Concrete and Masonry Dams, Spillways, Outlets and Mechanical Equipment, Inspecting General Areas, Visual Inspection using remotely Operated Vehicles (ROVs), Use of Remotely Operated Underwater Vehicles (ROVs), Use of Unmanned Aerial Vehicles (UAVs)	4
2.	<b>Documenting an Inspection:</b> Method, Checklist, Field Sketches, Photographs, Monitoring Data, Global Positioning Sensors (GPS), Inspection Notes, Visual Inspection Documentation, Writing an Inspection Report, Comprehensive Inspection Report.	8
3.	<b>Comprehensive Dam Safety Review:</b> Procedures, Details to be provided to DSRP before inspection, Composition of DSRP, Reports of Comprehensive Safety Evaluation, Roles and the Responsibilities of Dam Safety Review Panel, Empanelment of Members of DSRP	5
4.	<b>Instrumentation and Monitoring:</b> Monitoring Frequency, Measurement of Seepage and Leakage, Movement, Types of Movement, Reservoir / Tail water Elevations, Staff Gauge, Precipitation, Local Seismic Activity, Stress and Strain, Types of Pressure (Stress) Measuring Devices, Temperature, Critical Physical Data to be monitored, Data Evaluation. <b>Instrumentation System Planning: Embankment Dams:</b> Instrumenting Existing Embankment Dams, Monitoring Seepage and Water Pressure, Monitoring Soil Stresses, Indian Standards Instrumentation System Planning, Instrumentation System Planning: Seismic Monitoring, Instrumentation of Existing Dam	5
5.	<b>Hydro-Meteorological Instrumentation:</b> Measurement, Recording, Installation, Data validation, Errors in measurement of rainfall, temperature,	4

	relative humidity, wind speed, evaporation, snowfall, water level, suspended load etc.	
6.	<b>Instrumentation Data Collection and Management:</b> Introduction, Data Collection, Manual Data Collection, Stand Alone Data loggers, Real time Monitoring Networks, Advantages and Disadvantages, Data Management and Presentation, Database software, Data Processing, Data Maintenance, Data Presentation, Critical Data Analysis.	8
7.	<b>Monitoring Data Organization and Analysis:</b> Introduction, Design Aspects, Numerical Modelling, Back Analysis for Calibration, Dynamic Loading, Dynamic Analysis, Monitoring Data Analysis, The Purposes of Monitoring Data Analysis, Automatic Data Acquisition, Evaluation of Measurement Data, Data analysis and Evaluation Summary	5
8.	<b>Automation of Instrumentation:</b> Power for remote equipment, Vandalism, Lightning protection, Notification protocols, Data Acquisition and Management	3
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Bartholomew C. L. and Murray B. C., "Embankment dam instrumentation manual", US Department of the Interior, Bureau of Reclamation	1987
2.	Dunnicliff J., "Geotechnical instrumentation for monitoring field performance", John Wiley & Sons	1993
3.	Penman A.D.M., Saxena K.R. and Varma V.M., "Instrumentation, Monitoring and Surveillance: Embankment, Dams", Hardcover, Routledge	1999
4.	"Guidelines for instrumentation and measurements for monitoring dam performance", ASCE Task Committee on Instrumentation and Dam Performance	2000
5.	Roth J. J. and Hughes W., "Dam Maintenance and Rehabilitation II". CRC Press	2010
6.	"Guidelines for instrumentation of large dams" GoI, CWC, Central Dam Safety Organization, New Delhi	2018
7.	"Guidelines for preparing operation and maintenance manual for dams", CWC, DoWR, MoJ, GoI, New Delhi	2018
8.	"Guidelines for safety inspections of dams", CWC, DoWR, MoJ, GoI, New Delhi	2018
9.	Penman A. D., "Instrumentation, monitoring and surveillance: embankment dams", Routledge	2018
10.	"Monitoring Dam Performance: Instrumentation and Measurements", United States: American Society of Civil Engineers	2018
11.	Technical Specifications of Hydro-meteorological, Geodetic, Geotechnical and Seismic Instruments	2018

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-511                      **Course Title:** Seepage through Dams
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To develop the understanding of basic principles and concepts of Seepage and its control in Dams.

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	Importance of seepage in dam safety and rehabilitation, Types and causes of seepage through various types of Dams	4
2.	Fundamentals of seepage through porous media, Darcy's law, seepage velocity, Dupuits theory, Seepage charts, Phreatic lines, Flow nets, Determination of free surface and seepage discharge through dams for isotropic and anisotropic media. Flow net for earth dam under steady/transient seepage condition, the stability of dams	10
3.	Seepage Analysis, Boundary conditions, numerical techniques and modelling tools, Phreatic line with and without filter, stability conditions	5
4.	Seepage through main body of various types of dams; Measurement of seepage water in galleries, Various methods of seepage control, Selection of core materials, Drainage of embankments, Design criteria of filters, Use of geo-textiles, Seepage Control through Embankments, Foundations	7
5.	Seepage through bottom of reservoir area; various types of geological formations in the bed; identification techniques to know the seepage from the beds, Dam Grouting, Design and installation of grout curtains	6
6.	Seepage detection, control and monitoring, Plan and design of various dams and adopt suitable measures for its safety	6
7.	Practical examples and site visits	4
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Sherard J. L., "Earth and Earth-rock Dams: Engineering Problems of Design and Construction", United States: John Wiley & Sons	1967



2.	Mahgerefteh K., “Seepage and Stability Analysis of Earth Dams”, (n.p.): Virginia Polytechnic Institute and State University	1979
3.	“Seepage Analysis and Control for Dams: Engineering and Design”, Department of the Army, Corps of Engineers, Office of the Chief of Engineers	1986
4.	Cedergren H. R., “Seepage, Drainage, and Flow Nets” (Vol. 16). John Wiley & Sons	1997
5.	Bedmar A. P. and Araguas L., “Detection and prevention of leaks from dams”, Netherlands: Taylor & Francis	2002
6.	Pezhman T.G., Junaidah A., Amirhoss M., “Seepage Modelling of the Dam” Paperback – Import, 28, Scholars Press; Illustrated edition	2004
7.	“Internal Erosion of Dams and Their Foundations: Selected and Reviewed Papers from the Workshop on Internal Erosion and Piping of Dams and Their Foundations”, Aussois, France, Netherlands: Taylor & Francis	2007
8.	Garg S. K., “Irrigation Engineering and Hydraulic Structures” Twenty-fourth Revised Edition.	2011
9.	Jansen R. B., “Advanced dam engineering for design, construction, and rehabilitation”, Springer Science & Business Media	2012
10.	Guyer, J.P. “An Introduction to Seepage Mitigation in Embankment Dams”, The Clubhouse Press	2020

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-512      **Course Title:** Assessment and Management of Environmental Issues in Reservoirs
2. **Contact Hours:**      **L:** 3      **T:** 1      **P:** 0
3. **Examination Duration (Hrs.):**      **Theory:** 3      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35      **PRS:** 0      **MTE:** 20-30      **ETE:** 40-50      **PRE:** 0
5. **Credits:** 4      6. **Semester:** Both      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide background of ecosystem, environment, legal issues, guidelines etc. and necessary practices and application on environmental issues in reservoirs.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Water quality issues:</b> Impact of reservoir on water flow; Impacts on thermal regime; Water chemistry; Sedimentation; Nutrient enrichment; Water pollution; Emission of greenhouse gases; Climate change; Hydrological and water quality impacts; Soil and landscape changes; Agro-economic issues; Human health impacts.	7
2.	<b>Ecosystem resilience issues:</b> Concept of an Ecosystem; importance of biological diversity; Destruction in ecosystem; Impacts on organisms and biodiversity; Influence in primary production; Effects on aquatic ecosystems; Value of ecosystem goods and services; Social and cultural impacts	8
3.	<b>Assessment of carbon footprints in dams</b>	2
4.	<b>Guidelines and Standard Codes:</b> Introduction; National and international legislative frameworks, codes; Future challenges.	5
5.	<b>EIA methods and Tools:</b> Introduction; basic principles of EIA for reservoir; Development of scope; Mandate and study design; Base line survey; Methodology for EIA; Economic approaches; Environmental Impact Statement (EIS) preparation; temporal and spatial scales; socio-environmental factors; Planning and reservoir management; case studies.	8
6.	<b>Environmental Clearances:</b> Introduction; Requirement for environmental clearances; Procedure for environmental clearances; Analysis of alternatives	5
7.	<b>Legal Issues:</b> Introduction; Policy, legal and regulatory compliance; Statutory clearance approval and permissions	5
8.	<b>Societal considerations in dams:</b> Societal considerations, Gender related issues in Dam safety and rehabilitation	2
<b>Total</b>		<b>42</b>

# 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Govardhan V., “Environmental Impact Assessment of Tehri Dam, India”, Ashish Publishing House	1993
2.	Canter L.W., “Environmental Impact Assessment”. McGraw Hill International Edition, New York	1995
3.	Petts J., “Handbook of Environmental Impact Assessment”, Vol., I and II, Blackwell Science London	1999
4.	Barathwal R. R., “Environmental Impact Assessment”, New Age International Publishers, New Delhi	2002
5.	Lawrence D. P., “Environmental Impact Assessment – Practical solutions to recurrent problems”, Wiley-Inter Science, New Jersey	2003
6.	Berga L., Buil J. M., Bofill E., De Cea J. C., Perez J. G., Mañueco G., and Yagüe J., “Dams and Reservoirs, Societies and Environment in the 21st Century”, Two Volume Set: Proceedings of the International Symposium on Dams in the Societies of the 21st Century, 22nd International Congress on Large Dams (ICOLD), Barcelona, Spain, CRC Press	2006
7.	“Issues in Environmental Law, Policy, and Planning: 2012” Edition United States: Scholarly Editions	2013
8.	“Evolution of Dam Policies: Evidence from the Big Hydropower States”, Germany: Springer Berlin Heidelberg	2014
9.	Dević G., “Environmental Impacts of Reservoirs”, In: Armon R., Hänninen O. (eds), Environmental Indicators, Springer, Dordrecht. <a href="https://doi.org/10.1007/978-94-017-9499-2_33">https://doi.org/10.1007/978-94-017-9499-2_33</a>	2015
10.	Annandale G. W., Morris G. L. and Karki P., “Extending the life of reservoirs: sustainable sediment management for dams and run-of-river hydropower. The World Bank. <a href="https://doi.org/10.1596/978-1-4648-0838-8">https://doi.org/10.1596/978-1-4648-0838-8</a>	2016
11.	Shah A. and Mareddy A. R., “Environmental Impact Assessment: Theory and Practice”, India: Elsevier Science	2017
12.	“Water Conflicts in Northeast India”, Taylor & Francis	2017
13.	Khagram S., “Dams and Development: Transnational Struggles for Water and Power”, United States: Cornell University Press	2018
14.	Singh A., Saha D. and Tyagi A. C., “Water governance: challenges and prospects”, Singapore: Springer	2019

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-513                      **Course Title:** Earthquake Geotechnical Engineering
2. **Contact Hours:**                      **L:** 2                      **T:** 1                      **P:** 2/2
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 15-30                      **PRS:** 20                      **MTE:** 15-25                      **ETE:** 30-40                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** The objective is to introduce the potential consequences of strong earthquakes on dam site areas for Design, construct and maintain the safety and evaluation.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Earthquakes, characteristics and distribution, tectonic features of the earth, geo-tectonic divisions of the Indian continent, geologic hazards perception. Background and lessons learnt from damages in past earthquakes.	3
2.	<b>Earthquakes in Different Geological Set-Ups:</b> Geological structures and deformation pattern, inter and intra – continent set up, convergent zones, divergent margins, trenches, thrusts and faults. Earthquake implication of structural discontinuities, the impact of the neo-tectonic activity.	3
3.	<b>Mapping:</b> Coordinate and coordinate systems; geographical and map projection system, 2D and 3D data transformation, types of maps, scales, map sheet numbering systems and uses, types of maps, introduction to topographical and geological maps, thematical maps, geological sections, data processing, analysis and presentation techniques.	2
4.	<b>Wave Propagation:</b> Waves in semi-infinite media – one-, two- and three-dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, waves in a layered medium.	2
5.	<b>Dynamic Soil Properties:</b> Stress & strain conditions, the concept of stress path; Measurement of seismic response of soil at low and high strain, using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, plate load test, block vibration test, SASW/MASW tests, cross borehole; Evaluation of damping and elastic coefficients; Stress-strain behaviour of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear and cyclic nonlinear models; Static and dynamic characteristics of soils.	4
6.	<b>Ground Response Analysis:</b> Introduction-, one-, two- and three-dimensional analyses; Equivalent and nonlinear finite element approaches; Introduction to soil-structure interaction.	2

7.	<b>Liquefaction:</b> Introduction; pore pressure, liquefaction related phenomena – flow liquefaction and cyclic mobility; Factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility; State Criteria –CVR line, SSL, FLS; <b>Evaluation of liquefaction potential:</b> characterization of earthquake loading and liquefaction resistance, cyclic stress ratio, Seed and Idriss method; Effects of liquefaction.	3
8.	<b>Earth Pressure:</b> Active and passive earth pressures; Terzaghi's passive wedge theory, numerical methods, earth pressure measurements.; Seismic design of retaining walls: types, modes of failures, static pressure, seismic response (including M-O Method), seismic displacement, design considerations.	2
9.	<b>Seismic Slope Stability:</b> Types of earthquake-induced landslides; Evaluation of slope stability – stability analysis with dynamic loading, friction circle method, effective and total stress methods of analysis, factor of safety, yield acceleration, damage potential, displacement analysis, effect of saturated and submerged conditions, FEM analysis of slope stability.	3
10.	<b>Remote Sensing in Earthquake Geology:</b> Basic concepts of satellite imaging of ground, types of satellite data in identifying the tectonic features, recognising characteristics of earthquake deformation features, SAR interferometry for earthquake deformation studies; Application of GPS for mapping;	4
<b>Total</b>		<b>28</b>

**List of Experiments:** Processing of pre and post-earthquake satellite images, Collection of data using GPS and mapping, Use of SAR interferometry for surface displacement measurement, Liquefaction Resistance of Soil using Vibration Table, Shear Velocity Profile using MASW,  $N$  values of cohesionless soils using SPT,  $c$  and  $\Phi$  of soil using direct shear/triaxial tests, Liquefaction resistance of soil using cyclic triaxial test apparatus, Determination of dynamic properties using laboratory tests; Shear velocity profile using cross-bore test; Model Testing on Small Geotechnical Centrifuge.

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Prakash S., "Soil Dynamics", McGraw Hill Book Company	1981
2.	Mather P.M., "Computer Processing of Remotely Sensed Images", John Wiley	1999
3.	Demers Michael N., "Fundamentals of Geographic Information Systems", John Willey	2000
4.	Gibson P.J. and Power C.H., "Introductory Remote Sensing – Digital Image Processing and applications", Routledge	2000
5.	Kameshwara Rao, N.S.V, "Dynamic Soil Tests & Applications", Wheeler Publications	2000
6.	Ranjan G. and Rao A.S.R., "Basic and Applied Soil Mechanics", New Age Int. Ltd	2000

7.	Day Robert W., "Geotechnical Earthquake Engineering Handbook", McGraw-Hill	2001
8.	Hoffmann-Wellenhoff B., "GPS Theory & Practice", Springer	2001
9.	Kramer S.L., "Geotechnical-Earthquake Engineering", Pearson Education – Indian Low-Price Edition	2004
10.	Chandra A.M. and Ghosh S.K., "Remote Sensing and Geographical Information System", Narosa, Oxford: Alpha Science International	2006
11.	Saran S., "Soil Dynamics & Machine Foundation", Galgotia Publication, New Delhi	2006
12.	Das B. M. and Ramana G.V., "Principles of soil dynamics", Cengage Learning	2011

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-514 **Course Title:** Study Tour/ Case Studies
2. **Contact Hours:** **L:** 2 **T:** 1 **P:** 2/2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 15-30 **PRS:** 20 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To reinforce the understanding of different physical aspects of dams through the case studies and visits to major national and international dams.

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Introduction to dams; types of dams; major dams in India and abroad; characteristics of major dams.	2
2.	<b>Case studies:</b> Case studies on major dams in India and abroad, such as Tehri Dam, Hirakund Dam, Tungabhadra Dam, Bhakra Nangal Dam, Nagarjuna Sagar Dam and Krishnasagar dam	2
3.	<b>Discussions on Detailed Project Report (DPRs) of major dams:</b> Introduction to DPRs; understanding the different elements of DPRs: survey & investigation, geology, hydrology, structural design, hydro-mechanical design, power generation, cost estimates, etc.; discussions on DPRs	4
4.	<b>Field visits to majors dams:</b> Visits to some of the dams; visit reports; and discussions. Tehri Dam, Hirakund Dam, Tungabhadra Dam, Bhakra Nangal Dam, Nagarjuna Sagar Dam and Krisnasagar dam	2
5.	<b>Expert lectures:</b> Lectures by experts from different national and international agencies/institutes on design and operations of dams.	4
6.	Provision of the visit to one or cluster of the international dams following the best practices during semester breaks	-
<b>Total</b>		<b>14</b>

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Detailed Project Report (DPRs) of major dams	
2.	“Advanced Dam Engineering for Design, Construction, and Rehabilitation”, United States: Springer US	1988

3.	Paranjpye V. “Evaluating the Tehri Dam: An Extended Cost Benefit Appraisal”, India: Indian National Trust for Art and Cultural Heritage	1988
4.	Weaver K. D., “Dam Foundation Grouting”, United States: American Society of Civil Engineers	1991
5.	Jain S. K., Singh V. P. and Agarwal P. K., “Hydrology and Water Resources of India”, Germany: Springer Netherlands	2007
6.	Ramanathan K. and Abeygunawardena P., “Hydropower Development in India: A Sector Assessment”, Philippines: Asian Development Bank	2007
7.	Scudder T. T., “The Future of Large Dams: Dealing with Social, Environmental, Institutional and Political Costs”, Iran: Taylor & Francis	2012
8.	“Dam and Levee Safety and Community Resilience: A Vision for Future Practice”, United States: National Academies Press	2012



## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-515 **Course Title:** Geo-Mechanics
2. **Contact Hours:** L: 3 T: 1 P: 0
3. **Examination Duration (Hrs.):** Theory: 3 Practical: 0
4. **Relative Weightage:** CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0
5. **Credits:** 4 6. **Semester:** Both 7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide *mechanical* behaviour of geological materials. The engineering aspects of these studies, or applied *geo-mechanics*.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Basics of Engineering Geology:</b> A brief about Earth's Interior and Plate Tectonics; brief about Minerals, Formation of minerals and their Classification; Types of Rock: Igneous, Sedimentary and Metamorphic; Formation of Rocks and Rock Cycle; Classification and Properties of Rocks; Weathering, Erosion and Soil Formation;	4
2.	<b>Structural Geology:</b> Structural Configuration of Strata: Strike, Dip, Bedding Plane, etc., Types of Fractures: Joints, Faults, Folds, Unconformity; Formation and Classification of Joints, Faults and Folds; Effects of Joints, Faulting, Folding and their Civil Engineering Importance; Shear Zone; Topographic and Geological Maps;	8
3.	<b>Engineering Properties of Rocks:</b> Engineering Properties of Rocks; Rock Deformation: Hooke's Law, Volumetric Strain, Elastic Moduli; <b>Types of Rock Stresses:</b> In-situ Stresses, Induced Stress;	5
4.	<b>Hydrological Studies:</b> Sources of Ground Water; Aquifer, Aquiclude, Aquitard and Aquifuge; Types of Aquifer: Unconfined and Confined; Permeability of Rock mass and its test; Chemical properties of Ground Water and its effects on Rock Mass; <b>Geological Exploration:</b> Bore Holes (Vertical and inclined), Drifts in Abutments; Methods of Drilling;	5
5.	<b>Rock Strength and Rock Mass Strength:</b> Rock Strength Test and Rock Failure Criteria; Rock Mass Strength and its measurement; Rock Mass Classification: Rock Mass Rating and Norwegian Q System;	4
6.	Geophysical Methods and their Suitability; <b>Geology of Dam sites and Reservoirs -</b> Importance of Geology in Dam Construction; Types of Dams and bearing of Geology in their selection; Geological considerations in the selection of a Dam Site; Factors affecting	8

	the Feasibility of Reservoir Site; Investigation of Reservoir Sites; Geological Considerations and the Stability of the Sides of Reservoirs; Sedimentation in Reservoir and Leakage from Reservoir;	
7.	<b>Geological Hazards</b> - Landslides, Subsidence; Slope Stability; Slope Strengthening and Stabilization Effect of Reservoir and Tunnel Construction;	5
8.	Numerical and computer methods in Geomechanics.	3
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Desai C. S. and Christian J. T., "Numerical Methods in Geotechnical Engineering", McGraw-Hill	1977
2.	Goodman R. E., "Introduction to Rock Mechanics", 2nd Edition, Wiley	1988
3.	Hudson J. A. and Harrison J. P., "Engineering rock mechanics: an introduction to the principles", Elsevier	1997
4.	Bell F. G., "Geological Hazards: Their Assessment, Avoidance and Mitigation", United Kingdom: Taylor & Francis	2003
5.	Jager J. C., Cook N. G. W. and Zimmerman R., "Fundamental Rock Mechanics", 4 <sup>th</sup> Edition, Wiley	2007
6.	Peng S. and Zhang J., "Engineering geology for underground rocks", Springer Science & Business Media	2007
7.	Farmer I. W., "Engineering behaviour of rocks", Springer Science & Business Media	2012
8.	Zhang L., "Engineering Properties of Rocks", Germany: Elsevier Science	2016
9.	Wyllie D. and Mah C. W., "Rock Slope Engineering", 5 <sup>th</sup> Edition, CRC Press	2017
10.	Kesavulu N. C., "A Textbook of Engineering Geology", Laxmi Publications	2018
11.	Desai C. S., Prashant A. and Sachan A., "Advances in Computer Methods and Geomechanics: IACMAG Symposium 2019 Volume 1", Germany: Springer Singapore	2020
12.	Pollard D. D. and Martel S. J., "Structural Geology: A Quantitative Introduction", United Kingdom: Cambridge University Press	2020

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-516                      **Course Title:** Geospatial Technology for Monitoring of Dams
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:** CWS: 20-35                      PRS: 0                      MTE: 20-30                      ETE: 40-50                      PRE: 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** This course will impart the knowledge and application of geospatial technologies in monitoring changes in geomorphological characteristics and structural changes of dams and other hydraulic structures.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	Overview of Geospatial Technologies	2
2.	Introduction to optical remote sensing and its applications to surface water changes; Fundamentals of Digital Image Processing	4
3.	Introduction to microwave (SAR) remote sensing; InSAR processing and its application to dam monitoring and associated tools/software; Structural Monitoring of Dam Structures using SAR	6
4.	Introduction to UAV sensing; various components of UAV; autonomous UAVs; UAV data collection and processing methods; Indian Regulatory Systems for UAV sensing	6
5.	Introduction to LiDAR; LiDAR data collection methods; Application of LiDAR technology to dam monitoring	6
6.	Introduction to GPS Systems; GPS data collection techniques; Application of GPS to dam monitoring	6
7.	Monitoring of Catchment Characteristics using geospatial technologies: Snow covered areas and rain-fed areas	6
8.	Monitoring of landslide zones using geospatial technologies and their representation in GIS	3
9.	Application of geospatial technologies for land use/cover change monitoring in flood-prone downstream areas of dams and risk assessment	3
<b>Total</b>		<b>42</b>

### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Burrough P.A. and McDonnell R.A., "Principles of Geographic Information System", Oxford University Press	2000

2.	Joseph G., “Fundamentals of Remote Sensing”, India: Universities Press	2005
3.	Nayak S. and Zlatanova S., “Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters”, Germany: Springer Berlin Heidelberg	2008
4.	Richards J.A., “Remote Sensing Digital Image Analysis”, Springer	2013
5.	Ferretti A., “Satellite InSAR Data – Reservoir Monitoring from Space”, Eage Publications	2014
6.	Thenkabail P.S., “Remote Sensed Data Characterization, Classification, and Accuracies”, CRC Press	2016
7.	Shaw R., “Land Use Management in Disaster Risk Reduction: Practice and Cases from a Global Perspective”, Japan: Springer Japan	2016
8.	Dong P and Chen Q., “LiDAR Remote Sensing Applications”, CRC Press	2018
9.	Shimada M., “Imaging from Spaceborne and Airborne SARs, Calibration, and Applications”, Taylor and Francis	2018
10.	Garg P.K., “Introduction to Unmanned Aerial Vehicles”, New Age International Publishers	2020

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-517      **Course Title:** Hydraulic and Structural Design of Dams, Spillways and Energy Dissipators
2. **Contact Hours:**      **L:** 3      **T:** 1      **P:** 0
3. **Examination Duration (Hrs.):**      **Theory:** 3      **Practical:** 0
4. **Relative Weightage:** CWS: 20-35      PRS: 0      MTE: 20-30      ETE: 40-50      PRE: 0
5. **Credits:** 4      6. **Semester:** Both      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To discuss design methodology for dams, spillways and energy dissipators.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	Introduction to hydraulic structures and their necessity.	2
2.	<b>Embankment Dams:</b> Types, design considerations, seepage analysis and control, stability analysis, construction techniques	7
3.	<b>Gravity Dams:</b> Forces acting on failure of a gravity dam, stress analysis, elementary profile, design of gravity dam, other functional features of a gravity dam	7
4.	<b>Spillways:</b> Types and their design, Ogee spillway, Chute and side spillway, Shaft spillway, Labyrinth and Piano Key Weirs, spillway gates, cavitation, aerators, inflatable rubber weirs, stepped spillway, nappe and skimming flow	7
5.	<b>Energy dissipators:</b> Necessity, Types and their selection, design of hydraulic jump type stilling basins, Bucket and Flip type energy dissipators, Impact and pipe outlet	9
6.	Supercritical flow, oblique jump, supercritical transition	3
7.	Hydraulic modelling of spillways and energy dissipators, dimensional analysis, modelling of turbulence, friction, air entrainment etc., scale effects,	3
8.	Life time assessment of dam and associated works	4
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Creager W. P., Justin J. D. W. and Hinds J., "Engineering for Dams, Vol I & Vol II", John Wiley & Sons	1945
2.	Peterka A. J., "Hydraulic design of stilling basins and energy dissipators", USBR Engineering Monographs No. 25	1984

3.	“Design of Small Dams-Third Edition”, A Water Resources Technical, Publication - US Bureau of Reclamation	1987
4.	Hager W.H. and Vischer D.L., “Energy Dissipators: IAHR Hydraulic Structures Design Manuals”, CRC Press	1992
5.	Varshney R. S., “Engineering for Embankment Dams”, Netherlands: A.A. Balkema Publishers.	1995
6.	Varshney R. S., “Hydro Power Structures”, Nem Chand & Bros., Roorkee	2001
7.	Khatsuria R. M., “Hydraulics of spillways and energy dissipators”, CRC Press	2004
8.	Singh B. and Varshney R. S., “Embankment Dam and Engineering”, Nem Chand & Bros, Roorkee	2004
9.	Novak P. and Nalluri C., “Hydraulic Structures”, Edition 4, Taylor & Francis	2007
10.	Chanson H., “Energy Dissipation in Hydraulic Structures” Netherlands: CRC Press	2015
11.	Nalluri C., Narayanan R., Novak P. and Moffat A., “Hydraulic Structures”, United States: CRC Press	2017
12.	Guyer J. P., “An Introduction to Construction Control for Embankment Dams”, Amazon Digital Services LLC - KDP Print US	2019

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-518                      **Course Title:** Ground Improvement and Geosynthetics
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the ground improvement techniques and geo-synthetics for the dam safety, repair and rehabilitation.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Basics:</b> Principles of ground improvement, Types/Classification of ground improvement techniques. Mechanical modification, Types of compaction techniques, Properties of compacted soil. Hydraulic modification, dewatering systems, preloading and vertical drains, electro-kinetic dewatering, chemical modification, modification by admixtures, stabilization using industrial wastes, grouting, soil reinforcement principles,	6
2.	<b>Methods of stabilizations:</b> – Mechanical – Admixture (Cement/Lime) - Bituminous - Chemical. Types of admixture stabilisation- Grouting (permeation grouting, compaction grouting, jet grouting), Deep Soil Mixing, Mass Soil Stabilisation, Cutter Soil Mixing. Grouting: - basic functions- permeation-compaction-hydro fracture, classification of grouts- grout ability ratio- properties of grouts - viscosity, stability, fluidity, rigidity, thixotropy, permanence Grouting applications: - seepage control in soil and rock under dams- seepage control in soil for cut off walls – stabilization grouting for underpinning. Properties of admixture stabilised soils, Design of hydraulic cut-off walls, grout curtains.	10
3.	<b>Geosynthetics:</b> Properties of geosynthetics and its testing, applications of geosynthetics in bearing capacity improvement, slope stability, retaining walls, embankments on soft soil, and pavements, filtration, drainage and seepage control with geosynthetics, geosynthetics in landfills, soil nailing and other applications of geosynthetics. improvement of ground using geomembranes, geocells, geonets, geotubes	8
4.	<b>Reinforced earth:</b> - Mechanism- types of reinforcing elements- reinforcement-soil interaction –applications- reinforced soil structures with vertical faces. Design of reinforced earth retaining walls, reinforced earth embankments structures	6

5.	<b>Advances</b> in ground improvement technologies- thermal stabilisation, biotechnical stabilization, hydroseeding etc.	2
6.	<b>Case Studies:</b> Different case studies in India and around the world in the field of Ground Improvement and Geosynthetics.	10
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	“Reinforced Soil Engineering: Advances in Research and Practice”, Switzerland: Taylor & Francis	2003
2.	Indraratna B., Chu J., Hudson H.A., “Ground Improvement- Case Histories”, Elsevier	2005
3.	Saran S., “Reinforced Soil and Its Engineering Applications”, I.K. International	2005
4.	Shukla S.K. and Yin J. H., “Fundamentals of Geosynthetic Engineering”, Taylor & Francis	2006
5.	Rao G.V., “Geosynthetics – An Introduction”, Sai Master geo-environmental services	2007
6.	Kitazume M., and Terashi M., “The Deep Mixing Method”, CRC Press	2012
7.	Koerner R.M., “Designing with Geosynthetics”, Sixth Edition, Xlibris Corporation	2012
8.	Kirsch K. and Bell A., “Ground Improvement”, Third Edition, CRC Press	2013
9.	Mittal S., “An Introduction to Ground Improvement Engineering”, Medtech	2013
10.	Denies N., and Huybrechts N., “Handbook- Soil mix walls, Design and Execution”, First Edition, CRC Press	2018
11.	“Ground Improvement Techniques and Geosynthetics: IGC 2016 Vol (2)”, Germany: Springer Singapore,	2018
12.	Huat B. B., Anggraini V., Prasad A. and Kazemian S., “Ground Improvement Techniques”, Netherlands: CRC Press	2019



## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-519                      **Course Title:** Contract and Financial Management
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To ensure and aware to the contract and financial management over respective obligations as efficiently and effectively as possible for the dam safety evaluation.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Contract Management:</b> Formation, Standard bid documents, tender and award of tenders, Online contracts, mistake and auctions, Breach and termination of contract, Impossibility of performance (force majeure clause), Forfeitures, loss and damages, Delays and liquidated damages, Risk, loss and indemnities, Condition, warranty, merchantability and quality of goods, Transportation, delivery, and Incoterms, Letters of credit, bank guarantee, and performance guarantee, Jurisdiction of courts, arbitration and dispute resolution, Confidentiality clauses and exemption/exclusion clauses, Contracts and taxation.	4
2.	<b>Financial Management, Financial Analysis:</b> Introduction, uses, M&A, Private Equity, Equity Research, Career Opportunities, Skills Required	8
3.	<b>Financial Statement Preparation:</b> Balance Sheet, Profit and Loss and Cash Flow, Revenues and Expenses, Consolidated Accounts, Tangible Assets, Goodwill, Depreciation	5
4.	<b>MS Excel:</b> Spreadsheet Vocabulary, Logical & Statistical Functions, Data Validation, Custom List, Goal Seek, Scenarios, Data Manipulation, Pivot Tables and Macros	5
5.	<b>Accounting Basics:</b> The Accounting Process, Accounting & Book-Keeping, Financial Terminologies, Accounting Concepts, the Accounting Cycle, Hindalco: Walk Through of Financial Statements	4
6.	<b>Ratio Analysis:</b> Introduction to Ratio Analysis, Objectives of Ratio Analysis, Dupont Analysis, Types of Ratios, Simple Consolidation, Preparing Consolidated Statements	8
7.	<b>Financial Modelling:</b> Create a Basic IB Financial Model, Types of Data & Variables, Growth Rates and Proportions, BEDMAS Principle	5
8.	Forecasting and Modelling	3
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

S.No.	Contents	Contact hours
1.	Hughes W. and Champion R, "Construction contracts: law and management", Routledge	2007
2.	Juan D. A., "Fundamentals of Accounting: Basic Accounting Principles Simplified for Accounting Students", United States: Author House	2007
3.	Fletcher S. and Gardner C., "Financial Modelling in Python", Germany: Wiley	2010
4.	Netscher P., "Successful Construction Project Management: The Practical Guide", Createspace Independent Pub	2014
5.	Roy M., "Microsoft Excel 2018: Learn Excel Basics with Quick Examples" United States: Create Space Independent Publishing Platform	2018
6.	Syrstad T. and Jelen B. "Microsoft Excel 2019 VBA and Macros" (n.p.): Pearson Education	2018
7.	Jelen B. and Syrstad T., "Microsoft Excel 2019 VBA and Macros (Business Skills)", Microsoft Corpn	2019
8.	Raina V. K., "Raina's Construction and Contract Management Vol.1", Shroff	2020

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: International Centre for DAMS

- |    |  |  |               |                     |                             |               |
|----|--|--|---------------|---------------------|-----------------------------|---------------|
| 1. | <b>Subject Code:</b> DS-520  | <b>Course Title:</b> Sustainable Tourism around Dams |               |                     |                             |               |
| 2. | <b>Contact Hours:</b>  | <b>L:</b> 3  | <b>T:</b> 1   | <b>P:</b> 0         |                             |               |
| 3. | <b>Examination Duration (Hrs.):</b>  | <b>Theory:</b> 3                                     |               | <b>Practical:</b> 0 |                             |               |
| 4. | <b>Relative Weightage:</b>   | <b>CWS:</b> 20-35                                    | <b>PRS:</b> 0 | <b>MTE:</b> 20-30   | <b>ETE:</b> 40-50           | <b>PRE:</b> 0 |
| 5. | <b>Credits:</b> 4  | <b>6. Semester:</b> Both                             |               |                     | <b>7. Subject Area:</b> PEC |               |
| 8. | <b>Pre-requisite:</b> Nil  |  |               |                     |                             |               |
| 9. | <b>Objective:</b> To explore the opportunities, sustainable tourism across the world and awareness for dam safety. |  |               |                     |                             |               |

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	Understanding the concepts of Sustainability, Sustainable Development, Sustainable tourism	4
2.	Socio-cultural problems related to dams- Social problems of displaced people, Strategies for integration of local people into mainstream tourism, Skill up-gradation as an essential mechanism for success of sustainable tourism	8
3.	Understanding dam Tourism as a tool to enhance socio-economic and environmental aspects, Techno-Economics aspects of Dam sustainability, Tools and methodology for determining economic sustainability of dams	5
4.	Understanding feasibility report for Dam tourism, components of feasibility reports	5
5.	Concept of Sustainable Tourism around dams, issues and challenges	4
6.	Challenges and limitations of sustainable tourism around dams in India	8
7.	Current state of tourism around dams in India Best case studies of sustainable tourism around dams in India and world	3
8.	Discussion and possible line of action for the dams in the purview of the Implementing Agencies	3
9.	Risk Associated with tourism around dams; awareness and management	2
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Stevens J. E., "Hoover Dam: An American Adventure", University of Oklahoma Press.	1990
2.	"Guidelines for community-based ecotourism development", WWF International	2001

3.	Prasad K., “Water resources and Sustainable Development: challenges of 21st century”, Shipra Publications	2003
4.	Narasaiah M. L., “Water and sustainable tourism”, Discovery Publishing House	2005
5.	Bansal S. P. and Gautam P., “Sustainable Tourism Development: A Himalayan Experience”, India: Indus Publishing Company	2007
6.	Schleiss A. J. and Boes R. M. (Eds.), “Dams and reservoirs under changing challenges”, CRC press	2011
7.	Bass S. and Dalal-Clayton B., “Sustainable development strategies: a resource book”, Routledge	2012
8.	Sharma N. and Flügel W. A., “Applied geoinformatics for sustainable integrated land and water resources management (ILWRM) in the Brahmaputra River basin”, Springer India	2015

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-521      **Course Title:** Earth Retaining Structures and Dams (Concrete, RCC, CFRD, Arch. Earth, Rockfill Dams & Barrages)

2. **Contact Hours:**                      **L:** 3                                      **T:** 1                                      **P:** 0

3. **Examination Duration (Hrs.):**      **Theory:** 3                                      **Practical:** 0

4. **Relative Weightage:**    **CWS:** 20-35      **PRS:** 0      **MTE:** 20-30      **ETE:** 40-50      **PRE:** 0

5. **Credits:** 4                                      6. **Semester:** Both                                      7. **Subject Area:** PEC

8. **Pre-requisite:** Nil

9. **Objective:** The objective is to introduce the various earth retaining structures design and its analysis by various software.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Basic Concept/ Design:</b> Classification of Dam Types, Physical Factors governing Selection of Type, General Arrangement, Area Capacity Curve, Fixation of different hydraulic Levels and Capacities	4
2.	<b>Diversion Arrangement:</b> Design of Cofferdams, Design of Diversion Tunnels, Design of Diversion Channels	8
3.	<b>Spillways:</b> Types of Spillways (Ogee, Sluice, Side Channel, Chute channel, Conduit and Tunnel, Morning Glory etc.), Hydraulics, Profiles and Spillway Capacity, Types of Energy Dissipation Arrangement (EDA) (Stilling Basin, Bucket type etc.), Design of EDAs	5
4.	<b>Foundation Design:</b> Embankment: Treatment of foundation, Cut off trenches, Toe Drains and Pressure relief wells etc., Concrete Dam: Consolidation Grouting, Curtain Grouting etc., Other suitable foundation measures for other type of dams and barrages	5
5.	<b>Stability Analysis:</b> Forces/ Loads to be considered, Different load cases, Factors of safety in different conditions, Allowable stress/ deformation conditions	4
6.	<b>Design of other structures:</b> Free board calculations and conditions for different types of dams, Piers, Spillway bridges, Different Galleries, Stair Case/ Lift, Control Room, Retaining walls, Dam Toe Power House etc	8
7.	Construction Methods and suitable treatments for Concrete Dams/ RCC Dams/ CFRD Dams/ Arch Dams, Earth/ Embankment Dams/ Rock fill Dams, Barrages, Specific Studies such as Thermal Analysis etc., Physical & Numerical Model Studies	5
8.	<b>Software analysis:</b> Different software and their detailed applications, Analysis of all the above designs using Softwares.	3
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S.No.	Contents	Contact hours
1.	“Treatise on Dams”, United States: U.S. Department of the Interior, Bureau of Reclamation, [Commissioner's Office]	1950
2.	“Design of gravity dams: design manual for concrete gravity dams”, Bureau of Reclamation United States	1976
3.	Hoek E. and Brown E.T., “Underground Excavation in Rocks”, The Institution of Mining and Metallurgy, London	1980
4.	Saran S., “Reinforced soil and its engineering applications”, IK International Pvt Ltd	2005
5.	Weaver K. D. and Bruce D. A., “Dam Foundation Grouting”, revised and expanded edition, American Society of Civil Engineers, ASCE Press, New York, 504	2007
6.	Desai Y. M. and Shah A. H., “Finite Element Method with Applications in Engineering”, India: Pearson Education India	2011
7.	Saran S., “Analysis and design of foundations and retaining structures subjected to seismic loads”, IK International Publish	2012
8.	Clayton C. R., Woods R. I. and Milititsky J., “Earth pressure and earth-retaining structures”. CRC press	2013
9.	Zhang C., “Seismic Safety Evaluation of Concrete Dams: A Nonlinear Behavioral Approach”, Netherlands: Elsevier Science & Technology Books	2014
10.	Mohammad A. R., “Nonlinear Finite Element Analysis of Earthen Dam”, Germany: Lap Lambert Academic Publishing GmbH KG	2015

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-522                      **Course Title:** Seismic Safety of Embankment Dams
2. **Contact Hours:**                      **L:** 2                      **T:** 1                      **P:** 2/2
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 15-30    **PRS:** 20    **MTE:** 15-25    **ETE:** 30-40    **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To cover the issues pertaining to earth and rock-fill dams under seismic loads and their analysis using classical and contemporary approaches.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction to Earth and Rock-fill Dams:</b> Introduction to dams; Characteristics of embankment dams; Differences between embankment dam and other types of dams; Components of embankment dam, functions and suitable materials; Zones of an embankment dam; Types of embankment dams: Homogeneous, Zoned and Diaphragm type dams; Influence of inclined and vertical core; Composite dams; Site selection for an embankment dam: Geology and seismicity of dam site, Reservoir rim and basin, Construction materials, Suitable spillway location, Submergence aspects, and Construction infrastructure;	6
2.	<b>Case Studies Related to Dam Failures:</b> Performance of embankment dams in past earthquakes; Causes of dam failure: Non-Earthquake conditions, and Earthquake conditions; Different modes of dam failures; Inferences from various case studies: Teton dam, Machchhu dam failure, Hebgen dam, Los Angeles dam, San Fernando dam, and Sheffield Dam.	3
3.	<b>Stability Analysis of Dams:</b> Effective and total stress methods of analysis; Analysis by Fellinius, Spencer, Bishop, Spencer method, Morgenstern price methods; Seismic slope stability methods: Inertial slope stability methods, Pseudostatic analysis, Displacement analysis; Pseudo-static analysis by Friction-circle, Fellinius and Bishop's methods; Factor of safety, yield accelerations and damage potential under saturated and submerged conditions; Displacement analysis by Newmark and Makdisi-Seed methods; Different loading cases for dam stability analysis: End of the construction, Partial submergence, Sudden drawdown, Steady state seepage, Sustained rainfall, and Earthquake; Slope protection measures	8

4.	<b>FEM for Dam Analysis:</b> Application of FEM, Dam-foundation interaction; Identification of zones of hydraulic fractures and cracks; Nonlinear analysis, Tangent stiffness, Secant stiffness methods and No-tension analysis; Inertial and Weakening slope stability analysis; Modelling aspects: Element size, Domain size, Boundary conditions. Computer applications: Software to compute static & dynamic stresses induced, Deformations & displacements resulted, and Zones of liquefaction within the dam; Dynamic analysis of dams with examples;	8
5.	<b>Seismic Performance Criteria for Large Embankment Dams:</b> Background; Integral dam safety concept; Seismic hazard a multi-hazard; Primary factors to consider in seismic design: Regional factors, Local factors; Selection of earthquakes for analysis; Seismic evaluation requirements; Seismic input parameters for analysis; The conceptual and constructional criteria for seismic-resistant fill dams	3
6.	<b>Design Response Spectra – Generation of Time History:</b> Introduction, Standard code of practices; Synthesis of uncorrelated accelerograms: Modification of recorded accelerograms in time-domain, Modulated sum of harmon, Superposition of narrow-band time histories, Parametric time series modelling, Modification of recorded time history in frequency domain, Ground motion synthesis in frequency-domain; Spatially correlated accelerograms: Modelling of spatial variation, Method of spectral factorization, Method of principal components.	4
7.	<b>Reservoir Rim and Basin Stability:</b> Causes and effects of rim stability, methods for assessing rim and basin stability: Earthquake induced landslide activity, Different types of earthquake induced landslides and their assessment methods.	3
8.	<b>Assessment of Seepage Pressures:</b> Seepage in earth and rockfill dams and their foundations, Different methods of seepage assessment; Standard analytical solutions for seepage problems, Piping and Liquefaction; Estimation of pore pressure by flow net and its construction: Confined flow and Unconfined flow; FEM analysis for the estimation of seepage pressures.	4
9.	<b>Guidelines for the Seismic Design and Construction of Embankment Dams:</b> Different codal provisions: Core, Shell, Cut-off wall, Cut-off Barrier, Transition Zones and Transition Filters; Internal drainage system; Protective layers for erosion control; Free board; Parapet wall; Riprap;	3
<b>Total</b>		<b>42</b>

#### List of Experiments:

1. Demonstration of GeoStudio
2. Stability assessment of an existing dam using SLOPE/W
3. Seismic stability assessment of an existing dam using QUAKE/W
4. Assessment of seepage pressures using SEEP/W.
5. Generation of spectrum compatible time histories.



6. Deconvolution of time histories to obtain base input motions.
7. Dynamic stability assessment of a model dam using shake table experiment.

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	“Embankment Stability Analysis, Preliminary Design: Proposed Indian Creek Dam, North Dakota”, United States: Soil Exploration Company	1974
2.	“IS 7894, Code of practice for stability analysis of earth dams”, Bureau of Indian Standard (BIS), New Delhi, India	1975 (Reaffirmed 2002)
3.	Prakash S., “Soil Dynamics”, McGraw Hill Book Company	1981
4.	Zienkiewicz O. C. and Morgan K., “Finite Elements and Approximation”, John Wiley & Sons	1983
5.	Kramer S.L., “Geotechnical-Earthquake Engineering”, Pearson Education – Indian Low-Price Edition	2004
6.	Singh, B. and Varshney, R.S., “Embankment Dam Engineering”, Nem Chand & Brothers.	2004
7.	Akin J.E., “Finite Element Analysis with Error Estimators”, Elsevier Publications	2005
8.	Bandyopadhyay J. N., “Design of Concrete Structures”, India: PHI Learning	2008
9.	“Earthquake-Induced Landslides: Proceedings of the International Symposium on Earthquake-Induced Landslides, Kiryu, Japan, 2012”, Germany: Springer Berlin Heidelberg	2012
10.	“Selecting Seismic Parameters for Large Dams, Guidelines, Bulletin 148 Committee on Seismic Aspects of Dam Design”, International Commission on Large Dams (ICOLD), Paris	2014
11.	Al-Labban S. N., “Seepage and Stability Analysis of the Earth Dams Under Drawdown Conditions by Using the Finite Element Method”, United States: University of Central Florida	2018

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-523                      **Course Title:** Concepts of Planning and Design of Hydro-Mechanical Components in Dams
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4                      6. **Semester:** Both                      7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the basic concepts of Planning and Design of hydro-mechanical components of the Dam.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	<b>Introduction &amp; Types of Gates:</b> Brief history of development, Gates components, main applications, types and classification.	4
2.	<b>Selection of Hydraulic Gates:</b> Selection criteria of Hydraulic gates,	8
3.	<b>Hydraulic Gates Design &amp; Weight Estimation:</b> Hydrostatic, load cases, allowable stresses, design of skin plate, horizontal beams, embedment, gate weight estimation	5
4.	<b>Hydro-dynamic Forces:</b> Hydro-dynamic forces (down pull, uplift, cavitation etc.), aeration, modeling, etc.	5
5.	<b>Gate Operating Systems:</b> Gate operating forces, hoists (Hydraulic & mechanical).	4
6.	<b>Materials, Fabrication, Erection, Testing&amp; Commissioning etc.:</b> Materials, rubber seals, fabrication, transportation & erection materials, fabrication transportation, erection, testing & commissioning.	8
7.	<b>Hydraulic Gates for Dam Safety:</b> Operation & maintenance of hydraulic Gates, rehabilitation, inspection, operation & maintenance, automation, etc. Recent trends & developments in Hydraulic gates engineering.	5
8.	Practical Examples/ Workshops	3
<b>Total</b>		<b>42</b>

### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Singh B. and Varshney R. S., "Hydropower Structures", Nem Chand & Bros., Roorkee	1977

2.	“Safety of Existing Dams: Evaluation and Improvement”, United States: National Academy Press	1983
3.	Nigam P. S., “Handbook on Hydro Electric Engg”, Nem Chand & Bros., Roorkee	1985
4.	“Small Hydro Stations” (Publication No. 175), Central Board of Irrigation and Power, New Delhi	2008
5.	“Dam and Levee Safety and Community Resilience: A Vision for Future Practice”, United States: National Academies Press	2012
6.	“Standards/Manual/Guidelines for small Hydro Development”, IIT Roorkee	2013
7.	Erbisti P. C., “Design of Hydraulic Gates, 2nd Edition”, Netherlands: Taylor & Francis	2014
8.	Chen S., “Hydraulic Structures”, Belgium: Springer Berlin Heidelberg	2015
9.	Ascila R. and Hartford D. N. D., “Operational Safety of Dams and Reservoirs: Understanding the Reliability of Flow-control Systems”, United Kingdom: ICE Publishing	2016
10.	“Guidelines for Preparing Operation and Maintenance Manual for Dams”, DRIP, MoWR, New Delhi	2018
11.	Sur S. K., “A Practical Guide to Construction of Hydropower Facilities”, United States: CRC Press	2019

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** International Centre for DAMS

1. **Subject Code:** DS-524 **Course Title:** Engineering Seismology and Hazard Assessment for Dams

2. **Contact Hours:**                **L:** 3                                **T:** 1                                **P:** 0

3. **Examination Duration (Hrs.):**        **Theory:** 3                                **Practical:** 0

4. **Relative Weightage:**    **CWS:** 20-35        **PRS:** 0        **MTE:** 20-30        **ETE:** 40-50        **PRE:** 0

5. **Credits:** 4                                6. **Semester:** Both                                7. **Subject Area:** PEC

8. **Pre-requisite:** Nil

9. **Objective:** To provide the concepts of engineering seismology, seismological instrumentation, reservoir induced seismicity, seismic hazard assessment.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Scope of seismology; Definitions of important terms; Causes of earthquakes and their classifications; Earthquake effects on ground and structures, Plate tectonics- continental drift, types and characteristics of various plate margins; Earthquake catalogue and seismicity of the earth; Major earthquakes in the world; Important Indian earthquakes	10
2.	<b>Wave Propagation and Instrumentation:</b> Theory of elasticity; Body and surface waves; Local site effects; Seismic phases; Internal structure of earth; Reference models, Earthquake intensity, Earthquake magnitude, frequency magnitude relations, Earthquake recordings - principles and theory of seismograph; Real time warning system; International monitoring system (IMS); Local seismological networks, strong motion networks and their engineering importance.	8
3.	<b>Seismic Hazard Assessment:</b> Definitions- seismic hazard, disaster and risk; Probabilistic and deterministic approach; Earthquake occurrence models; Seismotectonic modeling and type of sources; Estimation of maximum magnitude, maximum credible earthquake, design basis earthquake; Frequency magnitude relationship; Poissonian and Non Poissonian models; Ground motion prediction equations; Uncertainties in seismic hazard assessment and their quantification; Return periods and strong motion exceedance rates; Site-specific design earthquake parameters; Case studies.	8
4.	<b>Geophysical Methods:</b> Seismic methods; Well logging; Steady state Rayleigh method; Spectral analysis of surface waves-SASW and MASW methods; Ground penetrating radar, bedrock profiling. Quantification of Site Effects: Experimental methods; Microearthquake- standard spectral ratio method & horizontal to vertical spectral ratio method; Microtremors - absolute spectra, SSR method & H/V ratio; Empirical relations; Analytical method; 1D ground response of layered medium	6

5.	<b>Site-specific Ground Motion Estimation:</b> Empirical Green's function; Numerical methods; Basic concept, recent developments; Domain method, boundary method & hybrid method; Effects of nonlinearity on ground motion	5
6.	<b>Seismic Microzonation:</b> PSHA and DSHA; Seismic microzonation of mega cities, scales used in seismic microzonation; Recent developments and case studies.	5
<b>Total</b>		<b>42</b>

#### 11. Suggested Books:

S.No.	Contents	Contact hours
1.	Gupta H., "Reservoir Induced Earthquakes", Netherlands: Elsevier Science	1992
2.	Lay T. and Wallace T. C., "Modern Global Seismology", United States: Elsevier Science	1995
3.	Bertero V. V., "Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering", Ukraine: CRC Press	2004
4.	"Earthquake Early Warning Systems", Germany: Springer Berlin Heidelberg	2007
5.	Shearer P. M., "Introduction to Seismology", Cambridge University Press	2009
6.	Mayne P. W. and Coutinho R. Q., "Geotechnical and Geophysical Site Characterization 4", Netherlands: CRC Press	2012
7.	Gupta H. and Rastogi, "Dams and Earthquakes", Netherlands: Elsevier Science	2013
8.	Wyssession M. and Stein, S., "An Introduction to Seismology, Earthquakes, and Earth Structure", Germany: Wiley	2013
9.	Shroder J. F., "Earthquake Hazard, Risk and Disasters", United Kingdom: Elsevier Science	2013
10.	Lai C. G., Rix G. J., Strobbia C. and Foti S., "Surface Wave Methods for Near-Surface Site Characterization", United Kingdom: Taylor & Francis	2014
11.	Beer M., "Encyclopaedia of Earthquake Engineering", Germany: Springer Berlin Heidelberg	2015
12.	Murru M., Console R., Falcone G. "Earthquake Occurrence: Short- and Long-term Models and Their Validation", United Kingdom: Wiley	2017
13.	"Monitoring Dam Performance: Instrumentation and Measurements", United States: American Society of Civil Engineers	2018
14.	Chopra A. K., "Earthquake Engineering for Concrete Dams: Analysis, Design, and Evaluation", United Kingdom: Wiley	2020

**Item No. 86.8: To consider the revision of eligibility criteria under 'Extensive Professional Experience Scheme' for Ph.D. Admission.**

The IRC in its 37<sup>th</sup> meeting held on 04 March 2020 vide its agenda item 37.2.11 suggested the modified eligibility criteria as given below:

"Candidate having M.Tech. / M.Arch./M.U.R.P. / M.Pharm / MS (Research) / Post-Graduate degree in Medical Sciences / equivalent degree with at least 12 years of professional experience."

**OR**

"Candidate having B.Tech. / B.Arch. / MBA/M.Sc. / B.Pharm / Graduate degree in Medical Sciences / equivalent degree with at least 14 years of professional experience."

The above is submitted for consideration and approval of the Senate.

**Item No. 86.9: To consider the report on the plagiarism complaint against Mr. Pramod Sharma's published papers and Ph.D. thesis.**

A complaint was received by the Institute on 13.10.2020 stating that Pramod Sharma and J.K. Nayak, *Journal of Hospitality and Tourism Management* 43 (2020) 1-10 is plagiarized from Roy et al. *Marketing Intelligence and Planning*, 34(1), (2016) 117-136.

The Director constituted the committee on 16.10.2020 in accordance with Notification No. IITR/ES(Wing 'A')/4499/E-4759 dated 20.12.2019 to establish the facts of the case and submit its report.

Prof. B.S.S. Daniel	Chairperson, IAEC
Prof. Rajat Agarwal, DOMS	Expert Member
Prof. P.M. Pathak, MIED	Expert member

In the course of the inquiry it was found that FIVE papers are retracted (Four by the Editor and one by the Authors themselves). In all the papers Mr. Pramod Sharma is the first author and corresponding author. All the papers were published while Mr. Pramod Sharma was a registered research scholar in the Department of Management Studies. The list of retracted papers are:

1. Sharma, P. & Nayak, J. K. (2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management* 43 (2020) 1-10.  
*is Editor retracted citing high similarity with*  
Roy, R., Rabbanee, F. K., & Sharma, P., Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence and Planning*, 34(1), (2016) 117-136.
2. Sharma, P., & Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.  
*is Editor retracted citing high similarity with*  
Prayag G., Hosany S., Muskat B., Chiappa G.D., Understanding the Relationships between Tourists' Emotional Experiences, Perceived Overall Image,

Satisfaction, and Intention to Recommend, *Journal of Travel Research*, 2017, Vol. 56(1) 41-54

3. Sharma, P., & Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research*, 21(4), 504-518.  
*is Editor retracted citing high similarity with*  
 Kim, J. H. (2018). The impact of memorable tourism experiences on loyalty behaviours: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, (2018) 57(7), 856-870.
4. Sharma, P. & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioural intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342  
*is Author retracted... has high similarity with*  
 Prayag G., Hosany S. Odeh, K. (2013) The role of tourists' emotional experiences and satisfaction in understanding behavioural intentions, *Journal of Destination Marketing & Management* 2 (2013) 118-127
5. Sharma, P. & Nayak, J. K. (2018): An analysis on the emotional approach to segmentation: A study of yoga tourism, *Journal of Convention & Event Tourism*, DOI: 10.1080/15470148.2018.1509038  
*is Editor retracted citing high similarity with*  
 Hosany S. & Prayag G. (2013), Patterns of tourists' emotional responses, satisfaction, and intention to recommend, *Journal of Business Research*, 66, pp 730-737.

The findings of the committee are:

1. Five papers published by Mr. Pramod Sharma as a research scholar are retracted citing plagiarism. TMP 2018, JCET 2018, IJTR 2019 and JHTM 2020 are retracted by the Editor and JDMM 2019 is retracted by the Authors. The publication of multiple retraction notices has gravely hurt the image and reputation of the Department and the Institute.
2. Of the five papers retracted, Mr. Pramod Sharma did not take the co-author's consent before submitting three papers i.e. JDMM 2019, IJTR 2019 and JHTM 2020. Moreover, while submitting the papers on the Journal's portal he provided an alternate email ID



(pramodsharmaaias1990@gmail.com) for the co-author, Prof. J.K. Nayak.

3. The Thesis is plagiarized and lacks originality. It uses the same constructs as in Prayag 2017, Prayag 2013 and Kim 2018. Moreover, there is discrepancy in data with Pramod Sharma's own paper TMP 2018 casting a doubt on the validity of the results.
4. Three journal editors flagged Mr. Pramod Sharma's papers for plagiarism before the PhD thesis defence held on 11.11.2019 (IJTR on 24.06.2019, JDMM on 20.07.2019 and TMP in Aug 2019). The concern expressed by the editors was not shared with the thesis evaluation board.

The full report pertaining to Mr. Pramod Sharma is enclosed as **Appendix-A**.

On the recommendation of 42nd IRC vide item number 42.2.8 held on 07.11.2020, the Senate vide item number 84.1 in its meeting held on 24.11.2020 withheld the Ph.D. degree of Mr. Pramod Sharma.

The above is submitted for the consideration of the Senate.

## **Report of the Fact-finding Committee**

**Examining the plagiarism complaint submitted by Professor Rajat Roy dated 13.10.2020**

### **1. Introduction:**

Professor Rajat Roy, Bond University, Queensland, Australia submitted a plagiarism complaint to the Institute stating that “It came to my recent attention that faculty members from IIT Roorkee have engaged in research activities that goes against scientific publication. The retracted paper, which has a very high similarity with one of my PWYW papers published in MIP is enclosed herewith.” The email from Prof. Roy sent to the Director, IIT Roorkee on 13.10.2020 is enclosed as **Annexure 1**.

In his complaint, he has alleged that the paper:

Sharma P., Nayak J.K., Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach, *Journal of Hospitality and Tourism Management* 43 (2020) 1–10

has high similarity with his paper on PWYW published in MIP journal:

Roy, R., Rabbanee, F. K., & Sharma, P., Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence and Planning*, 34(1), (2016) 117–136

He pointed out that the above paper is Retracted by the Editor-in-Chief of JHTM with the comment that “This article represents a severe abuse of the scientific publishing system, rules and ethics. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that these issues were not detected during the submission process.” A copy of the retraction notice is enclosed as **Annexure 2**.

The Director constituted the following committee on 16.10.2020 in accordance with Notification No. IITR/ES(Wing ‘A’)/4499/E-4759 dated 20.12.2019 to establish the facts of the case and submit its report (**Annexure 3**).

#### **Committee Members:**

- |                              |                   |
|------------------------------|-------------------|
| 1. Prof. B.S.S. Daniel       | Chairperson, IAEC |
| 2. Prof. Rajat Agarwal, DOMS | Expert Member     |
| 3. Prof. P.M. Pathak, MIED   | Expert member     |

The committee met on two occasions over webex and carried our further discussion over email. This version of the report pertains to the complaint against Mr. Pramod Sharma.

### **2. Findings of the inquiry**

The preliminary response of Mr. Pramod Sharma and Prof. J.K. Nayak to the plagiarism complaint are enclosed as **Annexure 4** and **Annexure 5**, respectively. It is inferred that Mr. Pramod Sharma as corresponding author submitted a paper on pay-what-you-want pricing in tourism to the Journal of Hospitality and Tourism Management. He included his supervisor,

Prof. J.K. Nayak, as co-author without taking his permission to do so. He claims to have informed his supervisor about the paper after it was published. His supervisor in turn requested Mr. Sharma as corresponding author to contact the Editor and remove his name as he has not contributed to the paper. Mr. Pramod Sharma contacted the journal Editor with the request to remove Prof. J.K. Nayak as co-author and also to allow him to make some corrections in the citations of the paper or withdraw the paper. The Editor clarified that once published a paper cannot be withdrawn, but may be retracted. Nevertheless, was willing to allow a corrigendum. Subsequently, the journal pointed out that there is some similarity with the paper of Roy et al (2016).

Mr. Pramod Sharma has tried to defend his work by stating that *“both the papers have considered “Pay What You Want Pricing” as the topic. However, my paper conceptualises “Pay What You Want Pricing” in tourism unlike Roy et al, which investigates the topic in marketing. Moreover, I have cited Roy et al. for 25 times in the paper to create a connection between both the papers and show the extended application of this pricing concept. Further the variables given in the model of Roy et al., have been duly recognized and referred to in the last paragraph of the first page of my paper (attached paper). At the same time I would like to point out and claim that there exists no plagiarism/similarity in the paper as may be verified with the help of turnitin.”*

Without finding the explanation given by Mr. Pramod Sharma to be satisfactory, the Editor chose to retract the paper and issue the retraction notice.

The committee expressed concern that Mr. Pramod Sharma, as the corresponding author did not take the consent of his co-author. Also Turnitin login is provided only to faculty members, it was not immediately clear as to how he gained access to carry out the similarity check without his supervisor's knowledge. It was important to ascertain Mr. Pramod Sharma's views on plagiarism as he is acting as the corresponding author. Therefore, it was decided to ask him to share all email correspondence between him, the journal and his supervisor regarding this paper. Mr. Pramod Sharma replied to these questions posed by the committee in his email dated 23.10.2020. A copy of the email is included as **Annexure 6**.

Mr. Pramod Sharma has admitted that he has not taken the consent of the co-author. He states that *“No, I have not taken the consent of my co-author. I don't like to bother my respected guide with the continuous emails sent by the journals. Professionally it may not be correct, but the relation between a respected guide and student is more than professional nature. I have a deep respect for my guide which is above all professional relations.”* (see **Annexure 6**)

As to how he managed to keep the supervisor in the dark, he states that *“Initially, I have submitted the paper to the journal as a single author. So, there is no question of providing co-authors' email id initially on submission. However, in my last review I have added (Dr. J.K.Nayak sir's name) as the co-author of my paper with my own email id as the email id of co-author. My intention of adding my email id as co-authors' email id is to surprise my respected guide. I had no ill intentions to create problems for my respected guide by adding his name as the co-author of my paper.”* (see **Annexure 6**)

Mr. Pramod Sharma has defended his work against allegation of plagiarism by citing a particular reference “25 times” and by relying entirely on the similarity-check software generated index values. He states that *“My paper is an application of the concept (PWYW*

*Pricing) in a different set of context. Roy et al. have conducted their study in marketing but I have studied PWYW Pricing in tourism, as tourism is my area of research. I have only extended the concept of PWYW Pricing in tourism giving maximum credit to the paper of Roy et al. by citing their paper 25 times in my paper. I have also mentioned that the variables used in my study are taken from the paper of Roy et.al. (Kindly check page number 5, point number 3.3 in the manuscript). ... As far as my knowledge of plagiarism is concerned, my work is not identical to any paper and this is evident from the software provided to us." (see **Annexure 6**)*

Mr. Pramod Shama uses the email ID (*pramodsharmaias1990@gmail.com*). He had created an alternative email ID (*pramodsharmaaias1990@gmail.com*) and provided the same as co-author (Prof. J.K. Nayak) email ID to the journal during the revision stage. He has admitted to creating an alternative email ID in his email communication to his supervisor on 22.05.2019 (see **Annexure 7**). Such misrepresentation is a form of identity theft and a serious misconduct, as such meriting severe disciplinary action.

Mr. Pramod Sharma has admitted that he has used the Turnitin account of one of his friends. When asked to name the friend so that the information can be verified, he denied stating "*With due respect, I cannot name my friend because I don't want to trouble my friend for the favour. My life is completely ruined and I don't want to trouble my friend for the help.*" (see **Annexure 8** for full statement)

In the course of the inquiry it was found that in all FIVE papers of Pramod Sharma and J.K. Nayak are retracted (Four by the Editor and one by the Authors themselves). In all the papers Mr. Pramod Sharma is the first author and corresponding author. All the papers were published while Mr. Pramod Sharma was a registered research scholar in the Department of Management Studies. The committee examined the papers and prepared a comparison for all five papers. They are included in the Annexures which also include the correspondence with the Editors. The list of retracted papers are:

1. Sharma, P. & Nayak, J. K. (2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management* 43 (2020) 1–10.  
*is Editor retracted citing high similarity with*  
 Roy, R., Rabbance, F. K., & Sharma, P., Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence and Planning*, 34(1), (2016) 117–136.  
 (see **Annexure 9** for comparison and Editor correspondence)
2. Sharma, P., & Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.  
*is Editor retracted citing high similarity with*  
 Prayag G., Hosany S., Muskat B., Chiappa G.D., Understanding the Relationships between Tourists' Emotional Experiences, Perceived Overall Image, Satisfaction, and Intention to Recommend, *Journal of Travel Research*, 2017, Vol. 56(1) 41–54  
 (see **Annexure 10** for comparison and Editor correspondence)

3. Sharma, P., & Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research*, 21(4), 504-518.  
*is Editor retracted citing high similarity with*  
 Kim, J. H. (2018). The impact of memorable tourism experiences on loyalty behaviors: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, (2018) 57(7), 856–870.  
 (see **Annexure 11** for comparison and Editor correspondence)
4. Sharma, P. & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342  
*is Author retracted... has high similarity with*  
 Prayag G., Hosany S. Odeh, K. (2013) The role of tourists' emotional experiences and satisfaction in understanding behavioural intentions, *Journal of Destination Marketing & Management* 2 (2013) 118–127  
 (see **Annexure 12** for comparison)
5. Sharma, P. & Nayak, J. K. (2018): An analysis on the emotional approach to segmentation: A study of yoga tourism, *Journal of Convention & Event Tourism*, DOI: 10.1080/15470148.2018.1509038  
*is Editor retracted citing high similarity with*  
 Hosany S. & Prayag G. (2013), Patterns of tourists' emotional responses, satisfaction, and intention to recommend, *Journal of Business Research*, 66, pp 730-737  
 (see **Annexure 13** for comparison)

In the course of the inquiry Pramod Sharma has stated that he submitted incorrect co-author email ID in three papers, namely, IJTR 2019, JDMM 2019 and JHTM 2020. (see **Annexure 8**)

He also stated that he informed Prof. J.K. Nayak about IJTR 2019, JDMM 2019 and JHTM 2020 at the time of retraction/ withdrawal. (see **Annexure 8**). But when confronted with a copy of his PhD thesis where he has listed these as published papers, he changed his statement to “After publishing the papers online, I informed my supervisor.” (see **Annexure 14**)

The PhD thesis draws heavily from Prayag et al 2013, Prayag et al 2017 and Kim 2018. The model constructs are almost similar with very minor modification. The measurement parameters are similar except for the place. The research hypothesis matches completely except for the word “wellness tourism” which is an addition. It is also noted that the values from Pramod Sharma's own paper (TMP 2018) and Thesis using the same model don't match. Such large discrepancies raise doubts about the validity of the data and the research work. A detailed analysis of the PhD thesis is included in **Annexure 15**.

### 3. Analysis of the available facts

Five papers with Pramod Sharma and J.K. Nayak as co-authors are retracted due to plagiarism. Turnitin software was assiduously misused to alter text in such a manner that the percentage similarity is minimized without changing the ideas and sequence of thought/arguments. Prof. Nayak carried out the similarity check of the first paper (TMP 2018). Pramod Sharma accessed

the Turnitin software through a “friend” to do the similarity-check for the other papers. He denied to share the name of his friend. It may be noted that turnitin login facility is available only to faculty. Only faculty members can extend access to students through student login.

Pramod Sharma submitted all five papers to the journal as corresponding author in the period between December 2017 and December 2018. While he gave the correct email ID for the co-author in the TMP paper, he submitted an alternative email ID which was not accessible to Prof. J.K. Nayak for the remaining papers. This is a violation of serious violation of professional ethics with regard to research publications.

The papers are arranged below in the sequence of retraction including the submission/ acceptance/ Complaint/ start of retraction dates:

TMP paper // **Prayag 2017** (Annexure 10)

submission: 28.12.2017; acceptance: 18.07.2018; complaint: xx.08.2019; retraction start: 06.05.2020

JDMM paper // **Prayag 2013** (Annexure 12)

submission: 23.03.2018; acceptance: 05.02.2019; complaint: 20.07.2019; retraction start: 06.05.2020

IJTR paper // **Kim 2018** (Annexure 11)

submission: 08.07.2018; acceptance: 15.03.2019; complaint: 24.06.2019; retraction start: 20.05.2020

JHTM paper (2020) // **Roy 2016** (Annexure 9)

submission: 06.12.2018; acceptance: 01.02.2020; complaint: 28.05.2020; retraction start: 22.06.2020  
20.01.2020 (add co-author) 09.05.2020 (drop co-author)

JCET paper (2018) // **Hosany & Prayag 2013** (Annexure 13)

submission: 03.05.2018; acceptance: 03.08.2018; complaint: -----; retraction start: -----

Initially, Pramod and Prof. Nayak claimed that Prof. Nayak knew only about the TMP paper from the time of submission, whereas all other papers had alternate email ID and Prof Nayak knew about those papers only at the time of retraction. But when presented with the evidence that Annexure III of the Pramod’s PhD thesis submitted on 31.05.2019 has three papers (TMP 2018, JDMM 2019, IJTR 2019) published/ accepted as the outcome of the PhD research, both Pramod and Prof. Nayak changed their statement to say that Prof. Nayak were aware of the papers after acceptance/online publication of the papers.

Three complaints of potential plagiarism were received between the time of Pramod’s thesis submission in May 2019 and defence in November 2019. The first complaint was received on 24.06.2019 from Prof. John Fletcher, Chief Editor IJTR stating that the paper bears much resemblance to **Kim 2018**. Pramod replied the same day stating that he took inspiration from Kim’s work. Pramod’s lack of confidence in his own work is exposed in his stated willingness to withdraw the paper if it is a case of plagiarism. (see **Annexure 11** for correspondence with Editor)

The second complaint was received by Pramod on 20.07.2019 from Prof. Alan Fyall, Co-editor, JDMM stating that a potential plagiarism claim is received. Pramod acknowledged the communication immediately and sought an update at regular intervals. But when he learnt from Prof. Catheryn Khoo that she is in touch with the editor of JDMM (Her email dated 06.05.2020, **Annexure 10**), Pramod wrote to Prof. Alan Fyall, co-Editor, JDMM on the same day

requesting to immediately withdraw the paper permanently (see email correspondence dated 06.05.2020 in **Annexure 12**). It is pertinent to note here that the JDMM paper matches with Prayag 2013, and it is possible that Girish Prayag, University of Canterbury, New Zealand had complained to both journals. Fortunately, Prof. Fyall was willing to allow an author retraction as the journal was yet to complete its investigation. But there was no such luck with the TMP paper as the Editor-in-chief decided to issue an Editorial retraction on 08.05.2020 stating that the authors have plagiarized the paper by Prayag 2017.

The third complaint was received by both Pramod and Prof Nayak sometime in August 2019 according to Prof. Catheryn Khoo, Chief Editor TMP stating that the paper is identical to **Prayag 2017**. Both Pramod and Prof. Nayak deny receiving the email, but the journal has stated that it is unlikely as both their emails are registered correctly in their computer system. (see email dated 02.12.2020 in **Annexure 10**)

Soon after permanently withdrawing the JDMM paper, Pramod wrote to Prof. Marianna Sigala, Editor-in-chief, JHTM on 09.05.2020 to stop the paper from appearing in the June 2020 issue of JHTM as scheduled. The paper was already available online since 06.02.2020. Pramod gave the reason that the co-author's name that he had added "*as a mark of respect ... is not interested in the authorship of the paper, since he has not contributed in the paper. Therefore, looking at all this I would like to withdraw my paper from your journal.*" (Email dated 09.05.2020 in **Annexure 9**). The persistent requests by Pramod to the Editor asking to drop Prof. Nayak's name as co-author, and allow substantial corrections causes the Editor to take a closer look. On finding substantial overlap with Roy (2016), she asks Pramod Sharma to clarify the originality of his paper. Noting that the paper is simply a replication of the study in a different industry without explicitly stating so, the Editor decided to issue a retraction (see email dated 22.06.2020 in **Annexure 9**).

While the discussion with JHTM was on-going, the Editor, IJTR initiated the retraction proceedings citing that the paper is copied from Kim 2018. The authors have attempted to defend the allegation stating that Kim has been cited in the text "25 times." The has Editor in turn has explained the it is not a question of verbatim plagiarism, but rather that the models are identical and the values are also near identical making it basically the same study, but in a different wrapper (see email dated 29.05.2020 in **Annexure 11**). IJTR published its online retraction on 01.09.2020.

Pramod's PhD viva voce was held on 11.11.2019. It is pertinent to note here that the authors did not share the information about the plagiarism complaint against the three papers with the members of the PhD thesis viva voce board. In such situations where the work is related to the PhD thesis one would expect that these concerns are properly addressed before holding the viva voce.

The retraction of four journal papers by the same author-pair has severely damaged the reputation of the Institute in the public domain. The supervisor should not have allowed the student to take him for granted and inform him after the paper is published. Taking others work and simply replacing with your data

#### **4. Concluding remarks pertaining to Mr. Pramod Sharma**

The findings of the committee are:

1. Five papers published by Mr. Pramod Sharma as a research scholar are retracted citing plagiarism. TMP 2018, JCET 2018, IJTR 2019 and JHTM 2020 are retracted by the Editor and JDMM 2019 is retracted by the Authors. The publication of multiple retraction notices has gravely hurt the image and reputation of the Department and the Institute.
2. Of the five papers retracted, Mr. Pramod Sharma did not take the co-author's consent before submitting three papers i.e. JDMM 2019, IJTR 2019 and JHTM 2020. Moreover, while submitting the papers on the Journal's portal he provided an alternate email ID (pramodsharmaaias1990@gmail.com) for the co-author, Prof. J.K. Nayak.
3. The Thesis is plagiarized and lacks originality. It uses the same constructs as in Prayag 2017, Prayag 2013 and Kim 2018. Moreover, there is discrepancy in data with Pramod Sharma's own paper TMP 2018 casting a doubt on the validity of the results.
4. Three journal editors flagged Mr. Pramod Sharma's papers for plagiarism before the PhD thesis defence held on 11.11.2019 (IJTR on 24.06.2019, JDMM on 20.07.2019 and TMP in Aug 2019). The concern expressed by the editors was not shared with the thesis evaluation board.

\*\*\*



## Annexure 1

**From:** "Rajat Roy" <rroy@bond.edu.au>  
**To:** "Director IIT Roorkee" <director@iitr.ac.in>  
**Sent:** Tuesday, October 13, 2020 6:04:14 AM  
**Subject:** Paper retraction

Dear Professor Chaturvedi,

Greetings!

It came to my recent attention that faculty members from IIT Roorkee have engaged in research activities that goes against scientific publication. The retracted paper, which has a very high similarity with one of my PWYW papers published in MIP is enclosed herewith. You will find further details of their work (journal retraction, notification message, reasons for retraction) in the URL below. I also reproduce part of this message from the journal (i.e. Journal of Hospitality and Tourism Management) where the paper was initially published, for your ready reference (in italics) below:

*"A thorough investigation showed one further issue with the paper: it had far too many similarities with the existing study outlined in Roy, R., Rabbanee, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. Marketing Intelligence & Planning. When asked about it, the author admitted to replicating the study in a different industry, and though Roy et al were cited throughout his paper, not once was the replication made explicit within the paper text.*

*This article represents a severe abuse of the scientific publishing system, rules and ethics. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that these issues were not detected during the submission process."*

<https://www.sciencedirect.com/science/article/pii/S1447677018304492>

RETRACTED: Understanding the  
determinants and outcomes of internal  
reference prices in pay-what-you-want  
(PWYW) pricing in tourism: An analytical  
approach - ScienceDirect

RETRACTED: Understanding the determinants and outcomes  
of internal reference prices in pay-what-you-want (PWYW)  
pricing in tourism: An analytical approach

[www.sciencedirect.com](http://www.sciencedirect.com)

I strongly believe that this is a serious academic misconduct and thought of bringing this to your kind attention. IIT Roorkee is held in high esteem in India and across the globe.

Best regards,

**Rajat Roy**

**Associate Professor of Marketing**

**Associate Editor** - Journal of Creative Communications <https://journals.sagepub.com/editorial-board/crc>

Editorial Board Member – European Journal of Marketing

Editorial Board Member - Journal of Business Research

Editorial Board Member - International Journal of Advertising

Distinguished Faculty SIBM Pune <https://www.sibm.edu/welcome/distinguishedprof>

Bond Business School

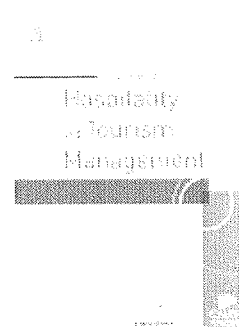
*Building tomorrow's business leaders. one by one*

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Bond University | Gold Coast, Queensland, 4229, Australia

CRICOS Provider Code 00017B

## Annexure 2



Journal of Hospitality and Tourism Management

Volume 43, June 2020, Pages 1-10

**RETRACTED: Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach**

Pramod Sharma, Jogendra Kumar Nayak

Indian Institute of Technology Roorkee, Uttarakhand, 247667, India

Available online 6 February 2020.

<https://doi.org/10.1016/j.jhtm.2020.02.001>

This article has been retracted: please see Elsevier Policy on Article Withdrawal (<https://www.elsevier.com/about/our-business/policies/article-withdrawal>).

This article has been retracted at the request of the Editor-in-Chief.

Shortly after the article was published, Pramod Sharma contacted the Editor-in-Chief to request the withdrawal of his paper – something that is not possible once articles are already published, as they are then part of the scientific record. There were two key issues identified by the author: 1. Jogendra Kumar Nayak's name needed to be removed as an author, because the former was not informed and did not contribute to the paper and 2. Citations and related references had been missed throughout the article.

A thorough investigation showed one further issue with the paper: it had far too many similarities with the existing study outlined in Roy, R., Rabbanee, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence & Planning*. When asked about it, the author admitted to replicating the study in a different industry, and though Roy et al were cited throughout his paper, not once was the replication made explicit within the paper text.

This article represents a severe abuse of the scientific publishing system, rules and ethics. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that these issues were not detected during the submission process.

[View Abstract](#)

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### Annexure 3

**From:** "Director IITRoorkee" <director@iitr.ac.in>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Sent:** Friday, October 16, 2020 7:17:25 PM  
**Subject:** Re: Constitution of Fact Finding Committee

Approved.

Ajit

----

अजित कुमार चतुर्वेदी/Ajit Kumar Chaturvedi  
निदेशक/Director  
भारतीय प्रौद्योगिकी संस्थान रुड़की  
Indian Institute of Technology Roorkee  
रुड़की - 247667, उत्तराखंड, भारत  
Roorkee - 247667, Uttarakhand, INDIA  
Tel (O) : +91 1332 272742 / 285500  
Tel (O) : +91 9837070794  
Email: director@iitr.ac.in, dir\_office@iitr.ac.in  
[https://www.iitr.ac.in/~ECE/Ajit\\_K\\_Chaturvedi](https://www.iitr.ac.in/~ECE/Ajit_K_Chaturvedi)  
<https://www.iitr.ac.in>

**From:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**To:** "Director IIT Roorkee" <director@iitr.ac.in>  
**Sent:** Friday, October 16, 2020 7:10:29 PM  
**Subject:** Constitution of Fact Finding Committee

**Professor A.K. Chaturvedi**  
The Director  
IIT Roorkee

Ref. No.: IAEC/2020/DOMS/06

Dear Sir,

The Institute received a communication from Dr. Rajat Roy, Associate Professor, Bond Business School, Bond University on 13.10.2020 stating that his paper

R. Roy, F.K. Rabbanee & P. Sharma, "Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing." *Marketing Intelligence & Planning*, 34(1), (2016) 117–136

was plagiarized by Pramod Sharma and J.K. Nayak in writing their paper

P. Sharma and J.K. Nayak, "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" *Journal of Hospitality and Tourism Management*, 43, 2020, 1-10

which was subsequently retracted by the Editor-in-chief with the comment that "This article represents a severe abuse of the scientific publishing system, rules and ethics. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that these issues were not detected during the submission process."

As this matter concerns Academic Ethics violation it is proposed to constitute a committee in accordance with the approved Institute policy (IITR/ES(Wing 'A')/4499/E-4759 dated 20.12.2019). In this regard, the following committee is proposed to establish the facts of the case.

- |                          |               |
|--------------------------|---------------|
| 1. Prof. B.S.S. Daniel - | Chairman      |
| 2. Prof. Rajat Agarwal - | Expert Member |
| 3. Prof. P.M. Pathak -   | Expert Member |

Considering the seriousness of the allegation it is proposed that the PhD degree of Mr. Pramod Sharma be withheld until the inquiry is concluded.

This is presented to you for your approval, please.

---

B.S.S. Daniel / B.S.S. डैनियल

Chairperson, Institute Academics Ethics Committee / अध्यक्ष, संस्थान शैक्षणिक आचार समिति

Indian Institute of Technology Roorkee / भारतीय प्रौद्योगिकी संस्थान रुड़की

Roorkee 247667, Uttarakhand, INDIA / रुड़की - 247667, उत्तराखंड, भारत

Ph: +91-1332-285751 (o); Mob: +91-9410164898

Webpage: <https://mt.iitr.ac.in/~MT/s4danfmt>

## Annexure 4

From: "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
To: "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
Sent: Thursday, October 15, 2020 1:14:16 PM  
Subject: Re: Paper retraction

Respected Daniel Sir,

Thank you for your email seeking clarification on my retracted paper published titled "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" in the Journal of Hospitality and Tourism Management!

1. The above paper was written by me after conducting a thorough research on PWYW pricing in tourism context as tourism was my area of research.
2. I have added Dr. J.K. Nayak sir as the co-author of this paper as a mark of respect to my guru. I have added his name without his permission to give him a surprise that I have published a paper in "A" rated journal.
3. Immediately after publishing the paper, I informed my guide that I have published this paper and added him as the co-author. However, Dr. J.K. Nayak sir (my supervisor) replied to me that he has not contributed anything to the paper, so the entire credit goes to me and suggested that his name should be removed from the paper.
4. Accordingly, I, as the corresponding author of the paper, contacted the journal's editor-in-chief to remove the name of Dr. J.K. Nayak sir as the co-author of the paper.
5. Moreover, immediately after publishing the paper, I also found some missing citations in the paper (especially citations in the model of the paper). Accordingly, I have requested the editor-in-chief to allow me to correct the paper or withdraw my paper, so that I can correct my paper and publish it again or elsewhere. However, the journal informed me that the paper once published cannot be withdrawn. Rather, it would be retracted.
6. After my request to withdraw my paper or allow me to correct the same, the journal informed me that my paper has some similarity with the paper of Roy et al. I have replied that the paper may have some similarity, as both the papers have considered "Pay What You Want Pricing" as the topic. However, my paper conceptualises "Pay What You Want Pricing" in tourism unlike Roy et al, which investigates the topic in marketing. Moreover, I have cited Roy et al. for 25 times in the paper to create a connection between both the papers and show the extended application of this pricing concept.
7. Further the variables given in the model of Roy et al., have been duly recognized and referred to in the last paragraph of the first page of my paper (attached paper). At the same time I would like to point out and claim that there exists no plagiarism/similarity in the paper as may be verified with the help of turnitin.
8. My work on PWYW Pricing in tourism is an application of the concept in tourism. It is original. The paper has gone through all the process of publication starting from plagiarism check, desk of editor, peer review by two experts and final decision by the editor. Moreover, if my intention was to plagiarize the paper then I would not have cited his paper or informed the journal to withdraw my paper for such "A" rated journal without any complaint. It is I who has first contacted the journal not Roy et al. or the editor.
9. Instead of sufficient explanation, the journal retracted my paper.

10. I would also like to highlight that my supervisor (Dr. J.K. Nayak sir) is in no way involved in this paper. I have informed the journal about the non-involvement of my supervisor in the paper. Instead of such an explanation, the journal has also included his name in the retraction which is quite unfair.

In conclusion, I want to highlight that I have toiled day and night to research the topic and publish my paper. And I do not see any significant reason for retracting my paper for the journal.

This retraction of my paper has greatly demotivated me to study and research further in this pandemic situation.

Thanks & regards

Dr. Pramod Sharma  
Assistant Professor  
Department of Commerce & Management,  
Assam Don Bosco University, Assam  
Azara Campus  
Email id: [pramod.sharma@dbuniversity.ac.in](mailto:pramod.sharma@dbuniversity.ac.in)  
[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)

On Wed, Oct 14, 2020 at 7:46 PM Chairperson IAEC <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)> wrote:

Dear Mr. Pramod Sharma,

The institute has received information regarding a paper published titled "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" in the Journal of Hospitality and Tourism Management along with your PhD supervisor, Professor J.K. Nayak which was retracted by the Editor.

I would appreciate if you could give your views concerning this matter as it is alleged that the paper is plagiarized from Roy, R., Rabbanee, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. Marketing Intelligence & Planning, 34(1), 117–136.

Sincerely,

-daniel

---

B.S.S. Daniel  
Chairperson IAEC  
IIT Roorkee

## Annexure 5

From: "Jogendra K. Nayak" <jogendra.nayak@ms.iitr.ac.in>  
To: "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
Sent: Thursday, October 15, 2020 4:37:42 PM  
Subject: Re: Paper retraction

Dear Professor Daniel,

Please refer to your email dated 14-10-2020 regarding the retraction of a paper titled " "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" by the Journal of hospitality and tourism management. In this regard, I would like to appraise that I came to know about this publication sometime back around the month of May 2020 when Mr. Pramod Sharma informed me about the publication of the said paper. Since I did not know anything about this paper and haven't contributed anything to the paper (which has been acknowledged by the Journal itself in point 1 in the retraction note). I asked the scholar (who had passed out in 2019) to withdraw my name immediately since he was the corresponding author. Thereafter on my instructions, Pramod initiated the process of withdrawal of my name. Finally, the paper has been retracted for the reasons best known to Mr. Pramod and the Journal.

Thanks

Warm Regards  
Dr. J.K.Nayak  
Associate Professor (Marketing)  
Professor Placement in-charge  
Department of Management Studies  
Associated Faculty-Centre for Transportation Systems  
Indian Institute of Technology Roorkee  
M-09627204370  
webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)  
"SAVE WATER AND SAVE THE EARTH"

From: "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
To: "Jogendra K. Nayak" <jogendra.nayak@ms.iitr.ac.in>  
Sent: Wednesday, October 14, 2020 7:43:46 PM  
Subject: Fwd: Paper retraction

Dear Professor Nayak,

The institute has received information regarding a paper published titled "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" in the Journal of Hospitality and Tourism Management along with your PhD scholar, Mr. Pramod Sharma which was retracted by the Editor.

I would appreciate if you could give your views concerning this matter as it is alleged that the paper is plagiarized from Roy, R., Rabbanee, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence & Planning*, 34(1), 117–136.



Sincerely,  
-daniel

---

B.S.S. Daniel  
Chairperson IAEC  
IIT Roorkee

## Annexure 6

**From:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Sent:** Friday, October 23, 2020 4:14:04 PM  
**Subject:** Information on JHTM retraction

Respected Daniel Sir,

With due respect, I have provided the information concerning my retracted paper in the form of questions and answers which would help the committee to establish the facts of the case. Kindly find the information listed below:

1. As the corresponding author, it is your professional responsibility to take the consent of the co-author before submitting the paper. Did you take the consent of the co-author?

*Reply: No, I have not taken the consent of my co-author. I don't like to bother my respected guide with the continuous emails sent by the journals. Professionally it may not be correct, but the relation between a respected guide and student is more than professional nature. I have a deep respect for my guide which is above all professional relations.*

2. On submitting the paper, does the journal send an email confirmation to all authors? What email address did you provide for your co-author?

*Reply: Initially, I have submitted the paper to the journal as a single author. So, there is no question of providing co-authors' email id initially on submission. However, in my last review I have added (Dr. J.K.Nayak sir's name) as the co-author of my paper with my own email id as the email id of co-author. My intention of adding my email id as co-authors' email id is to surprise my respected guide. I had no ill intentions to create problems for my respected guide by adding his name as the co-author of my paper.*

3. You have stated, "I would like to point out and claim that there exists no plagiarism/ similarity in the paper as may be verified with the help of turnitin." Whose Turnitin account did you use to check for similarity?

*Reply: I have used the turnitin account of one of my friends.*

4. Plagiarism is not only about copying text, it is also copying ideas without giving due credit. In this case it appears that you have deliberately altered the words in sentences to overcome the similarity check software. A simple reading shows that your paper is developed on an identical premise and follows the chain-of-thought of Roy's paper entirely. The Editor-in-chief in her retraction notice has described your paper in these words: "This article represents a severe abuse of the scientific publishing system, rules and ethics." Please comment.

*Reply: My paper is an application of the concept (PWYW Pricing) in a different set of context. Roy et al. have conducted their study in marketing but I have studied PWYW Pricing in tourism, as tourism is my area of research. I have only extended the concept of PWYW Pricing in tourism giving maximum credit to the paper of Roy et al. by citing their paper 25 times in my paper. I have also mentioned that the variables used in my study are taken from the paper of Roy et al. (Kindly check page number 5, point number 3.3 in the manuscript. It is also highlighted in the paper: <https://drive.google.com/file/d/1TGmzKexAmPTDjNwCtiPsoG5zr3k2U8W/view?usp=sharing>).*

*As far as my knowledge of plagiarism is concerned, my work is not identical to any paper and this is evident from the software provided to us. But yes, I have seen several such papers which look similar*

but they have worked in different contexts and have got published. Second, I have cited the work of Roy et al. sufficiently which can be found in my paper. Moreover, regarding a new idea developed in the paper like PWYW Pricing, I don't think there are any authors who hold patent rights on that idea (Roy et al. have also adopted this idea from some other paper). For example, the scale variables used by Roy et al. in their paper is also adopted from that of Kim et al. 2009 (Kindly find the paper of Kim et al. 2009: <https://drive.google.com/file/d/1mYJg1Q6Jj-TdJTsMv-Jg1WqOrYwqyRbx1/view?usp=sharing>).

Moreover, I would like to highlight that Roy et al. have suggested replicating the study in a different set of product, service etc. in their paper. (Kindly find the paper of Roy et al. highlighting the suggestion: <https://drive.google.com/file/d/1BARF0uAm4jI-khNYMYSGLID6V4gY-n3Dw/view?usp=sharing>). Following the suggestion, I have studied the concept in different contexts i.e. tourism with proper citation of their paper.

It is also to be kindly noted, since all my papers were sent to blind reviewed journals and they have gone through different levels of verifications such as:

- Editorial office.
- Desk of editor (who are acknowledged experts in research).
- Peer reviewers (who are acknowledged experts in the topic).
- Again the desk of the editor for final approval.

I thought my work to be satisfactory since the paper got appreciation from the journal and reviewer. Accordingly following the same process I have published all my work but now the journal has retracted my paper after publishing.

I had clearly explained to the journal regarding the originality of my paper. Despite my explanation the journal had retracted my paper. I completely deny the allegation made by the journal in their retraction note.

*\*[I have secured first class throughout my career including securing distinction in my graduation. Moreover, I have also qualified UGC-NET (JRF) in two different subjects (Management and Commerce). And I don't believe in copying others' work)].*

5. Please share all email communications (both From and To) with the Journal from the submission of the paper right up to the retraction. You may forward each mail to the Chairperson IAEC email ID.

**Reply:** Sent to the Chairperson IAEC email ID.

6. Please share all email communications (both From and To) with your supervisor regarding this paper. You may forward each mail to the Chairperson IAEC email ID.

**Reply:** I had no email communication with my supervisor regarding this paper.

*In conclusion, I want to clarify that the journal has taken an ex-parte decision despite all my explanations and elaborations to the authorities and I don't accept the decision of retraction of my paper. I will continue to contest their decision citing more such examples to the journal where the papers have been published following the approach that I followed in my paper.*

*I would like to place on record that regarding the withdrawal of this paper it was me who had written to the journal and not otherwise. Since I wanted to withdraw the name of my supervisor and make some further improvements in the paper in that context I requested the journal to either allow me to make the changes or allow me to withdraw the paper.*

Thanks and regards  
Pramod Sharma

## Annexure 7

**From:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**To:** "Jogendra K. Nayak" <jogendra.nayak@ms.iitr.ac.in>  
**Sent:** Friday, May 22, 2020 11:19:22 AM  
**Subject:** Re: Withdrawl of papers

Dear sir,

Sorry for delay in replying! (Since last two days, there is no network in my mobile connection)

Apologies for all the problems caused by me!

With due respect, I am informing you that I have added your name as the co-author of my papers without your permission. I am sorry for my act.

As suggested by you, I am assuring you that I shall not include your name as the co-author in my future publications.

Currently, I have not communicated any paper to any journal (not there is any under review paper) with you as the co-author.

The list of publications in which you are a co-author in my papers are attached with this e-mail.

You are correct sir, I have used my second email id to add your name as the co-author of my papers

(Id: [pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com), pw: Pramod12@)

I believe that the way I have used to add your name as the co-author of my paper is wrong. However, my intention of adding you as the co-author was to provide you the credit of my paper as a mark of respect to teacher.

Apologies once again!

With due respect  
Pramod Sharma

On Wed, May 20, 2020 at 10:52 PM Jogendra K. Nayak <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)> wrote:

Dear Pramod,

I have been severely hurt by your approach regarding your research and publications. I have a few things to tell you.

1. Please do not include me as a co-author in your future publications.
2. If you have already communicated keeping me as a coauthor which is under review or under publication please withdraw them immediately.
3. Please let me know the list of publications in which you have made me co-author.

4. Please let me know the email id which you have used for me while communicating with the journals. I am getting a feeling that the email id used was fake and therefore I never received any communication from many of the the journals where your papers have been published.

Kindly respond with a proper reply.

Warm Regards

Dr. J.K.Nayak

Associate Professor (Marketing)

Professor Placement in-charge

Department of Management Studies

Associated Faculty-Centre for Transportation Systems

Indian Institute of Technology Roorkee

M-09627204370

webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)

"SAVE WATER AND SAVE THE EARTH"

## Annexure 8

**From:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Sent:** Monday, November 30, 2020 11:06:00 PM  
**Subject:** Re: IAEC inquiry matter

Respected Daniel sir,

Thank you for your kind words!

I want to kindly clarify that once again that my two papers have been retracted by the journal. They are:

\*Sharma, P., Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research* (2019) 21, 504–518. <https://doi.org/10.1002/jtr.2278>.

\*Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.

My following paper was retracted by the journal when I asked for help for the editor and journal to remove the co-author for the article. Additionally there was some citation issue. Later on the journal retracted my paper despite of my sufficient explanation.

\*Sharma, P., Nayak, J.K. (2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*, 2020, 43, pp. 1-10.

Moreover, the following paper was withdrawn by my and it is not retracted. It can be confirmed from the journal editor. The withdrawal of this paper by the journal is agreed via my email.

\*TEMPORARY REMOVAL: Sharma, P., & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342

**The response to the questions as asked by you are provided in the following statements:**

1. Please provide the co-author email ID given at the time of submission (or addition of co-author) to the journal in each of the above listed papers.

**Reply:** The email id of the co-author are provided in the following:

\*Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.

(Email id: <joginder.nayak@gmail.com>)

\*Sharma, P., Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research* (2019) 21, 504–518. <https://doi.org/10.1002/jtr.2278>.

(Email id: <pramodsharmaaia1990@gmail.com>)

\*Sharma, P., Nayak, J.K.(2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*, 2020. 43, pp. 1-10.

(Email id: <pramodsharmaaia1990@gmail.com>)

\*TEMPORARY REMOVAL: Sharma, P., & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342

(Email id: <pramodsharmaaia1990@gmail.com>)

2. At what stage did your Supervisor come to know of each of the four papers? At the time of submission/ revision/ acceptance/ retraction?

**Reply:** My supervisor came to know the papers at the following stages:

\*Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.

(At the time of submission)

\*Sharma, P., Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research* (2019) 21, 504–518. <https://doi.org/10.1002/jtr.2278>.

(At the time of retraction)

\*Sharma, P., Nayak, J.K.(2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*, 2020. 43, pp. 1-10.

(At the time of retraction)

\*TEMPORARY REMOVAL: Sharma, P., & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342.

(At the time of permanent withdrawal, since this paper is not retracted but withdrawn by me)

3. Whose login was used to do the similarity-check on Turnitin for each of the four papers before they were submitted to the journal? Please note that Turnitin access is provided to faculty members only. Students can access Turnitin only with faculty permission.

**Reply:** The plagiarism of my first paper was checked using my supervisors' login. Other three papers were checked using free plagiarism software of my friend which is available online. Kindly pardon me sir. I cannot name my friend.

\*Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.

(Dr. Jogendra Kumar Nayak sir)

\*Sharma, P., Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research* (2019) 21, 504–518. <https://doi.org/10.1002/jtr.2278>.

(My friend)

\*Sharma, P., Nayak, J.K.(2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*. 2020. 43, pp. 1-10.

(My friend)

\*TEMPORARY REMOVAL: Sharma, P., & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342

(My friend)

I want to repeat my statement that I have written my paper with my utmost good intention. I have never plagiarized any paper (which can be checked using any plagiarism software). My paper is the result of my hard work of 4.5 years (full time) at IIT Roorkee. I have followed the style of well-known papers in tourism research. My intention was never bad. If following any good practice with proper citation is a case of plagiarism then our constitution is also fully plagiarized since it is written after following 60 constitutions of the world.

The kind of mental harassment that I am going through from the last 1.5 years from the journal first and now for the IIT Roorkee is very painful for a student like me who is already a physically challenged student. This kind of harassment is pushing me to the verge of the end of my life. I am not understanding how to end this matter.

Thanks and regards  
Pramod Sharma

On Mon, Nov 30, 2020 at 12:42 PM Chairperson IAEC <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)> wrote:

Dear Pramod,

I understand and sympathize with you regarding the emotional burden you are carrying on account of the retraction of your papers over the last one and half years.

I also appreciate you for being forthright with me with regard to the inquiry thus far.

My role is to establish the facts of the case and present the correct picture to the Senate. The Senate will then make a decision.

I believe you when you said that you are a good and honest student. Such qualities will always help you to find favour.

For us to come to the correct conclusion it is important that you respond to the questions given below.

Your cooperation in this matter is noted and recognized.

According to the information shared with me, the following are the four retracted papers jointly published by you and Prof. J.K. Nayak:



Editor Retraction:

1. Sharma, P., Nayak, J.K.(2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*. 2020. 43, pp. 1-10.
2. Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 28, 41-52.
3. Sharma, P., Nayak, J. K. (2019). Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research* (2019) 21, 504–518. <https://doi.org/10.1002/ijtr.2278>.
- Kim, J. H. (2018). The impact of memorable tourism experiences on loyalty behaviors: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, (2018) 57(7), 856–870.

Author Retraction:

4. TEMPORARY REMOVAL: Sharma, P., & Nayak, J. K. (2019). The role of destination image as a mediator between tourists' emotions and behavioral intention: A study on wellness tourism. *Journal of Destination Marketing & Management*. Volume 16, June 2020, 100342

Kindly respond to the following questions:

1. Please provide the co-author email ID given at the time of submission (or addition of co-author) to the journal in each of the above listed papers.
2. At what stage did your Supervisor come to know of each of the four papers? At the time of submission/ revision/ acceptance/ retraction?
3. Whose login was used to do the similarity-check on Turnitin for each of the four papers before they were submitted to the journal? Please note that Turnitin access is provided to faculty members only. Students can access Turnitin only with faculty permission.

Thank you for your cooperation in this matter.

Sincerely,

-daniel

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B.S.S. Daniel / B.S.S. डैनियल

Chairperson, Institute Academics Ethics Committee / अध्यक्ष, संस्थान शैक्षणिक आचार समिति

Indian Institute of Technology Roorkee / भारतीय प्रौद्योगिकी संस्थान रुड़की

Roorkee 247667, Uttarakhand, INDIA / रुड़की - 247667, उत्तराखंड, भारत

Ph: +91-1332-285751 (o); Mob: +91-9410164898

Webpage: <https://mt.iitr.ac.in/~MT/s4dan/m>

## Annexure 9

### Paper 1: JHTM 2020 and Roy 2016

Following table will help in understanding similarity between paper authored by Pramod Sharma and J K Nayak (JHTM 2020) and paper authored by Rajat Roy et al (2015). The reference of the papers are given below:

Sharma, P., Nayak, J.K.(2020). Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach. *Journal of Hospitality and Tourism Management*, 2020, 43, pp. 1-10.

Roy, R., Rabbance, F. K., & Sharma, P., “Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing.” *Marketing Intelligence and Planning*, 34(1), (2016) 117–136

Conceptual Development	Paper of Sharma and Nayak follows the same argument as given in the paper of Roy et al.
Use of various variables	<p>Paper of Roy et al. uses three independent variables, namely, altruism, social desirability and price consciousness, one mediating variable, internal reference price and three dependent variables, willingness to pay, attitude and future intention.</p> <p>The paper of Sharma and Nayak also uses same independent variables, same mediating variable and same dependent variable.</p>
Conceptual Model	Both papers have given a conceptual model to describe the theory behind the arguments. Conceptual model of Roy et al. has 7 variables while conceptual model of Sharma and Nayak paper has 6 variables which are exactly similar to paper of Roy et al.
Hypothesis	Both papers use six hypothesis. There is some minor language related changes in these hypotheses of two papers, otherwise both papers have similar hypotheses. However, sixth hypothesis in paper of Sharma and Nayak is divided into three parts, i.e. H6a, H6b and H6c which is not done by Roy et al.
Instruments used for Data collection	To collect data with respect to variables used in two papers, both papers have used same scales.
Data Analysis	Paper of Sharma and Nayak has followed the same methodology for data analysis as used by Roy et al.

Results and Discussion	Results and discussion presented in Sharma and Nayak's paper are similar to results and discussion in Roy et al paper. However, Sharma and Nayak mentioned the results from the point of tourism while Roy discussed in a bigger scope as a conceptual aspect.
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The above analysis confirmed that the paper by Pramod Sharma and J.K. Nayak is cast in the mould of Roy et al (2016) paper substituting the tourism data from Pramod's PhD research. Therefore the committee was in agreement with the decision of the journal to retract the paper.

### Correspondence between the Authors and the Editor:

From: **PRAMOD SHARMA** <pramodsharmalas1990@gmail.com>  
Date: Sat, May 30, 2020 at 11:51 AM  
Subject: Re: Seeking advise on the withdrawal of paper [200509-001551]  
To: Mesquita, Laura (ELS-AMS) <l.mesquita@elsevier.com>  
Cc: Marianna Sigala <Marianna.Sigala@unisa.edu.au>, jog nayak <joginder.nayak@gmail.com>, Journal of Hospitality and Tourism Management <jhlm@elsevier.com>

Dear Marianna madam,

Thank you for considering my report (consisting of various citations) for incorporation in my research paper.

With due respect, I want to highlight that my study is an extension of the concept of Pay What You Want Pricing concept in tourism. This study was done to see whether PWYW pricing is applicable to tourism or not. The concept of PWYW pricing has been researched several times in psychology and marketing but the evidence of researching this innovative pricing in tourism is less. In this respect, I want to focus on the paper of Roy et al. (2016) which examines this pricing in marketing. However, I have examined this concept in tourism. As far as possible, the researchers working in the field of PWYW pricing were cited in my paper. For example, Roy et al. (2016) has been cited for more than 20 times, Kim et al. (2009) more than 10 times in the paper etc. This was done to reveal that I have not created anything new but I have applied the concept that was examined earlier by the respected researchers in a new set of context of tourism. There may be some sort of similarity of my paper with their papers. However, they are not the same.

The explanation highlighting the originality of my research and the difference between my paper and the paper of Roy et al. (2016) is explained below:

#### Explanation justifying the originality of my paper

**Paper Title:** Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach

The most important contribution of my study is the investigation of the concept of Pay What you Want Pricing in tourism research only. It is context specific and different from all others research of PWYW

pricing in psychology marketing. It may be considered as an extension of the new concept in tourism. The point by point difference and contribution are explained below:

My study is based on studying the emerging concept of Pay What You Want Pricing in *tourism research*. This concept was studied in marketing literature several time (including Roy et al., 2016). As far as my knowledge is concerned, my study is the first known attempt to investigate the concept of Pay What You Want Pricing in tourism. This is the first difference.

Second, my study considered tourists visiting different destinations as their sample for the study. Roy et al. (2016) considered the undergraduate students as their sample for the study. Moreover, my study took into account the tourists visiting multiple destinations.

Third, the study of Roy et al. (2016) was based on the respondents visiting restaurant. However, in my case the respondents are tourists visiting souvenir shops.

Fourth, the specific contribution unique to my research can be understood from the following statements:

\* My research contributes by highlighting that PWYW pricing is suitably applicable to pricing in tourism marketing.

\* The findings of my study contributes by highlighting that price consciousness and social motivation affects prices offered under PWYW by influencing internal reference price which shapes tourists attitude and behavior.

\*My study demonstrated that PWYW pricing may prove an alternate opportunity for destination managers to form a positive impression of tourists' destination and work as a differentiator in a tourist destination.

\*This study also provides specific suggestions to the destination manages such as:

- making arrangement in which the tourists who cannot pay can offer their voluntary services;
- projecting that a part of the contribution as price would be donated for social causes such as cancer foundation;
- tying up business at tourists' destination with social and charitable institutions in the destination.
- Last but not least, PWYW pricing may also be considered as a promotional strategy to penetrate a tourism market without incurring any promotional cost such as advertisement cost and cost of the free sample.

I want to conclude my explanation with the statement that this study is the extension of the concept of PWYW pricing in tourism. This is the unique contribution of the study in tourism.

Hope, I could explain the point of difference of the two studies and the original contribution of my paper.

Looking forward for your final decision!

Thanks and regards,

Dr. Pramod Sharma  
Assistant Professor  
Assam Don Bosco University  
Azara Campus, Assam  
Email ids:  
[pramodsharmatas1990@gmail.com](mailto:pramodsharmatas1990@gmail.com)  
[pramod.sharma@dbuniversity.ac.in](mailto:pramod.sharma@dbuniversity.ac.in)

Institutional Website: <http://erp.dbuniversity.ac.in/emplist/viewprofile.php?id=487>

On Thu, May 28, 2020 at 2:30 PM Mesquita, Laura (ELS-AMS) <[lmesquita@elsevier.com](mailto:lmesquita@elsevier.com)> wrote:

Dear Pramod,

Marianna and I have discussed your case today. Although it is ultimately her decision on the best course of action to take regarding your paper, as the publisher of the *Journal of Hospitality and Tourism Management*, we are advising her in accordance with COPE principles and guidelines.

Firstly thank you for sending us the list of missing citations in your article.

Since receiving your initial email and now your list of missing citations, a thorough investigation was initiated on potential issues with your paper. Substantial overlap was found with Roy, R., Rabbane, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence & Planning* (<https://www.emerald.com/insight/content/doi/10.1108/MIP-08-2015-0157/full/html>). While you do cite their study in your paper, it is unclear at this point how exactly the two studies differ. Your input is required for Marianna to better be able to assess this. We ask that you focus on what original contribution you have made, and differences that could help her understand the originality of your study.

We look forward to hearing from you.

Best wishes,

Laura Mesquita  
Deputy Editor, JHTM & JOTM, Emerald Group Publishing Ltd  
| Global STM Journals  
Phone: +44 (0)20 7323 3800  
Fax: +44 (0)20 7323 3802  
[lmesquita@elsevier.com](mailto:lmesquita@elsevier.com)

**From:** PRAMOD SHARMA <[pramodsharmalas1990@gmail.com](mailto:pramodsharmalas1990@gmail.com)>  
**Sent:** Thursday, May 14, 2020 5:40 AM  
**To:** Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)>  
**Cc:** jog nayak <[joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)>; Mesquita, Laura (ELS-AMS) <[lmesquita@elsevier.com](mailto:lmesquita@elsevier.com)>; Journal of Hospitality and Tourism Management <[jhtm@elsevier.com](mailto:jhtm@elsevier.com)>  
**Subject:** Re: Seeking advise on the withdrawal of paper [200509-001551]

Dear Marianna madam,

Apologies for the delay!

With due respect, I have attached the report with this email, detailing the correction to be made in the paper. Additionally, I hope that you have received the email of Dr. J.K.Nayak sir with respect to dropping down his name as the co-author of the paper.

Hope you will provide a chance to correct the two issues

Sorry for creating inconvenience!

Thanks and regards

Pramod Sharma

On Wed, May 13, 2020 at 5:50 AM Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)> wrote:

Dear Pramod

Thanks

Laura forwarded me the e-mails, as I had not received them before

Waiting for your report

Best

Marianna

**From:** PRAMOD SHARMA <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Sent:** Wednesday, 13 May 2020 12:06 AM  
**To:** Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)>  
**Cc:** jog nayak <[joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)>; Mesquita, Laura (ELS-AMS) <[L.mesquita@elsevier.com](mailto:L.mesquita@elsevier.com)>; Journal of Hospitality and Tourism Management <[jhtm@elsevier.com](mailto:jhtm@elsevier.com)>  
**Subject:** Re: Seeking advise on the withdrawal of paper [200509-001551]

Dear Marianna Madam,

Thank you for considering the request of dropping the name of Dr. J.K.Nayak sir, as the co-author of the paper. He has sent you the email permitting the removal of his name as the co-author of the paper.

Moreover, with respect to the citation issue of the paper, I am preparing a detailed specific report indicating the exact text from the manuscript which requires citations.

With your permission, I will submit the report by tomorrow.

Thank you once again!

Pramod Sharma

On Tue, May 12, 2020 at 7:04 PM Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)> wrote:

Dear Pramod Sharma

Thanks for your e-mail

Apologies, I have not received any e-mail from Dr Nayak requesting his name to be removed

Please ask him to do this again unless if he sent the e-mail to someone else that I do not know

I guess Laura will be more expert to advice on the citation issue, but what we would also need to know is the exact text from the manuscript that needs to be cited and used from other sources so we better assess and know what is the best way to address this issue

But Laura will be able to come back to you on this with a more specific answer

Best  
Marianna

**From:** PRAMOD SHARMA <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Sent:** Tuesday, 12 May 2020 3:55 PM  
**To:** Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)>  
**Cc:** jog nayak <[joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)>; Mesquita, Laura (ELS-AMS) <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>; Journal of Hospitality and Tourism Management <[jhtm@elsevier.com](mailto:jhtm@elsevier.com)>  
**Subject:** Re: Seeking advise on the withdrawal of paper [200509-001551]

Dear Marianna Madam,

Thank you for your email!

With due respect, I would like to request you to kindly drop the name of Dr. J.K. Nayak sir as the co-author from the paper. I have added his name as the co-author of the paper as a mark of respect to my teacher. However, he has asked me to drop his name from the paper as he has not made any

contribution to the paper. And he has also given a formal permission to drop his name from the paper by replying to your email. This is the issue regarding authorship.

The second issue with the paper is in connection with way the paper is written and the appropriate citations which is missing throughout the paper. Recently I came to know about the correct technique of writing a paper which is free from plagiarism and does not adversely affect the rights of authors. Being a new student in the field of research I am learning those ethical codes, so that I can clearly adhere to those codes in my new papers. Moreover for published paper, I am requesting the editor of journal to correct the papers or otherwise withdraw the same from the journal, so that my paper may not violate the ethical rights of any authors in future. So, I have requested you to suggest for the correction or withdrawal of my paper from your journal.

I hope that the you will do the needful to drop the name of Dr. J.K. Nayak sir from the paper as co-author. And suggest correction or withdrawal of the paper from your journal.

Thanks you once again.  
Pramod Sharma

On Tue, May 12, 2020 at 10:30 AM Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)> wrote:

Dear Pramod

I now have some more information about your paper and your request below.

The paper is already published and appears online, which means that we are limited to what we can do about it, e.g. retraction, corrections etc. Withdrawal is not possible at this stage, but I cc Laura Mesquita from Elsevier who is the expert and can better inform us about the options we have

However, in order to better understand what we need to do and what is possible, we would need some further clarification from you in regards to the two issues you mention below.

Thus, we would appreciate if you can reply and act upon these two issues so that we can come back to you with more specific answers and possibilities:

1 – authorship

We understand that Dr Nayak does not want to be a co-author of the paper

We would need a formal e-mail from Dr Nayak to confirm this, so then we find out how we do it at this stage

Dr Nayak, please e-mail us your formal decision

2 – technical issues

Can you please provide further details on what these technical issues are so we better assess the situation, what changes are required if possible and what we need to do with the paper?



Please be as specific as possible

Thank you in advance and looking forward to your prompt response

Best

Marianna

*Marianna Sigala*

**My latest article** "*The 'sharing economy' simply dresses up our consumerist tendencies in a more palatable ideology*"

<https://theconversation.com/the-sharing-economy-simply-dresses-up-our-consumerist-tendencies-in-a-more-palatable-ideology-92090>

**Marianna Sigala** Professor of Tourism |Director of the Centre for Tourism and Leisure Management (CTLM)

EQUIS Accredited

[marianna.sigala@unisa.edu.au](mailto:marianna.sigala@unisa.edu.au)

<http://people.unisa.edu.au/Marianna.Sigala>

**My latest books:**

[Big Data and Innovation in Tourism, Travel, and Hospitality](#)

[Wine Tourism Destination Management and Marketing](#)

[Management and Marketing of Wine Tourism Business](#)

[Journal of Service Theory & Practice](#)

[Journal of Hospitality & Tourism Management](#)

[Journal of Hospitality & Tourism Cases](#)

[International Journal of Contemporary Hospitality Management](#)

[Tourismos Journal](#)

-----  
**From:** PRAMOD SHARMA <[pramodsharmalas1990@gmail.com](mailto:pramodsharmalas1990@gmail.com)>

**Sent:** Saturday, 9 May 2020 12:13 PM

**To:** Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)>

**Cc:** jog nayak <[joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)>

**Subject:** Seeking advise on the withdrawal of paper

Dear Marianna Madam,

Hope you are well!

With due respect, I would like to inform you that the paper "Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach" to be published in June 2020 volume and it is now available online in your journal (Journal of Hospitality and Tourism Management) contains some technical issues which requires attention.

Moreover, I had added the co-author of the paper (Dr. J.K.Nayak) as a mark of respect since he is my Ph. D. supervisor without informing him. He is not interested in the authorship of the paper, since he has not contributed in the paper. He has informed me by sending a mail.

Therefore, looking at all this I would like to withdraw my paper from your journal. It is for the benefit of reader, journal and myself.

Kindly suggest!

It will take a few months time to correct the paper.

I am sorry for the inconvenience caused to the readers, reviewers , and journal,

Thanks and regards

Pramod Sharma

\*The cc of this email is also sent to the co-author of the paper.

From: **Mesquita, Laura (ELS-AMS)** <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>  
Date: Mon, Jun 22, 2020 at 6:02 PM  
Subject: Letter of retraction  
To: PRAMOD SHARMA <[pramodsharma1990@gmail.com](mailto:pramodsharma1990@gmail.com)>, Jogendra K. Nayak  
<[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>  
Cc: Marianna Sigala <[Marianna.Sigala@unisa.edu.au](mailto:Marianna.Sigala@unisa.edu.au)>, Journal of Hospitality and Tourism  
Management <[jhltn@elsevier.com](mailto:jhltn@elsevier.com)>

**Understanding the determinants and outcomes of internal reference prices in pay-what-you-want (PWYW) pricing in tourism: An analytical approach, Volume 43, June 2020**

Dear Drs Sharma and Nayak,

The Editor in Chief of *Journal of Hospitality and Tourism Management* has reviewed the request to withdraw, then correct issues with the above article and the author's response, and has taken the decision to retract the article.

You should be aware that retraction means your paper will remain online at ScienceDirect with a retraction watermark and a linked retraction notice. Please find below, for your reference, a copy of the retraction notice to be used, subject to final approval by Elsevier's retraction committee:

=====

This article has been retracted: please see Elsevier Policy on Article Withdrawal (<http://www.elsevier.com/locate/withdrawalpolicy>).

This article has been retracted at the request of the Editor-in-Chief.

Shortly after the article was published, Pramod Sharma contacted the Editor-in-Chief to request the withdrawal of his paper – something that is not possible once articles are already published, as they are then part of the scientific record. There were two key issues identified by the author: 1. Jogendra Kumar Nayak's needed to be removed as an author, because the former was not informed nor contributed to the paper and 2. Citations and related references had been missed throughout the article.

A thorough investigation showed one further issue with the paper: it had far too many similarities with the existing study outlined in Roy, R., Rabbanee, F. K., & Sharma, P. (2016). Antecedents, outcomes, and mediating role of internal reference prices in pay-what-you-want (PWYW) pricing. *Marketing Intelligence & Planning* <https://doi.org/10.1108/MIP-08-2015-0157>. When asked

about it, the author admitted to replicating the study in a different industry, and though Roy et al were cited throughout his paper, not once was the replication made explicit within the paper text.

This article represents a severe abuse of the scientific publishing system, rules and ethics. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that these issues were not detected during the submission process.

=====

Reasonable requests for amendments to these texts may be considered but any changes will be made only with the approval of the Editor and the retraction committee.

Yours sincerely,

*Imane Mesquita*

Imane Mesquita, PhD, Associate Professor, Faculty of Sciences, University of Algiers, Algeria

mesquita@univ-alger.dz

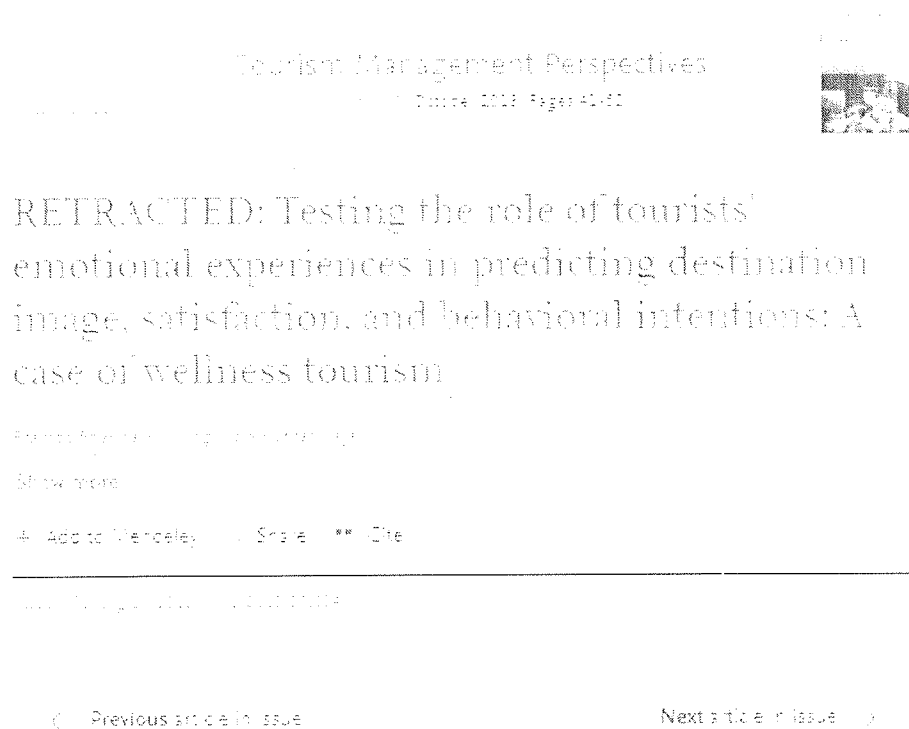
[i.mesquita@elsevier.com](mailto:i.mesquita@elsevier.com)

## Annexure 10

### Paper 2: TMP 2018 and Prayag 2017

**Paper (A):** Prayag G., Hosany S., Muskat B., Chiappa G.D., Understanding the Relationships between Tourists' Emotional Experiences, Perceived Overall Image, Satisfaction, and Intention to Recommend, *Journal of Travel Research*, 2017, Vol. 56(1) 41–54

**Paper (B):** Sharma, P., Nayak, J. K. (2018). Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism. *Tourism Management Perspectives*, 2018 28, 41-52.



This article has been retracted; please see Elsevier Policy on Article Withdrawal (<https://www.elsevier.com/locate/ymyp/article/pii/S1875966618300061>).

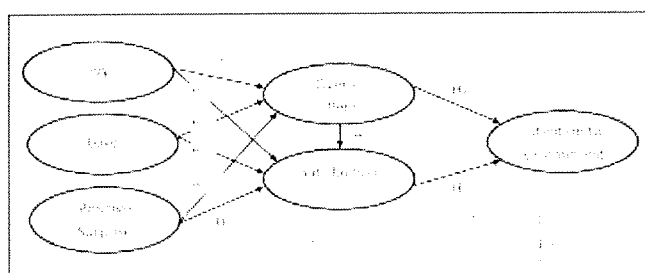
This article has been retracted at the request of the Editor-in-Chief.

The authors have plagiarized the paper by Prayag, G., Hosany, S., Muskat, B. and Del Chiappa, G., "Understanding the Relationships between Tourists' Emotional Experiences, Perceived Overall Image, Satisfaction, and Intention to Recommend" which appeared in *Journal of Travel Research* 56(1), pp. 41-54 (<https://doi.org/10.1016/j.jtr.2016.09.001>).

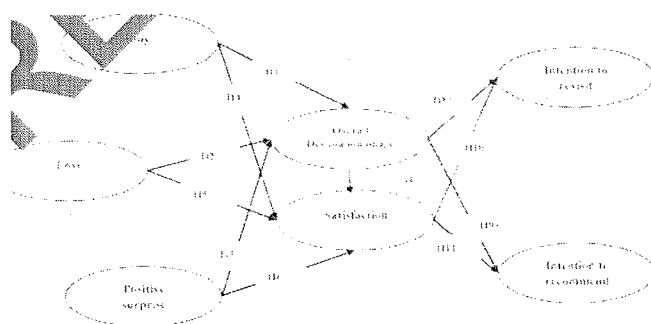
This article represents a severe abuse of the scientific publishing system. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal and the authors of the original paper that this was not detected during the submission process.

Since Paper (B) was retracted by the journal as shown above claiming that it was plagiarized from paper (A), therefore a comparative analysis is performed as follows:

The conceptual model of paper (A) is



While the conceptual model of Paper (B) is



Comparing these two models, it is clear that only one variable, i.e. intention to revisit is added in the model of paper (B). Rest of the model is similar to paper (A). It means that paper (B)'s model is almost copied from paper (A).

Comparison of Hypothesis in two papers

Paper A	Paper B
The emotion of joy has a positive influence on perceived overall image.	The emotion of joy positively impacts overall destination image.
The emotion of love has a positive influence on perceived overall image.	The emotion of love positively impacts overall destination image.
The emotion of positive surprise has a positive influence on perceived overall image.	The emotion of positive surprise positively impacts overall destination image.
The emotion of joy has a positive influence on tourist satisfaction with a destination.	The emotion of joy positively affects tourist's satisfaction.
The emotion of love has a positive influence on tourists satisfaction with a destination.	The emotion of love positively affects tourists' satisfaction.
The emotion of positive surprise has a positive influence on tourist satisfaction with a destination	The emotion of positive surprise positively affects tourists' satisfaction.
A more favorable overall image will result in higher level of tourist satisfaction with a destination.	Overall destination image positively impacts satisfaction.
A more favorable overall image will result in higher propensity to recommend the destination.	Overall image positively affects tourists' intention to revisit.
-----	Overall image positively affects tourists' intention to recommend.
A higher level of tourist satisfaction with a destination will result in higher propensity to recommend the destination.	Tourists' satisfaction positively influences their intention to revisit.

-----	Tourists' satisfaction positively influences intention to recommend.
-------	--

The above table shows that paper (A) has 9 hypothesis while paper (B) has 11 hypothesis. Out of 11 hypotheses of paper (B), 9 are similar to paper (A)'s hypotheses.

#### Measurement Scales used by two papers

Paper (A)	Paper (B)
<b>Joy</b> I feel Cheerful toward Sardinia I feel a sense of Delight toward Sardinia I feel a sense of Enthusiasm toward Sardinia I feel a sense of Joy toward Sardinia I feel a sense of Pleasure toward Sardinia  <b>Love</b> I feel a sense of Affection toward Sardinia I feel a sense of Caring toward Sardinia I feel a sense of Love toward Sardinia  <b>Positive Surprise</b> I feel a sense of Amazement toward Sardinia I feel a sense of Astonishment toward Sardinia I feel Fascinated about Sardinia I feel a sense of Inspiration toward Sardinia I feel a sense of Surprise toward Sardinia  <b>Overall Image</b> Unfavorable – favorable Very negative – very positive  <b>Satisfaction</b> Very dissatisfied – very satisfied Terrible – delighted  <b>Intention to Recommend</b> I will recommend Sardinia to other people I will say positive things about Sardinia to other people I will encourage friends and relatives to visit Sardinia	<b>Joy</b> Enthusiasm Delight Cheerful Pleasure Joy  <b>Love</b> Caring Warm Tenderness Affection Love  <b>Positive surprise</b> Amazement Astonishment Surprise Inspiration Fascinated  <b>Overall destination image</b> Very negative – very positive Unfavorable – favorable  <b>Satisfaction</b> Very satisfied – very dissatisfied Terrible – delighted  <b>Intention to revisit</b> One day revisit intention Three days revisit intention  <b>Intention to recommend</b> Recommend to friends and family Encourage others to visit Tell positive things to others

Since Paper (B) used one additional variable (intention to revisit), measurement items for this variable are not available in paper (A). For all other variable whether independent, mediating or dependent variables paper (B) used same measurement items which are used by paper (A).

#### Results

	Paper (A)	Paper (B)
H1	Supported	Supported
H2	Supported	Supported
H3	Not Supported	Supported
H4	Not Supported	Supported
H5	Not Supported	Supported
H6	Supported	Supported
H7	Supported	Supported
H8	Supported	Supported

H9	-----	Supported
H10	Supported	Supported
H11	-----	Supported

Values of various parameters for paper (B) is very much similar to values given in paper (A). Results of various hypothesis of paper (B) is also similar to paper (A).

### Final part of Papers

Both papers have academic implications, managerial implications and future scope on exactly similar lines.

### The correspondence between the Editor and the authors:

**From:** "Laura Mesquita, ELS-AMS" <l.mesquita@elsevier.com>  
**To:** "Jogendra K. Nayak" <jogendra.nayak@ms.iitr.ac.in>, "Catheryn Khoo-Lattimore" <c.khoo-lattimore@griffith.edu.au>  
**Cc:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**Sent:** Friday, May 8, 2020 12:53:41 PM  
**Subject:** RE: Potential Academic Misconduct: Plagiarism

Dear Dr Nayak,

I am afraid that once a paper has been fully published and appeared in an issue, it is part of the publication record and can no longer be removed. It can only be retracted. I will send you a letter of retraction momentarily.

Best wishes,

Laura

#### Laura Mesquita

Publisher – Tourism & Library and Information Science  
 ELSEVIER | Global STM Journals  
 +31 20 485 2532 fixed  
 +31 (0) 612366372 mobile  
[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)

**From:** Jogendra K. Nayak <jogendra.nayak@ms.iitr.ac.in>  
**Sent:** Friday, May 8, 2020 5:22 AM  
**To:** Catheryn Khoo-Lattimore <c.khoo-lattimore@griffith.edu.au>  
**Cc:** Mesquita, Laura (ELS-AMS) <l.mesquita@elsevier.com>; pramodsharmaias1990 <pramodsharmaias1990@gmail.com>  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

\*\*\* External email: use caution \*\*\*

\_/\*\*/

Dear Dr.Catheryn, thanks for the reply. I understand it as a serious concern and take it as a learning in my life.

Kindly let me know one last thing, I have authored a paper along with some of my coauthors and has made it in accordance with the Elsevier format, I had in mind to send it to Tourism Management Perspectives.

Can I send it or not. Kindly let me know.

Sorry for bothering you.

Warm Regards  
Dr. J.K.Nayak  
Associate Professor (Marketing)  
Professor Placement in-charge  
Department of Management Studies  
Associated Faculty-Centre for Transportation Systems  
Indian Institute of Technology Roorkee  
M-09627204370  
webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)  
"SAVE WATER AND SAVE THE EARTH"

**From:** "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>, "Laura Mesquita, ELS-AMS" <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>  
**Cc:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Sent:** Friday, May 8, 2020 8:23:32 AM  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Hi Dr Nayak,

I understand your predicament, and can sympathise.

I am however disappointed with your perception of the problem. The problem is not merely a lack of citation. The entire paper was structured after Prayag et al (2017), and all sub-headings are almost identical. The arrangement and order of sentences in many places are also almost identical right through. The model is also the same except with the addition of one construct. Also, did you see my comment regarding Table 4? As a result, there is no original intellectual input into the paper. I am afraid the problem is much more serious than just "methods of referencing".

I don't have the authority to approve a withdrawal, as the issue has been escalated to the Publisher, so will leave it for Laura to comment.

It is regretful that this has happened.

Kind regards,  
**Dr. Catheryn Khoo-Lattimore** I Associate Professor  
Griffith Institute for Tourism I Dept of Tourism, Sport & Hotel Management

M +61468 938 072 I E [c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)

- Curator, Humanising the Academy: A Tourism Conference for All
- Editor-in-Chief, [Tourism Management Perspectives](#)



- Regional Expert (Asia), 2019 UNWTO Global Report on Women in Tourism
- Proud Founder of: Women Academics in Tourism (WAT)
- Series Editor, Perspectives on Asian Tourism by Springer

**From:** Jogendra K. Nayak <[jogendra.nayak@ms.iiit.ac.in](mailto:jogendra.nayak@ms.iiit.ac.in)>  
**Sent:** Friday, 8 May 2020 11:18 AM  
**To:** Mesquita, Laura (ELS-AMS) <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>  
**Cc:** pramodsharmaias1990 <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>; Catheryn Khoo-Lattimore <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Dear Laura and Dr. Catheryn, I am thankful to you for informing me and now coming to an decision about the paper.

I want an suggestion from you. I am writing this because the retraction process will bring a lot of shame to me and hurt my image a lot as an academician. I am sure you can understand my situation.

1. The problem is we have not acknowledged the authors at some of the necessary places in the paper, although we felt we have done it in some parts, which was an mistake from our side in our understanding, Can we now correct that and do the needful. Since the study has been already done in India and it has been already published can we do this?

2. If point 1 is not possible my humble request would be to entirely remove the article so that we take it as a learning and improve our methods of referencing.

I am sure you will make your judgement with lot of heart and rationality.

Kindly reply

Warm Regards  
 Dr. J.K.Nayak  
 Associate Professor (Marketing)  
 Professor Placement in-charge  
 Department of Management Studies  
 Associated Faculty-Centre for Transportation Systems  
 Indian Institute of Technology Roorkee  
 M-09627204370  
 webpage: [https://www.iiit.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iiit.ac.in/~DM/Jogendra_Kumar_Nayak)  
 "SAVE WATER AND SAVE THE EARTH"

**From:** "Mesquita, Laura (ELS-AMS)" <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>  
**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iiit.ac.in](mailto:jogendra.nayak@ms.iiit.ac.in)>, "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Cc:** "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Sent:** Thursday, May 7, 2020 11:33:49 PM  
**Subject:** RE: Potential Academic Misconduct: Plagiarism

Dear Drs Sharma and Nayak,

I am the Publisher of *Tourism Management Perspectives*. Following Catheryn's decision to retract your paper due to plagiarism, I will put it forward to our publication ethics panel to proceed with the official retraction. Please note that this process may still take a few weeks to be finalized.

You can learn more about how your retracted article will appear in the publication record here: <https://www.elsevier.com/about/policies/article-withdrawal/article-retraction>.

Catheryn will be in touch with you once the retraction takes place.

Best wishes,  
Laura

**Laura Mesquita**

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**From:** Jogendra K. Nayak <[jogendra.nayak@msdlt.ac.in](mailto:jogendra.nayak@msdlt.ac.in)>  
**Sent:** Thursday, 7 May 2020 12:06 PM  
**To:** Catheryn Khoo-Lattimore <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Cc:** pramodsharmaias1990 <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Dear Dr. Catheryn,

This incident has disturbed and shaken up me mentally. I always maintain high integrity as an individual and keep explaining students to refrain from any unethical activity. Pramod being one of my student would agree to this. But the problem here was maybe trust on his ability. I think it is time to also change my method of supervising the students.

Generally the process is I read the student's paper, check the degree of plagiarism, discuss with them on the writing style and the interpretation of the data and suggest improvements.

I have to agree and take responsibility that I have not gone through each paper that has been used in the study and thus this problem have arisen.

I am extremely unhappy that I have hurt the soul of the author's and as a Teacher who has a high responsibility towards the society, I apologise to them. Please send my message to them.

Now, I leave it on to you to take the best possible decision.

But I hope that this act would not stop me from reviewing and publishing my articles in your journal.

Thanks and take care

Warm Regards  
Dr. J.K.Nayak  
Associate Professor (Marketing)  
Professor Placement in-charge  
Department of Management Studies

Associated Faculty-Centre for Transportation Systems  
Indian Institute of Technology Roorkee  
M-09627204370  
webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)  
"SAVE WATER AND SAVE THE EARTH"

**From:** "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>  
**Cc:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Sent:** Thursday, May 7, 2020 6:33:25 AM  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Dear Dr Nayak,

Please find a Plagiarism factsheet by Elsevier for your reference.

I also attach my annotations in your paper for the substantial portions of texts that are reproduced from Prayag et al (2017)'s paper without referencing their work in those places.

Further, contrary to your claim, ALL the constructs used in your study are taken in whole from Prayag et al (2017) (I note that you have added one more construct. i.e. intention to revisit).

In addition, the values for CR and AVE (which can be calculated from the standard factor loadings) are completely wrong and therefore also suggests a possible case of fabrication.

Based on my comparative analysis of the papers, and the evidence presented in Table 4, I regret to deem this a case of plagiarism and a breach of the journal's policies set out in our ethical statements.

I await your final response to this email before our next step which is to organise for a retraction note for the article, which both you and Pramod will need to sign.

Kind regards,

**Dr. Catheryn Khoo-Lattimore** I Associate Professor  
Griffith Institute for Tourism I Dept of Tourism, Sport & Hotel Management  
M +61468 938 072 I E [c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)

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- Editor-in-Chief, [Tourism Management Perspectives](#)
- Regional Expert (Asia), 2019 UNWTO Global Report on Women in Tourism
- Proud Founder of: [Women Academics in Tourism \(WAIT\)](#)
- Series Editor, [Perspectives on Asian Tourism](#) by Springer

**From:** Jogendra K. Nayak <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>  
**Sent:** Wednesday, 6 May 2020 8:46 PM  
**To:** Catheryn Khoo-Lattimore <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Cc:** pramodsharmaias1990 <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Dear Dr. Catheryn, I went through both the papers carefully and found that the other paper (Prayag et al. 2017) about which the author has claimed that some part of the model has been used by Mr. Pramod is partially true. In this regard, I would like to apprise you that the constructs used for our study are taken partly from Prayag et al. 2017 and other authors which we have mentioned in table 1. The authors have been given due recognition and duly cited in the paper itself.

Please refer to the highlighted part in table 1 and other parts of the paper. The context of both the papers also happens to be quite different as our paper is related to wellness tourism in India and their paper is done on the tourism industry in Italy. There is no doubt that we have been impressed by their paper and therefore we have given due recognition to their work as well.

After evaluating both the papers I have got a feeling that there is no malafide intention to disrespect and disregard the academic contribution of Prayag et al.

I hope you are satisfied with our response and clarification on this.

I shall be glad to respond to any further queries in this regard in the future.

The PDF version of our paper containing the highlighted part is attached here for your necessary perusal. After looking at the highlighted part in the paper I am sure you would be completely satisfied with our response.

Warm Regards

Dr. J.K. Nayak

Associate Professor (Marketing)

Professor Placement in-charge

Department of Management Studies

Associated Faculty-Centre for Transportation Systems

Indian Institute of Technology Roorkee

M-09627204370

webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)

"SAVE WATER AND SAVE THE EARTH"

**From:** "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>

**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>

**Cc:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Sent:** Wednesday, May 6, 2020 10:01:13 AM

**Subject:** Re: Potential Academic Misconduct: Plagiarism

Thank you for your quick, reply, Dr Nayak.

You may also be already aware, but your other paper with Pramod published in the Journal of Destination Marketing and Management was also found to be potentially plagiarised, and has since been temporarily removed - please

see <https://www.sciencedirect.com/science/article/pii/S2212571X18300696>. The journal editor and I have been in contact and I understand that he has also sent Pramod an email.

I await your response.

Best,

Dr. Catheryn Khoo-Lattimore | Associate Professor

Griffith Institute for Tourism | Dept of Tourism, Sport & Hotel Management  
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- Editor-in-Chief, [Tourism Management Perspectives](#)
- Regional Expert (Asia), 2019 UNWTO Global Report on Women in Tourism
- Proud Founder of: [Women Academics in Tourism \(WAT\)](#)
- Series Editor, [Perspectives on Asian Tourism](#) by Springer

**From:** Jogendra K. Nayak <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>  
**Sent:** Wednesday, 6 May 2020 1:48 PM  
**To:** Catheryn Khoo-Lattimore <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Cc:** [pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com) <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Subject:** Re: Potential Academic Misconduct: Plagiarism

Dear Dr. Catherine, thanks for enquiring about my safety and well being. I am sure you must be in good health too.

This is a serious concern and it has come to my knowledge. This paper is a part of the PhD research of my scholar Pramod Kumar who was the corresponding author and has now completed his PhD and left the place.

I had gone through the plagiarism check but I had no clue about the similarity. I will go through the other paper and look at it.

Meanwhile I am discussing it with Pramod and keeping him in thread.

Please have faith I will do my best and solve this issue.

Thanks for informing me.

Warm Regards  
Dr. J.K.Nayak  
Associate Professor (Marketing)  
Professor Placement in-charge  
Department of Management Studies  
Associated Faculty-Centre for Transportation Systems  
Indian Institute of Technology Roorkee  
M-09627204370  
webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)  
"SAVE WATER AND SAVE THE EARTH"

**From:** "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**To:** [pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com), [jogknfdm@iitr.ac.in](mailto:jogknfdm@iitr.ac.in)  
**Sent:** Wednesday, May 6, 2020 7:29:51 AM  
**Subject:** Potential Academic Misconduct: Plagiarism

Dear Drs Sharma and Nayak,

I hope you are all well and safe.

I'm writing to follow up on an email I had sent you last year in August 2019 with regards to your paper published in *Tourism Management Perspectives*, volume 28, 2018, titled, "Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism".

Concern was raised about the publication of the article listed above, for which you are both the corresponding authors. The complaint was that your paper is almost identical to <https://journals.sagepub.com/doi/10.1177/0047287515620567>. The only exception is that your paper included 'intention to revisit' as an extra outcome variable but a quick check of Table 4: measurement model (page 48) reveals that the values for CR and AVE (which can be calculated from the standard factor loadings) are completely wrong and therefore also suggests a possible case of fabrication. As the editor of the journal, I must take seriously any allegation raised that if true would violate the journal's policies set out in our ethical statements. The substance of the complaint is that your article, which if true, would violate our publishing policies.

As this is my second and a follow-up email, please provide me a prompt and full response within 14 days, which I will also discuss with the party raising this concern.

Depending on the nature of your response, I should also inform you that I may also consider it necessary to inform and involve the research institution at which the underlying research took place.

Please note that if we do not have an adequate and timely response, we may be forced to conclude that the allegations are truthful.

I look forward to hearing from you soon.

Yours sincerely,  
Editor-in-Chief, *Tourism Management Perspectives*

**Dr. Catheryn Khoo-Lattimore** I Associate Professor  
Griffith Institute for Tourism I Dept of Tourism, Sport & Hotel Management  
M +61468 938 072 I E [c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)

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- Regional Expert (Asia), [2019 UNWTO Global Report on Women in Tourism](#)
- Proud Founder of: [Women Academics in Tourism \(WAT\)](#)
- Series Editor, [Perspectives on Asian Tourism](#) by Springer

+++++

**From:** "Laura Mesquita, ELS-AMS" <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>  
**To:** "Chairperson IAEC" <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)>, "Catheryn Khoo-Lattimore" <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>  
**Sent:** Wednesday, December 2, 2020 7:06:31 AM  
**Subject:** RE: Retraction of TMP paper by Sharma and Nayak

Hi Daniel,

Answers to your 3 questions:

1. [joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)
2. As a known and registered co-author, Dr. Nayak would have been informed by our system of these steps, yes.

3. Dr. Nayak has used both [jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in) and [joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com) to email me on his three retracted/removed papers co-authored with his student.

Best wishes,

Laura

**Laura Mesquita**

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**From:** Chairperson IAEC <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)>

**Sent:** Tuesday, December 1, 2020 10:53 AM

**To:** Catheryn Khoo-Lattimore <[c.khoo-lattimore@griffith.edu.au](mailto:c.khoo-lattimore@griffith.edu.au)>

**Cc:** Mesquita, Laura (ELS-AMS) <[l.mesquita@elsevier.com](mailto:l.mesquita@elsevier.com)>

**Subject:** Re: Retraction of TMP paper by Sharma and Nayak

Dear Catheryn, Laura:

I understand that you will be busy in this thanksgiving/ semester ending time, but I do seek your kind cooperation to clear a few points regarding the trailing email sent on May 6, 2020.

1. Both J.K. Nayak and Pramod Sharma have denied receiving your email of Aug 2019 referred in the first paragraph. Can you please confirm if it was sent... if so to which email address.

This information will help us establish the timeline and sequence of events correctly.

Thank you.

-daniel

---

Dr. B.S.S. Daniel

Chairperson, Institute Academics Ethics Committee

Professor, Metallurgical and Materials Engineering

Indian Institute of Technology Roorkee

Roorkee 247667, Uttarakhand, INDIA

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## Annexure 11

### Paper 3: IJTR 2019 and Kim 2018

The table below will help in understanding similarity between paper authored by Pramod Sharma and J K Nayak (IJTR 2019) and paper authored by Kim (2018). The full reference of the paper is given below:

Sharma P. Nayak JK. Understanding memorable tourism experiences as the determinants of tourists' behaviour. *International Journal of Tourism Research*. 2019; 21: 504–518. <https://doi.org/10.1002/jtr.2278>

Kim JH (2018), The Impact of Memorable Tourism Experiences on Loyalty Behaviors: The Mediating Effects of Destination Image and Satisfaction. *Journal of Travel Research*, 2018, 57(7), 856-870 <https://doi.org/10.1177/0047287517721369>

	IJTR 2019	Kim, JTR 2018
Conceptual Model :	Both papers have exactly similar conceptual model on which study is based. Paper 1 has cited the paper 2 in development of the theoretical background but did not state that model is adopted from paper 2.	
Hypothesis Development	Both papers have exactly 9 hypotheses. The order of proposing these hypotheses in paper 1 is similar to paper2.	
Study Area	This paper collected data from tourists visiting Rishikesh for Yoga.	This paper is based on data collected from tourists visited Taiwan.
Measurement of variables	Though paper 1 is based on Yoga tourism, but it has used same statements to measure different variables as given in paper 2.	
Output of CFA Result	Values of Cronbach's alpha for various variables is almost similar in both papers. This is very unlikely in such type of studies. It raises doubt about authenticity of data collection and analysis by paper 1.	
Summary of Hypothesis Testing	Values of $\beta$ coefficients in both the papers are almost similar and all the hypothesis are supported in both the papers.	
Discussion	Two papers have explained almost similar theoretical and practical contribution.	

The Correspondence between the Authors and the Editors:



From: **PRAMOD SHARMA** <pramodsharmalas1990@gmail.com>  
Date: Mon, Jun 24, 2019 at 2:53 PM  
Subject: Re: JTR-18-0295 AN URGENT MATTER  
To: John Fletcher <jfletcher@bournemouth.ac.uk>

Dear sir,

I am highly thankful to you for providing me a chance to explain my research in yoga tourism as enunciated in the paper “Understanding memorable tourism experiences as the determinants of tourists’ behaviour”.

1. My research is all about yoga tourism and its wellness attributes conducted in India (i.e., Rishikesh).
2. Yoga has its origin in India. However, the growth of yoga tourism is not upto the mark. This slow pace of yoga tourism has its root in the psychology of tourists.
3. The thorough review of literature on general tourism especially the work of J. H. Kim in 2018 was remarkable.
4. The paper talked about improving tourism by influencing tourists’ revisit intention and WOM intention using memorable tourism experience.
5. Following his work in general tourism, I have conceptualized memorable tourism experience in yoga tourism.
6. I am very much thankful to Prof. J. H. Kim because his work has shown me the direction for research.
7. I have cited his work several times in the paper. As far as possible, reasonable credit has been provided to him.
8. Apart from small difference, the main difference between Prof. J. H. Kim’s work and my work is that I have conceptualized memorable tourism experience in yoga tourism and Prof. J. H. Kim conceptualized memorable tourism experience in general tourism.
9. My paper especially highlights on the importance of yoga tourism and the mechanism of developing the niche market.
10. Surely, I have taken inspiration from the work of Prof. J. H. Kim, for which I have provided appropriate recognition in the form of citations.
11. However, if this is a case of plagiarism then I am ready to withdraw my paper.

Thank you once again!

With best regards  
Pramod Sharma

On Mon, Jun 24, 2019 at 1:58 PM John Fletcher <onbehalf@manuscriptcentral.com> wrote:

Dear Pramod,

I have been contacted by an academic alleging that your manuscript "Understanding memorable tourism experiences as the determinants of tourists' behaviour" which has been accepted and published by IJTR bears too much resemblance to an article written by J. H. Kim in 2018 "The impact of memorable tourism experiences on loyalty behaviors" published by the Journal of Travel Research.

The diagrams in both articles are incredibly similar and so too are the coefficients achieved from the analysis - which is unusual to say the least, given the different context and sampling. I wonder if you could let me know whether there was to be some attribution in your paper to the earlier work and your comments on the allegations of plagiarism. Following your response i will contact COPE so that a full investigation can be undertaken.

Best wishes

john

Professor John Fletcher

+++++

**From:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**To:** "Brian Collins" <brcollins@wiley.com>  
**Cc:** "Jogendra K. Nayak" <jogendra.nayak@ms.iitr.ac.in>  
**Sent:** Saturday, June 6, 2020 6:23:52 PM  
**Subject:** Re: Allegation of plagiarism

Dear Brian Sir,

Apologies for the delay in replying!

With due respect, I would like to highlight that this study of mine in wellness tourism was conducted during my PhD work. However, Dr. J.K.Nayak who happens to be my supervisor, has checked the paper for plagiarism (report sent to you earlier) and has edited my final paper. The paper is solely my work.

I would like to highlight that my study is an extension of the concept of memorable tourism experiences in wellness tourism, which is a unique type of special interest tourism. This study was done to see whether improving memorable tourism experience can lead to positive behavioral intentions in wellness tourism or not. The concept of memorable tourism experience has been researched several times in general tourism but the evidence of researching this innovative concept in this special interest tourism (especially wellness tourism) is less. In this respect, I want to focus on the paper of Kim et al. (2017) which examined this concept of memorable tourism experience in general tourism. However, this study examined the concept of memorable tourism experiences in wellness tourism. As far as possible, the researchers working in the concept of memorable tourism experiences were cited in my paper. For example; Kim et al. (2017) has been cited for more than 10 times; Kim, H., & Chen, J. S. (2018); Kim, J. H. (2010); Kim, J. H., & Ritchie, J. B. (2014); Kim, J. H., Ritchie, J. B., & McCormick, B. (2012); Kim, J. H., Ritchie, J. R., & Tung, V. W. S. (2010) and so on were cited many times in the paper. This was done to reveal that I have not

created anything new but I have applied the concept that was examined earlier by the respected researchers in a new set of context of wellness tourism in India. There may be some sort of similarity of my paper with their papers. However, they are not the same.

If my intention was to plagiarize the work of any other authors such as Kim et al. (2017), then I would not have cited their work. This indicates that my intention was not to plagiarize but to extend the developed concept in a new set of context i.e. wellness tourism.

The model used in the paper of Kim et al. (2017) was used in my paper with some modification, which was done to fit the model according to the context of the study, i.e. wellness tourism (For example, 'WOM intention' was replaced with the construct 'intention to recommend'). Moreover, the measurement scale items were also selected from some of the related study such as Kim et al. (2017), Styliadis et al., (2017) and so on. However, this argument is stated throughout the paper, so I don't claim the model to be mine, and I have clearly highlighted this statement in the paper. But I have applied the model with some modification in a different set of context of wellness tourism (which is a special interest tourism).

For example: "A recent study by Kim (2017) found the influence of MTEs on tourists' behaviour among tourists visiting Taiwan. The unique nature of yoga tourism directs MTEs of the yoga destination to have a strong impact on the loyalty intentions of tourists' visiting such a destination. Therefore, obtaining support from the above discussed literature, it is hypothesized in yoga tourism that" (page no. 4).

Regarding the similarity of data with the study of Kim et al., I can only say that it was my lack of understanding and human error which has resulted in that situation. I will not try to justify that. I realized my mistake only after the paper was published.

The explanation highlighting the originality of my research and the difference between our paper and the paper of Kim et al. (2017) is explained below:

Explanation justifying the originality of my paper

Paper Title: "Understanding memorable tourism experiences as the determinants of tourists' behaviour".

The most important contribution of my study is the investigation of the concept of memorable tourism experience in wellness tourism only, which is a special interest tourism. It is context specific and different from all others research of memorable tourism experience in general tourism. It may be considered as an extension of the new concept in wellness tourism. The point by point difference and contribution are explained below:

My study is based on studying the emerging concept of memorable tourism experience in wellness tourism. This concept was studied in general tourism literature several time (including the study of Kim et al., 2017). As far as my knowledge is concerned, my study is the first known attempt to investigate the concept of memorable tourism experiences in wellness tourism. This is the first difference.

Second, my study considered tourists visiting wellness destination as the sample for the study. Kim et al. (2017) considered the general tourism as their sample for the study. There

are many differences between wellness tourists and general tourists. For example, the main purpose of general tourists are leisure and pleasure but the main aim of wellness tourists is improving wellness by practicing yoga etc. in tourists destination. Moreover, wellness tourism is special interest tourism.

Third, the study of Kim et al. (2017) considered tourists visiting the destination in Taiwan as their respondents. However, in my case the respondents were tourists visiting the destination in India i.e. Rishikesh.

Fourth, the specific contribution unique to our research can be understood from the following statements:

- \* My research contributes by highlighting that memorable tourism experience also influences tourists' behaviour in wellness tourism which is unique.

- \*My study demonstrated that improving memorable tourism experience may prove an opportunity for destination managers to form a positive behavioral intention of wellness tourists' and work as a differentiator in a wellness tourist destination.

- \*This study also provides specific suggestions to the destination manages such as:

Such as, marketing campaign of yoga tourism destination should be developed to highlight the wellness benefits of various forms of yoga such as Ashtanga, Vini, Hatha and Vinyasa yoga.

Tourists may be allowed to meet yoga gurus (yoga instructor) and have a long interaction with them beyond their normal yoga practices. Moreover, tourists may be provided an opportunity to stay in the houses of the local residents to enjoy their hospitality and better experience such destination. These practices create an intensive MTEs in the mind of tourists.

Tourists may be offered some newness in the destination such as yoga food, yoga drinks, and yoga lifestyle.

Last but not least, yoga practices may be conducted in such a way that the entire process becomes an enjoyable experience. These combined acts on the part of marketers, yoga gurus, residents, and local authorities would certainly create strong MTEs (page no. 11).

These are only some of the points highlighting the uniqueness of my paper, which is difficult to find in any other studies (e.g. Kim et al., 2017).

Moreover, before sending my paper to the journal for publication, the manuscript was checked for plagiarism using turnitin software to see whether there is any similarity of my paper with any other work. However, the paper was within the limit of similarity. The paper was also checked to see whether any statement is written without providing proper citations. But, there was none. Proper care was kept before sending the manuscript for review. However, despite of taking so much of care, the paper is being questioned for plagiarism.

I want to conclude my explanation with the statement that this study is the extension of the concept of memorable tourism experience in wellness tourism. This is the unique contribution of our study in wellness tourism.

Hope, I could explain the point of difference of the two studies and the original contribution of my paper.

If I am given a chance to correct the paper, I would be very much thankful to you for your favour!

Lastly, I would like to point out that with my limited knowledge of research, I have conducted the study as a research student. If my paper violates the right of any authors, then I am sorry for it. Because it was completely unintentional and it is caused due to lack of research knowledge on my part. Moreover, I feel sorry for my teacher Dr. J.K.Nayak sir, who is also being questioned for no mistake of his.

Looking forward for your final decision!

For any further clarification, kindly feel free to contact me at my following email ids!

Thanks and regards,

Dr. Pramod Sharma  
Assistant Professor  
Assam Don Bosco University  
Azara Campus, Assam  
Email ids:

[pramod.sharma@dbuniversity.ac.in](mailto:pramod.sharma@dbuniversity.ac.in)  
[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)

Website:

<http://erp.dbuniversity.ac.in/emplist/viewprofile.php?id=487>

On Wed, Jun 3, 2020 at 7:19 PM Collins, Brian <[brcollins@wiley.com](mailto:brcollins@wiley.com)> wrote:

Dear Dr. Nayak,

Can I then confirm that you were aware of the published paper of which you are listed as a co-author?

Kind regards,

Brian

**From:** Jogendra K. Nayak <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>

**Sent:** 01 June 2020 12:20

**To:** Collins, Brian <[brcollins@wiley.com](mailto:brcollins@wiley.com)>

**Cc:** pramodsharmaias1990 <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Subject:** Re: Allegation of plagiarism

☹ This is an external email.

\_/\*\*/

Dear Brian,

thanks for your email.

At the outset let me apologise for the mistake in my first email.

1. In my first email I wrote by mistake " this is the first time I have come to know of **this paper**" actually I was referring to the email you had referred to us that was sent by Prof. Fletcher. I had no clue about this email and therefore I asked you to resend it to me so that I could check the details. Since there is no reason I would not reply until and unless I am aware of it so I had written that. Kindly correct my mistake.
2. As a supervisor I checked the plagiarism of the paper (report attached in last email) and edited the paper for correcting the grammar, flow of the paper and improving the discussion section etc. Since this is a part of the PhD work of Pramod it is obvious that I did not conduct the data analysis, so I cannot comment on that part.
3. Apart from this if there is anything more, I think it would be better if Pramod answers them and makes it clear.

Thanks

Warm Regards

Dr. J.K.Nayak

Associate Professor (Marketing)

Professor Placement in-charge

Department of Management Studies

Associated Faculty-Centre for Transportation Systems

Indian Institute of Technology Roorkee

M-09627204370

webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)

"SAVE WATER AND SAVE THE EARTH"

**From:** "Brian Collins" <[brcollins@wiley.com](mailto:brcollins@wiley.com)>

**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>

**Cc:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Sent:** Friday, May 29, 2020 3:58:50 PM

**Subject:** RE: Allegation of plagiarism

Dear Dr Nayak,

Many thanks for your email.

Ultimately the allegation that has been made doesn't relate to direct, in verbatim, plagiarism between the two articles, rather the allegations that has been made is that the model is identical to Kim (2018) and the path coefficients and R2 values are near identical too. As such it could be said that what is alleged is that this is the same study, but in a different wrapper.

Now on the basis of what you've outlined in your first email, it would seem that there's potentially two separate items of academic misconduct arising from this paper. The first being the allegation of plagiarism attached to the article from the third-party, the second being a question regarding authorship, as you claimed to have no prior knowledge of this paper until such time as I contacted you in my email on the 20<sup>th</sup>.

For avoidance of doubt, I am unwilling of providing you information on the person who made the allegation as the misconduct here implicates the journal, who I represent on behalf of the publisher.

Please can you confirm whether the outline that I've placed above is reasonable.

Kind regards,

**Brian Collins** | Journals Publishing Manager | Research

John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, PO19 8SQ

[www.wiley.com](http://www.wiley.com)

T: +44 1243 770283 (ext: 43283) | M: +44 7717 878654 | E: [brcollins@wiley.com](mailto:brcollins@wiley.com)

**From:** Jogendra K. Nayak <[jogendra.nayak@ins.iitr.ac.in](mailto:jogendra.nayak@ins.iitr.ac.in)>

**Sent:** 21 May 2020 16:20

**To:** Collins, Brian <[brcollins@wiley.com](mailto:brcollins@wiley.com)>

**Cc:** pramodsharmaias1990 <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Subject:** Re: Allegation of plagiarism

☐ This is an external email.

\_/\*\*/\_

Dear Mr. Brian

Further to my yesterday's mail in response to your mail dated May 20, 2020, I would like to state as under:

1. After writing to you immediately on receipt of your mail about the similarity in ours and Kim's papers, I have made a content analysis of your mail and the academic content of both the papers.
2. You have written that Professor John Fletcher, Editor-in-Chief of IJTR, had written to me about one year back and brought the contentious issue to my notice and I haven't replied anything in that regard. In that context it is stated that I would like to know about the mail id and date and content of the said mail. I need all these details for the reasons that I haven't received any mail sent by The Chief Editor about one year back to me. There was no reason for me to NOT to reply the Prof. Fletcher's mail had I received the communication.
3. As far as the similarity of some part of the two papers is concerned, Mr. Pramod Sharma, the first author in the paper and my Ph.D. scholar at that time had already referred to Mr. Kim's paper in question in our paper and in the para 2 of the second part of page three clearly states that "**Kim (2017) defined MTEs as a tourism experience that is positively remembered and recalled after the event has occurred**". In the reference list as well, he has referred to the paper. The year of the Kim's paper has inadvertently been marked as 2017. The scholar (Mr. Pramod) has cited the Kim's work at many places in our paper so, I don't

understand it becomes a case of lifting some part of the paper without giving due credit to the author.

4. The undersigned being the Ph.D. supervisor of Mr. Pramod was responsible to check about any kind of plagiarism in the paper so, I have done that and attached the Turnitin report that testifies that there exists no content in the paper which may be termed as 'has been plagiarised'.

5. Further, I shall be obliged if, you could share with me the details of the person who has filed this complaint with the journal and if it is Mr. Kim, I can sort out this issue with him and keep the journal informed.

6. Mr. Pramod Sharma has already completed his Ph.D. under my supervision and now working as a faculty and independent researcher in another University so, for any further details he may be contacted by the Journal.

I have tried to reply you with the best of my knowledge. I am sure the Journal will take a judicious view about the facts as cited above.

Thanks

Warm Regards

Dr. J.K.Nayak

Associate Professor (Marketing)

Professor Placement in-charge

Department of Management Studies

Associated Faculty-Centre for Transportation Systems

Indian Institute of Technology Roorkee

M-09627204370

webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)

"SAVE WATER AND SAVE THE EARTH"

**From:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>

**To:** "Brian Collins" <[brcollins@wiley.com](mailto:brcollins@wiley.com)>

**Cc:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Sent:** Wednesday, May 20, 2020 10:43:35 PM

**Subject:** Re: Allegation of plagiarism

Dear Sir,

thanks for the email and informing me about this issue. Pramod sharma, the corresponding author was my student who has now completed and moved out from our institution.

Trust me, this is the first time I am coming to know about this paper. I am sure there must have been some mistake in my earlier email id, because I was unaware of this issue. Maybe the email given by Pramod in the beginning must have been wrong and therefore I got no communication.



Since I have come to know about it only a few hours back I have not been able to check and compare with the other paper. But I am sure you must have marked something clearly and therefore I respect your decision.

Kindly withdraw the paper since there is no point in owning a paper if it has been copied from others.

I have also asked Mr.Pramod to withdraw my name from all his papers and not to work with me in the future.

Although I was unaware of this incident, I still beg apology to the author and the publishing house as my name is also attached.

Sorry for all the inconvenience.

Warm Regards

Dr. J.K.Nayak

Associate Professor (Marketing)

Professor Placement in-charge

Department of Management Studies

Associated Faculty-Centre for Transportation Systems

Indian Institute of Technology Roorkee

M-09627204370

webpage: [https://www.iitr.ac.in/~DM/Jogendra\\_Kumar\\_Nayak](https://www.iitr.ac.in/~DM/Jogendra_Kumar_Nayak)

"SAVE WATER AND SAVE THE EARTH"

**From:** "Collins, Brian" <[brcollins@wiley.com](mailto:brcollins@wiley.com)>

**To:** "Jogendra K. Nayak" <[jogendra.nayak@ms.iitr.ac.in](mailto:jogendra.nayak@ms.iitr.ac.in)>, "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>

**Sent:** Wednesday, May 20, 2020 8:53:24 PM

**Subject:** Allegation of plagiarism

Dear both,

I'm contacting you today regarding the following article:

Sharma, P, Nayak, JK. Understanding memorable tourism experiences as the determinants of tourists' behaviour. Int J Tourism Res. 2019; 21: 504– 518. <https://doi.org/10.1002/jtr.2278>.

As I believe you are already aware, we've received an allegation that the above paper contains significant proportions of elements from another paper without appropriate citation. Specifically your model is identical to Kim (2018) [reference below] furthermore the path coefficients and R2 values are near identical too (e.g. in Kim (2018) – path from MTE to DI = 0.74 and in Sharma and Nayak (2019) – 0.73. For the path coefficients and R2 values to be identical - given the unique context, sampling methods and sample size of the 2 studies.

I believe that Professor John Fletcher, Editor-in-Chief of IJTR has already given you the opportunity to contest these allegations, with you offering no defence in return. That being

the case, we're left with no other option than retracting this paper and issuing an appropriate retraction statement. You will find that statement below. Please review this and let me know by Tuesday 26<sup>th</sup> May if you object.

Furthermore, presuming you remain unable to offer any defence for this malpractice, I will be left with no option than to report this instance to your respective institutions.

Kind regards,

**Brian Collins** | Journals Publishing Manager | Research  
John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, PO19 8SQ  
[www.wiley.com](http://www.wiley.com)  
T: +44 1243 770283 (ext: 43283) | M: +44 7717 878654 | E: [brcollins@wiley.com](mailto:brcollins@wiley.com)

### **Kim 2018:**

Kim, J. H. (2018). The impact of memorable tourism experiences on loyalty behaviors: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, 57(7), 856-870

### **Retraction Statement:**

Sharma, P, Nayak, JK. Understanding memorable tourism experiences as the determinants of tourists' behaviour. *Int J Tourism Res*. 2019; 21: 504– 518. <https://doi.org/10.1002/jtr.2278>

The above article from the *International Journal of Tourism Research*, published online on 2nd May 2019 in Wiley Online Library (<http://onlinelibrary.wiley.com/>), has been retracted by agreement between the authors, the journal Editor in Chief, Prof. John Fletcher and Wiley. The retraction has been agreed due to unattributed overlap between this article and the following article published in the *Journal of Travel Research*: Kim, J. H. (2018). The impact of memorable tourism experiences on loyalty behaviors: The mediating effects of destination image and satisfaction. *Journal of Travel Research*, 57(7), 856-870

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**From:** "pramodsharmaias1990" <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**To:** "Chairperson IAEC" <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)>  
**Sent:** Sunday, October 25, 2020 10:40:02 PM  
**Subject:** Fwd: JTR-18-0295 AN URGENT MATTER

## Annexure 12

### Paper 4: JDMM 2020 and Prayag 2013

The table below will help in understanding similarity between paper authored by Pramod Sharma and J K Nayak (JDMM 2020) and paper authored by Prayag (JDMM 2013). The full reference of the paper is given below:

Pramod Sharma and Jogendra Kumar Nayak (2019), The role of destination image as a mediator between tourists' emotional experiences and behavioral intentions: A study of wellness tourism, *Journal of Destination Marketing & Management*, Volume 16, June 2020, 100342 <https://doi.org/10.1016/j.jdmm.2019.02.002>

Gurush Prayag, Sameer Hosany and Khaled Odeh (2013), The role of tourists' emotional experiences and satisfaction in understanding behavioural intentions, *Journal of Destination Marketing & Management*, 2 (2013) 118–127 <http://dx.doi.org/10.1016/j.jdmm.2013.05.001>

	Sharma, JDMM 2020	Prayag, JDMM 2013
Title	This paper uses destination image as a mediator variable in the title of the paper.	There is no mention of any mediator variable.
Use of variables	Emotional experience, destination image and behavioral intention	Joy, love, positive surprise, unpleasantness, satisfaction and behavioral intentions
Conceptual model		
	Both conceptual models are almost similar, except mediator variable. In paper (a) destination image is mentioned as mediator variable while in paper (b) satisfaction is mentioned as mediator variable.	
No of Hypotheses	10	10
Hypotheses	<p>H1: The emotion of joy positively influences destination image.</p> <p>H2: The emotion of love positively influences destination image.</p> <p>H3: The emotion of positive surprise positively influences destination image.</p> <p>H4: The emotion of unpleasantness negatively influences destination image.</p>	<p>H1: Joy has a positive relationship with satisfaction.</p> <p>H2: Love has a positive relationship with satisfaction.</p> <p>H3: Positive surprise has a positive relationship with satisfaction.</p> <p>H4: Unpleasantness has a negative relationship with satisfaction.</p>
	To develop above four hypotheses, both papers started conceptual background from the work of Cohen & Areni (1991). Development of hypothesis by authors of paper (a) used same arguments as presented by authors of paper (b).	
	<p>H5: The emotion of joy positively influences behavioral intentions.</p> <p>H6: The emotion of love positively influences behavioral intentions.</p> <p>H7: The emotion of positive surprise positively influences behavioral intentions.</p> <p>H8: The emotion of unpleasantness negatively influences behavioral intentions.</p>	<p>H1: Joy has a positive relationship with behavioral intentions.</p> <p>H2: Love has a positive relationship with behavioral intentions.</p> <p>H3: Positive surprise has a positive relationship with behavioral intentions.</p> <p>H4: Unpleasantness has a negative relationship with behavioral intentions.</p>
	Paper (a) follows similar argument as paper (b) for developing these four hypotheses.	

Measures	Both papers use Hosany and Gilbert (2010) scale for estimating the positive emotions of tourists.
----------	---

## Sharma, JDMM 2020

Constructs and items	Standardized loadings	Expl. var.	Composite reliability	AVE
<b>Joy</b>			0.82	0.66
I feel a sense of joy toward Petra	0.78	31.3%		
I feel a sense of delight toward Petra	0.72	31.3%		
I feel a sense of happiness toward Petra	0.68	31.3%		
I feel a sense of fun toward Petra	0.65	31.3%		
I feel a sense of pleasure toward Petra	0.63	31.3%		
<b>Love</b>			0.79	0.57
I feel a sense of affection toward Petra	0.74	31.2%		
I feel a sense of love toward Petra	0.70	31.2%		
I feel a sense of fondness toward Petra	0.65	31.2%		
I feel a sense of attachment toward Petra	0.60	31.2%		
I feel a sense of devotion toward Petra	0.59	31.2%		
<b>Positive surprise</b>			0.74	0.50
I feel a sense of amazement toward Petra	0.72	31.5%		
I feel a sense of wonder toward Petra	0.69	31.5%		
I feel a sense of surprise toward Petra	0.67	31.5%		
I feel a sense of excitement toward Petra	0.65	31.5%		
I feel a sense of astonishment toward Petra	0.63	31.5%		
<b>Unpleasantness</b>			0.82	0.66
I feel a sense of dislike toward Petra	0.78	31.3%		
I feel a sense of aversion toward Petra	0.72	31.3%		
I feel a sense of repulsion toward Petra	0.68	31.3%		
I feel a sense of disgust toward Petra	0.65	31.3%		
I feel a sense of hatred toward Petra	0.63	31.3%		
<b>Destination image</b>			0.77	0.59
My impression of the destination (Petra) is good	0.72	31.2%		
My impression of the destination (Petra) is excellent	0.69	31.2%		
<b>Behavioral intentions</b>			0.83	0.74
I will recommend Petra to other people	0.80	39.5%		
I will say positive things about Petra to other people	0.79	39.5%		
I will encourage friends and relatives to visit Petra	0.83	39.5%		

Note: AVE = Average variance extracted;  $p < 0.001$ ,  $p < 0.01$ .

## Prayag, JDMM 2013

Item	Standardized loadings	t-Statistic	Composite reliability	AVE
<b>Joy</b>			0.88	0.65
I feel a sense of joy toward Petra	0.81	21.55***		
I feel a sense of pleasure toward Petra	0.82	28.50***		
I feel cheerful toward Petra	0.85	31.62***		
I feel a sense of delight toward Petra	0.85	39.91***		
I feel a sense of enthusiasm toward Petra	0.74	36.09***		
<b>Love</b>			0.89	0.59
I feel a sense of affection toward Petra	0.81	29.75***		
I feel a sense of love toward Petra	0.81	28.45***		
I feel a sense of tenderness toward Petra	0.77	20.65***		
I feel warm toward Petra	0.89	22.87***		
I feel a sense of caring toward Petra	0.87	25.11***		
<b>Positive surprise</b>			0.84	0.50
I feel fascinated about Petra	0.74	14.90***		
I feel a sense of inspiration toward Petra	0.80	21.90***		
I feel a sense of surprise toward Petra	0.82	30.08***		
I feel a sense of astonishment toward Petra	0.83	29.52***		
I feel a sense of amazement toward Petra	0.81	26.29***		
<b>Unpleasantness</b>			0.89	0.70
I feel a sense of hatred toward Petra	0.76	14.42***		
I feel a sense of dislike toward Petra	0.85	25.98***		
I feel a sense of repugnance toward Petra	0.82	21.98***		
I feel a sense of disgust toward Petra	0.89	38.26***		
<b>Satisfaction</b>			0.92	0.78
Very Dissatisfied/Very Satisfied	0.99	39.19***		
Neutral/Not Satisfied	0.85	24.48***		
Not at all very much/Not very much	0.83	23.24***		
<b>Behavioral intentions</b>			0.85	0.67
I will recommend Petra to other people	0.83	31.88***		
I will say positive things about Petra to other people	0.81	27.89***		
I will encourage friends and relatives to visit Petra	0.81	38.28***		

\*\*\* Significant at the 0.01 level. AVE = average variance extracted.

Sharma, JDMM 2020 uses same measurements for all variables as shown in above table of Prayag, JDMM 2013. However, authors of Sharma, JDMM 2020 gives different sequence for sentences as compare to Prayag, JDMM 2013. Values of composite reliability and AVE for Joy, Love, Positive surprise, unpleasantness and behavioral intentions are almost similar in two papers.

Both papers have exactly similar analysis and same results.

Conclusions and Future directions are also written on almost on similar lines in both the papers.

### Correspondence between the Authors and the Editor

From: **Alan Fyall** <Alan.Fyall@ucf.edu>

Date: Thu, May 7, 2020 at 1:48 AM

Subject: RE: Request to permanently withdraw a research paper

To: PRAMOD SHARMA <pramodsharmaias1990@gmail.com>, Mesquita, Laura (ELS-AMS) <l.mesquita@elsevier.com>

Cc: jog nayak <joginder.nayak@gmail.com>

Hello Pramod, thank you for your note. Yes, in the circumstances I am happy to oblige. Laura – can you please proceed with the request as outlined below? Parmod, I wish you well with your future studies.

Best wishes, Alan

**Dr. Alan Fyall**

Associate Dean, Academic Affairs

Interim Chair, Department of Tourism, Events & Attractions

Visit Orlando Endowed Chair of Tourism Marketing

Office: 407.903.8808

Cell: 407.921.6131

[alan.fyall@ucf.edu](mailto:alan.fyall@ucf.edu)

**Co-Editor: Journal of Destination Marketing & Management** - Impact Factor: 3.800 I 5-Year

Impact Factor: 4.675

<https://www.sciencedirect.com/journal/journal-of-destination-marketing-and-management>

**From:** PRAMOD SHARMA [mailto:[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)]

**Sent:** Wednesday, May 6, 2020 2:00 PM

**To:** Alan Fyall <Alan.Fyall@ucf.edu>

**Cc:** jog nayak <[joginder.nayak@gmail.com](mailto:joginder.nayak@gmail.com)>

**Subject:** Request to permanently withdraw a research paper

Dear Alan sir,

Hope you are well!

With due respect, I like to request you to permanently withdraw my paper entitled "The role of destination image as a mediator between tourists' emotional experiences and behavioral intentions: A study of wellness tourism" from your journal (Journal of destination marketing and management). This is due to the fact that I want to significantly improve the research paper to make it more meaningful and publish it in a suitable journal.

I am extremely sorry for the inconvenience caused to you and your team in publishing the paper.

Hope to see the paper being permanently withdrawn from the journal!

Thank you for your co-operation.

With regards,

Pramod Sharma

From: **PRAMOD SHARMA** <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
Date: Sat, Feb 1, 2020 at 3:53 PM  
Subject: Re: Your Paper - JDMM  
To: Alan Fyall <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)>

Dear Alan  
Kindly update me regarding my paper.

Thanks and regards  
Pramod Sharma

On Sun 29 Dec, 2019, 08:46 PRAMOD SHARMA, <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)> wrote:  
Dear Alan,  
Thank you for your email, and apology for bothering you during festival time. Hope to receive positive response from you.  
Thank you once again!

Regards  
Pramod

On Sat, Dec 28, 2019 at 1:20 AM Alan Fyall <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)> wrote:

Hello Pramod, I do apologize I was under the impression that this was all now clear, please do bear with me as I cannot fully check until I return to UCF (evidence is in my office) on January 2. I'll be back in touch with you soon, best wishes, Alan

**From:** PRAMOD SHARMA <[pramodsharmaias1990@gmail.com](mailto:pramodsharmaias1990@gmail.com)>  
**Sent:** Thursday, December 26, 2019 10:36 PM  
**To:** Alan Fyall <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)>  
**Subject:** Re: Your Paper - JDMM

Dear Alan  
Hope you are well!  
I am writing to you in connection with my paper "The role of destination image as a mediator between tourists' emotional experiences and behavioral intentions: A study of wellness tourism" provisionally published in the Journal of Destination Marketing & Management". Kindly update me status of my paper, if possible.

Thanks & Regards  
Dr. Pramod Sharma

On Mon, Aug 5, 2019 at 8:19 PM Alan Fyall <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)> wrote:

Thank you for your correspondence Pramod, I hope to be back in touch with you very soon. Kind regards, Alan

**Dr. Alan Fyall**  
Visit Orlando Endowed Chair of Tourism Marketing  
Interim Chair, Tourism, Events & Attractions Department  
Graduate Programs' Director, Rosen College of Hospitality Management  
Member, National Center for Integrated Coastal Research

University of Central Florida

Office: 407.903.8808 Cell: 407.921.6131 [alan.fyall@ucf.edu](mailto:alan.fyall@ucf.edu)

**Co-Editor: Journal of Destination Marketing & Management** - Impact Factor: 3.800 I 5-Year  
Impact Factor: 4.675

<https://www.sciencedirect.com/journal/journal-of-destination-marketing-and-management>

**From:** PRAMOD SHARMA [<mailto:pramodsharmaias1990@gmail.com>]

**Sent:** Saturday, July 20, 2019 12:49 PM

**To:** Alan Fyall <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)>

**Subject:** Re: Your Paper - JDMM

Thank you for the update.

On Sat 20 Jul, 2019, 1:29 AM Alan Fyall, <[Alan.Fyall@ucf.edu](mailto:Alan.Fyall@ucf.edu)> wrote:

Dear Pramod,

I am writing to make you aware of a claim that your paper "The role of destination image as a mediator between tourists' emotional experiences and behavioral intentions: A study of wellness tourism" provisionally published in the Journal of Destination Marketing & Management contains plagiarized material from another paper. Clearly this is a serious claim so as part of Elsevier's investigation, your paper is to be temporarily removed for the duration of the investigation. It is important at this stage to stress that there is no indication of your guilt in plagiarizing work from another paper. A claim has been made and in accord with Elsevier guidelines, we are conducting an investigation with which you will be fully informed of our findings as we progress through the process.

I appreciate the above may cause you unease and discomfort but rest assured we endeavor to complete this process as thoroughly and as quickly as possible. If there is no evidence to substantiate the claims made then your paper will be published accordingly.

I will be in touch again soon with regard to the claims made and evidence presented for your response.

Kind regards, Alan

**Dr. Alan Fyall**

Visit Orlando Endowed Chair of Tourism Marketing  
Interim Chair, Tourism, Events & Attractions Department  
Graduate Programs' Director, Rosen College of Hospitality Management  
Member, National Center for Integrated Coastal Research  
University of Central Florida

Office: 407.903.8808

Cell: 407.921.6131

[alan.fyall@ucf.edu](mailto:alan.fyall@ucf.edu)

**Co-Editor: Journal of Destination Marketing & Management** - Impact Factor: 3.667 I 5-Year  
Impact Factor: 3.993.

<https://www.sciencedirect.com/journal/journal-of-destination-marketing-and-management>

## Annexure 13

### Paper 5: JCET 2018 and Hosany 2013

**Paper A:** Sameer Hosany and Girish Prayag (2013), Patterns of tourists' emotional responses, satisfaction, and intention to recommend, Journal of Business Research, 66, pp 730-737

**Paper B:** Pramod Sharma & Jogendra Kumar Nayak (2018): An analysis on the emotional approach to segmentation: A study of yoga tourism, Journal of Convention & Event Tourism, DOI: 10.1080/15470148.2018.1509038

Both paper A and paper B have followed similar concept, i.e. using emotional response to segment the tourists. But careful reading of these two papers help in making following observations:

#### Introduction Section:

In the introduction section, paper A discussed about tourist typology formulation while paper B discussed about Yoga tourism in first two paras and then discussed segmentation of tourists. Paper B also discussed objective of paper in introduction section.

#### Literature review section:

Paper A starts LR section with tourist typologies and then gave review of literature on tourists' emotional responses.

Paper B starts LR from the conceptualization of yoga tourism. The second section of LR section is typological studies in tourism research. The third section is related to the concept of emotions in tourist studies.

Paper B uses two sections, second and third, similar to paper A.

#### Methodology Section:

Paper A collected data from a town located in the South East of England while paper B collected data from Rishikesh.

Both papers used same scale developed by Hosany and Gilbert (2010) for measuring destination emotion.

Both papers have followed similar methodology for data analysis.

#### Analysis and Findings:

Following table shows outcome of two papers:

	Paper A		Paper B	
	Composite reliability	AVE	Composite reliability	AVE
Joy	.89	.62	.93	.62
Love	.87	.56	.92	.57
Positive Surprise	.88	.59	.91	.55



The above table clearly shows that paper B has almost similar values of various variables as obtained by Paper A.

Paper A has created five clusters, namely unemotional, delighted, negatives, mixed and passionate.

Paper B has created three clusters, namely ecstatic, passionate and unemotional.

So, paper B has picked only three clusters from paper A.

Both papers have similar number of tables to present analysis and title of these tables are also similar. Table 4 in both the papers is given for cluster profiling. Both papers used socio-demographic characteristics for cluster profiling. Interestingly, paper A and B used age, visitation status and travel companion in this table. Moreover both papers have age brackets of 16-34, 35-54 and 55 and above. Visitation status is also having similar classification, namely first timer and repeaters. In travel companion, both papers have used alone, with partner, with family and with friends as basis of classification.

#### **Discuss and Implications Section:**

Paper B followed almost similar flow of discussions and implications as used in paper (A). Since context of paper B is yoga tourism, so words related to yoga tourism and Rishikesh are used in paper B.

Finally, it can be concluded that paper (B) has a lot of overlap with paper (A). This overlap is mainly related to basic idea of research, methodology, scales uses, data analysis, presentation of analysis. However, some part of paper (B) is different from paper (A) due to different context.

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-----  
Hosany, S., & Gilbert, D. (2010). Measuring tourists' emotional experiences toward hedonic holiday destinations. *Journal of Travel Research*, 49, 513–526

## Annexure 14

**From:** "pramodsharmaias1990" <pramodsharmaias1990@gmail.com>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Sent:** Wednesday, December 2, 2020 10:19:22 AM  
**Subject:** Re: IAEC matter

\*Do you still maintain that your supervisor, Prof. J.K.Nayak had no knowledge of the JDMM and IJTR papers, where he is shown as a co-author, before retraction?

**Reply:** Yes sir, my supervisor Dr. J.K.Nayak sir was not aware about my papers published in JDMM and IJTR.

I had written my paper published in JDMM and IJTR devoting my full energy and hard work. I had checked the plagiarism of those papers through the plagiarism software available online. I have communicated those papers to respective journals. I got the revisions of those papers. I had addressed those comments. And finally the papers get published. Just before final submission of my paper, I had added my supervisors' name as the co-author of the paper with my own email id.

The papers were accepted. Then the papers were published online. After publishing the papers online, I informed my supervisor. This is the time when I was about to submit my thesis. My supervisor scolded me because he was not informed about the papers. I requested to pardon me. I have given his name as co-author because I was the student at IIT Roorkee when I first submitted those papers to the journals.

After submission of my thesis, I got mail from the journal that someone had complained about my papers.

I am repeating the same thing that my supervisor was not aware about my papers before submission or at the time of revision or at the time of acceptance.

You are asking the same question again and again. Do you really want me to falsely name my supervisor for the work he has not done? Kindly don't force me to do it. If I do anything of this kind for a person who has been a rightful teacher and highly ethical, I would burden my conscience which I cannot do.

Thanks and regards  
Pramod Sharma

On Tue, Dec 1, 2020 at 11:06 PM Chairperson IAEC <chairperson.iaec@iitr.ac.in> wrote:

Dear Pramod,

Please find attached your PhD thesis submitted in May 2019 and shared with me by the Academic Office.

Annexure III lists the papers published/accepted in International journals which includes the subsequently retracted papers - TMP(2018), JDMM(2019) and IJTR(2019).

Do you still maintain that your supervisor, Prof. J.K.Nayak had no knowledge of the JDMM and IJTR papers, where he is shown as a co-author, before retraction?

Sincerely,  
-daniel

---

B.S.S. Daniel  
Chairperson, Institute Academics Ethics Committee  
Professor, Metallurgical and Materials Engineering  
Indian Institute of Technology Roorkee  
Roorkee 247667, Uttarakhand, INDIA  
Ph: +91-1332-285751 (o); Mob: +91-9410164898  
Webpage: <https://mt.iitr.ac.in/~MTEs4danielmt>

## Annexure 15

Comparative analysis of PhD thesis submitted by Pramod Sharma on topic “Examining Tourists’ Emotions and its impact on tourists’ behaviour” with the retracted papers published by Mr Pramod Sharma.

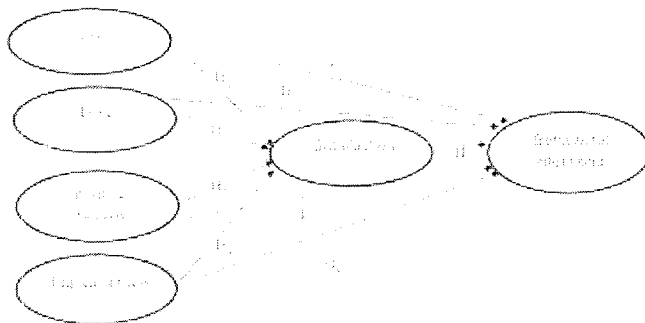
**Paper 1** Prayag G., Hosany S., Odeh, K. (2013), “ The role of tourists’ emotional experiences and satisfaction in understanding behavioural intentions”, *Journal of Destination Marketing & Management*, 2(2), 118-127

**Paper 2** Prayag, G., Hosany, S., Muskat, B. and Del Chiappa, G. (2017), “Understanding the Relationships between Tourists’ Emotional Experiences, Perceived Overall Image, Satisfaction, and Intention to Recommend”, which appeared in *Journal of Travel Research* 56(1), pp. 41-54 <https://doi.org/10.1177/0047287515620567>

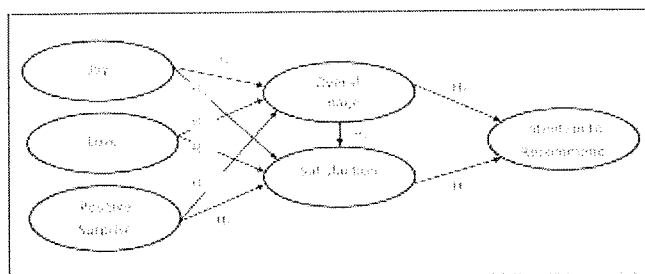
**Paper 3** Kim J H (2018), The Impact of Memorable Tourism Experiences on Loyalty Behaviors: The Mediating Effects of Destination Image and Satisfaction, *Journal of Travel Research*, 57 (7), 856-870, <https://doi.org/10.1177/0047287517721369>

### Similarity in conceptual Model:

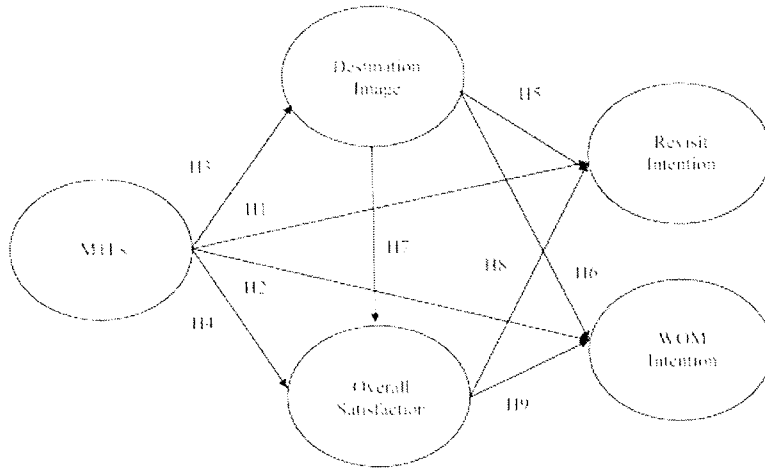
Paper 1 has following conceptual model:



Paper 2 has following conceptual model:



Paper 3 has following conceptual model:



Following conceptual model is shown in the thesis. This model is almost similar to model used by Paper 1 and paper 2.

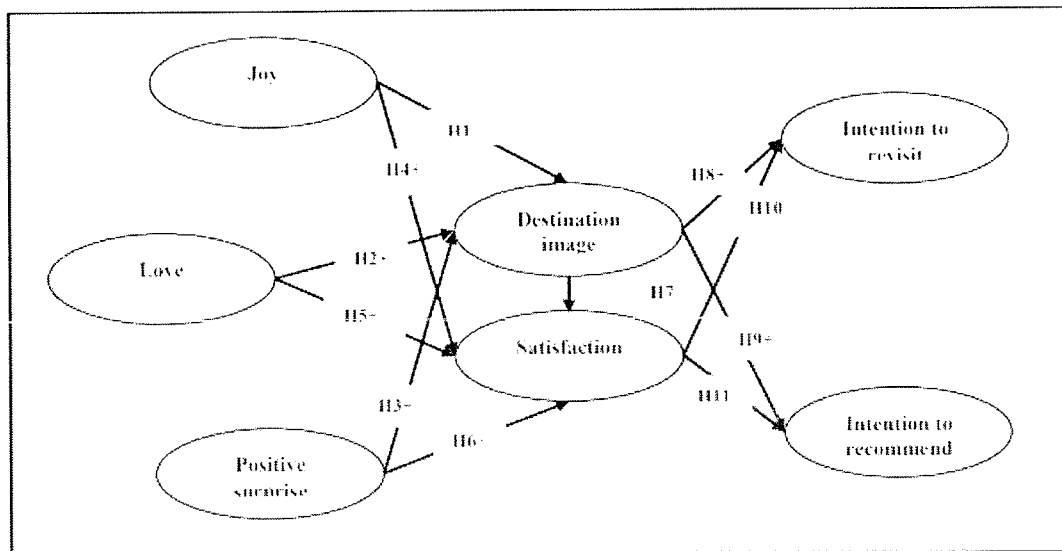


Figure 2.1. A conceptual model

- Paper 2 has used 3 independent variables which are as it is used in the thesis.
- Paper 3 has 2 mediating variables which are as it is used in the thesis .
- Thesis has 2 dependent variables which are taken by Paper 2 and Paper 3.

As these three papers were copied in developing two papers by Mr Pramod Sharma which were retracted by the journals, thesis is also based on the conceptual model of these two papers with minor changes in phrases but meaning same thing.

**Conclusion:** The model presented in thesis does not have any novelty and it is entirely based on the model of paper 1, 2 and 3.

### Similarity in Measurement Model:

Research Paper 1 and 2	Thesis	Remarks
<b>Joy</b> I feel Cheerful toward Sardinia I feel a sense of Delight toward Sardinia I feel a sense of Enthusiasm toward Sardinia I feel a sense of Joy toward Sardinia I feel a sense of Pleasure toward Sardinia	<b>Joy</b> "I felt a sense of enthusiasm during my visit to Rishikesh." "I felt a sense of delight during my visit to Rishikesh." "I felt a sense of cheerfulness during my visit to Rishikesh." "I felt a sense of pleasure during my visit to Rishikesh." "I felt a sense of joy during my visit to Rishikesh."	Both are exactly similar except place.
<b>Love</b> I feel a sense of Affection toward Sardinia I feel a sense of Caring toward Sardinia I feel a sense of Love toward Sardinia	<b>Love</b> "I felt a sense of care during my visit to Rishikesh." "I felt a sense of warm-heartedness during my visit to Rishikesh." "I felt a sense of tenderness during my visit to Rishikesh." "I felt a sense of affection during my visit to Rishikesh." "I felt a sense of love during my visit to Rishikesh."	Two additional items (warm heartedness and tenderness) are added in the thesis for this variable.
<b>Positive Surprise</b> I feel a sense of Amazement toward Sardinia I feel a sense of Astonishment toward Sardinia I feel Fascinated about Sardinia I feel a sense of Inspiration toward Sardinia I feel a sense of Surprise toward Sardinia	<b>Positive surprise</b> "I felt a sense of amazement during my visit to Rishikesh." "I felt a sense of astonishment during my visit to Rishikesh." "I felt a sense of surprise during my visit to Rishikesh." "I felt a sense of inspiration during my visit to Rishikesh." "I felt a sense of fascination during my visit to Rishikesh."	Both are exactly similar except place.
Research paper 3	<b>Destination image</b>	
<b>Destination Image (0.88)</b> The destination image of quality of service The destination image of entertainments The destination image of quality and variety of accommodation The destination image of local transportation The destination has an exotic image The image of architectures/buildings at the destination	"My perception of scenic beauty of Rishikesh as a wellness tourism destination..." "My impression of the natural environment of Rishikesh as a wellness tourism destination..." "My feeling of the cleanliness of Rishikesh as a wellness tourism destination..."	Some items were removed in thesis.
<b>Overall Satisfaction (0.89)</b> I am satisfied with this travel experience I feel enjoyable about this travel experience I feel pleasant about this travel experience	<b>Satisfaction</b> "I was satisfied with the travel experience of Rishikesh as a wellness tourism destination..." "The tourism experience in Rishikesh as a wellness tourism destination was exactly what I expected..." "My choice to visit Rishikesh as a wellness tourism destination was a wise one..."	Some items were changed in this variable.

Revisit Intention (0.91) I would like to revisit Taiwan in a year I plan to revisit Taiwan in a year I will make an effort to revisit Taiwan in a year	<b>Intention to revisit</b> "I will revisit Rishikesh as wellness tourism destination in future...." "I will plan to revisit Rishikesh as a wellness destination in future...." "I will make an effort to revisit Rishikesh as a wellness tourism destination in future...."	Both are exactly similar except place.
WOM Intention (0.87) I will recommend the places where I have visited to my friends/family I will convince my friends and/or family to visit Taiwan	<b>Intention to recommend</b> "I will recommend my family and friends to visit Rishikesh as wellness tourism destination...." "I will encourage other people to visit Rishikesh as wellness tourism destination...." "I will say positive things of Rishikesh as a wellness destination to other people...."	Both are exactly similar except place.

**Conclusion:** Thesis has used Items which were already used by earlier papers and items used to measure these variables were almost similarly used by the thesis. Therefore, it can be concluded that thesis is conceptually plagiarized from these papers and Mr Pramod Sharma has smartly rephrased sentences to bypass similarity-check requirements.

### **Research Hypothesis in Thesis:**

(H1): The emotion of joy has a favorable effect on destination image in wellness tourism". **It is H1 of paper 2.**

(H2): The emotion of love has a favorable effect on destination image in wellness tourism". **It is H2 of paper 2.**

(H3): The emotion of positive surprise has a favorable effect on destination image in wellness tourism". **It is H3 of paper 2.**

(H4): The emotion of joy has a favorable effect on satisfaction in wellness tourism". **It is H1 of paper1.**

(H5): The emotion of love has a favorable effect on satisfaction in wellness tourism". **It is H2 of paper1.**

(H6): The emotion of positive surprise has a favorable effect on satisfaction in wellness tourism". **It is H3 of paper 1.**

(H7): Tourists' perception of destination image has a favorable effect on satisfaction in wellness tourism". **It is H7 of paper 2.**

(H8): Tourists' perception of destination image has a favorable effect on intention to revisit a wellness tourism". **It is H5 of paper 3.**

(H9): Tourists' perception of destination image has a favorable effect on intention to recommend a wellness tourism". **It is H6 of paper 3.**

(H10): Tourists' perceived satisfaction has a favorable effect on intention to revisit a wellness tourism". **It is H8 of paper 3.**

(H11): Tourists' perceived satisfaction has a favorable effect on intention to recommend a wellness tourism". It is H9 of paper 3.

Hypothesis presented in above three papers

### **Paper 1**

- H1 : Joy has a positive relationship with satisfaction.
- H2: Love has a positive relationship with satisfaction.
- H3: Positive surprise has a positive relationship with satisfaction.
- H4: Unpleasantness has a negative relationship with satisfaction
- H5Joy has a positive relationship with behavioural intentions.
- H6: Love has a positive relationship with behavioural intentions.
- H7: Positive surprise has a positive relationship with behavioral intentions.
- H8: Unpleasantness has a negative relationship with behavioral intentions.
- H9: Satisfaction has a positive relationship with behavioral intentions.
- H10: Satisfaction mediates the relationship between emotions and behavioral intentions.

### **Paper 2**

- H1*: The emotion of Joy has a positive influence on perceived overall image.
- H2*: The emotion of Love has a positive influence on perceived overall image.
- H3*: The emotion of Positive Surprise has a positive influence on perceived overall image.
- H4*: The emotion of Joy has a positive influence on tourist satisfaction with a destination.
- H5*: The emotion of Love has a positive influence on tourist satisfaction with a destination.
- H6*: The emotion of Positive surprise has a positive influence on tourist satisfaction with a destination.
- H7*: A more favorable overall image will result in higher level of tourist satisfaction with a destination.
- H8*: A more favorable overall image will result in higher propensity to recommend the destination.
- H9*: A higher level of tourist satisfaction with a destination will result in higher propensity to recommend the destination

### **Paper 3**

- H1*: There is a direct, positive relationship between MTEs and revisit intention.
- H2* : There is a direct, positive relationship between MTEs and WOM intention.
- H3*: There is a positive relationship between MTEs and DI.
- H4*: There is a positive relationship between MTEs and overall satisfaction.
- H5*: There is a positive relationship between DI and revisit intention.
- H6*: There is a positive relationship between DI and WOM intention.
- H 7*: There is a positive relationship between DI and overall satisfaction.
- H8*: There is a positive relationship between overall satisfaction and revisit intention.
- H9*: There is a positive relationship between overall satisfaction and WOM intention.

**Observation:** All the hypothesis of thesis are from above three papers. Only "wellness tourism" word is added in hypotheses used for research.



## Further

**Paper** Testing the role of tourists' emotional experiences in predicting destination image, satisfaction, and behavioral intentions: A case of wellness tourism By Pramod Sharma and J K Nayak published in *Tourism Management Perspectives* (2018), 28, pp 41-52 is using the same final model as used in the thesis.

In this paper sample size is mentioned as 345, while thesis presents data of 388. Though it is possible to get few more data during the time paper was submitted and thesis is submitted, but there are various discrepancies in data. One such is as follows:

Paper Data	Thesis Data	
N= 345	N = 388	
Single 121 Married 224 Others Nil	Single 144 Married 175 Others 69	This comparison shows some issue with data .
10 <sup>th</sup> Class 67 12 <sup>th</sup> class 122 Graduation 82 PG & above 74	10 <sup>th</sup> Class 29 12 <sup>th</sup> class 92 Graduation 208 PG & above 59	This comparison again shows some issue with data

The analysis of data also has many discrepancies, as the values for same variables in above published paper and thesis are different. To give example, value of Cronbach alpha is compared in following table:

	Paper Value	Thesis Value
Joy	0.91	0.871
Love	0.78	0.897
Positive Surprise	0.77	0.912
Overall destination image	0.89	0.861
Satisfaction	0.77	0.857
Intention to revisit	0.81	0.813
Intention to recommend	0.79	0.871

This table shows that value of Cronbach alpha of all the variables are different in published papers and thesis, however for three variables, there is significant difference in values of three variables.

**Conclusion:** There is discrepancy in data presented in the paper published by Pramod Sharma and his Thesis. Without an explanation proffered in the Thesis or the paper, the data and the results obtained are questionable.

**Item No. 86.10: To consider the report on the plagiarism complaint against Mr. Vivek Kumar Mishra, M.Tech. (PP) and Mr. Elyas Khairandish, M.Tech. (WR).**

Following complaints of Academic Ethics violation were received against the two M.Tech students:

Case 1: A complaint against Mr. Vivek Kumar Mishra (Enr. No. 18546009) M.Tech. (PP) was received from Head, Department of Paper Technology on 30<sup>th</sup> June 2020 following the final presentation before the M.Tech. thesis examination board.

The IAEC in its finding reported as:

1. The thesis submitted by Mr. Vivek Mishra is copied from Mr. Kunal's MSc dissertation submitted to FRI, Dehradun under the guidance of Dr. (Mrs) Rita Tandon, CPPRI, Saharanpur.
2. Presenting the experimental data and inference contained in another's dissertation as one's own is a serious academic violation which warrants strict action.
3. Mr. Vivek Mishra must submit an apology to Dr. (Mrs) Rita Tandon, for including her name as supervisor without her consent.

He subsequently withdrawn his dissertation and asked the additional time to carry out his experiments. The full report pertaining to Mr. Vivek Kumar Mishra is given at **Appendix-A**.

Case2: A complaint of plagiarism against Mr. Elyas Khairandish was received from Mr. Taha Awar (Enrol. No. 17548013), who passed out in 2019 with an M.Tech. from WRDM, IIT Roorkee after checking the paper on his google Scholar alert. He alleged that more than 70% of the paper published by Elyas Khairandish, Prof. S.K. Mishra (WRDM) and Dr. A.K. Lohani Scientist G, NIH in the Modeling Earth Systems and Environment journal is reproduced from his M.Tech. thesis "Hydrological Modelling in Kabul river basin: a case study of Afghanistan" submitted in June 2019 under the guidance of Prof. Deepak Khare (WRDM). The paper in question is:

“Khairandish, E., Mishra, S.K. & Lohani, A.K. Modeling on Long- term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques”.

The Director constituted the following committee on 20.07.2020 to establish the facts of the case and submit its report within two weeks.

Prof. B.S.S. Daniel	Chairperson, IAEC
Prof. C.S.P. Ojha	Expert Member
Prof. D. Nagesh Kumar (IISc)	Expert member

The Committee has submitted its report **(Appendix-B)**.

The IAPC in its 91<sup>st</sup> meeting held on 01.10.2020 deliberated upon the inputs received from IAEC and it recommended that the students to be asked to repeat the dissertation and accordingly complete the programme.

The case was discussed in the 84<sup>th</sup> meeting of the Senate dated Nov 24, 2020 and it withheld the M. Tech. degree of the student (84.1).

The above is submitted for the consideration of the Senate.

**Report on the Ethics violation complaint**  
**against Mr. Vivek K. Mishra (Enrol. No. 18546009), DPT**

A complaint of Academic Ethics violation against MTech student, Mr. Vivek K. Mishra (Enrol. No. 18546009) was forwarded by the Head, Department of Paper Technology on June 30, 2020 following the final presentation before the MTech thesis examination board. The communication from the Head, DPT is enclosed as **Annexure 1**.

After interacting with Dr. (Mrs.) Rita Tandon, Scientist-G & Head, PCPB and SPPM Division, Central Pulp & Paper Research Institute (CPPRI), Saharanpur over telephone and email the following facts emerged. The email exchange is enclosed as **Annexure 2**.

1. Mr. Vivek Mishra met Dr. (Mrs.) Rita Tandon in Nov 2019 with the letter dated 21.11.2019 forwarded by the Dean, Saharanpur campus, requesting her to co-supervise his MTech thesis. The letter is enclosed as **Annexure 3**.
2. Dr. Rita Tandon in turn introduced Mr. Vivek Mishra to Mr. Satya Negi of CPPRI to coordinate his work at CPPRI. Mr. Satya Negi gave Mr. Vivek Mishra a copy of Kunal's MSc dissertation submitted to FRI (Dehradun)
3. Between Nov '19 and Feb '20 Mr. Vivek Mishra spent much of the time in Mumbai and Pune preparing and attending job interviews. He returned to Saharanpur after getting placed in DRDO Pune on the basis of his BTech degree.
4. When Mr. Mishra presented himself in CPPRI in March 2020 he was admonished for his long absence and for not doing the experimental work. Subsequently, COVID-19 struck and Mr. Mishra did not have a chance to carry out the experimental work.
5. Mr. Vivek Mishra shared a soft copy of his MTech thesis with Dr. Rita Tandon before submitting it to the examination board.
6. Dr. Rita Tandon observed that the experimental work and results in Mr. Vivek Kumar Mishra's M.Tech Thesis was reproduced from the dissertation work of Mr. Kunal (M.Sc. Cellulose and Paper Technology, FRI Deemed University, 2017-2019 Batch) guided by her and reported the same to the Head, Department of Paper Technology.
7. On presenting this evidence Mr. Vivek Mishra admitted that the experimental data included in pages 42-47 of his MTech dissertation are reproduced from pages 26-53 of Mr. Kunal's work titled "Evaluation of Soapstone and GCC as a filler and their impact on Strength and Optical Properties".
8. Mr. Vivek Mishra has subsequently submitted a letter dated 03.07.2020 to the Head, Paper Technology requesting to withdraw his dissertation and asking for additional time to carry out his experiments.

From the above facts the complaint received from Dr. (Mrs) Rita Tandon is borne out to be true and therefore the dissertation submitted by Mr. Vivek Mishra cannot be accepted by IIT Roorkee.

The examination board is commended for identifying and establishing that the Thesis is plagiarized during the viva voce.

#### **Concluding remarks**

1. The thesis submitted by Mr. Vivek Mishra is copied from Mr. Kunal's MSc dissertation submitted to FRI, Dehradun under the guidance of Dr. (Mrs) Rita Tandon, CPPRI, Saharanpur.
2. Presenting the experimental data and inference contained in another's dissertation as one's own is a serious academic violation which warrants strict action.
3. Mr. Vivek Mishra must submit an apology to Dr. (Mrs) Rita Tandon, for including her name as supervisor without her consent.

\*\*\*

## Appendix 1

**From:** "Head Paper" <head.papertech@iitr.ac.in>  
**To:** "Dean AcademicAffairs" <daa@iitr.ac.in>  
**Cc:** "Director IIT Roorkee" <director@iitr.ac.in>  
**Sent:** Tuesday, June 30, 2020 1:48:30 PM  
**Subject:** Breach of Academic Integrity | Vivek K Mishra, M.Tech PT

Dear sir,

It has been brought to my notice that M. Tech student Vivek Kumar Mishra (Enr. Number 18546009) has breached the academic code of conduct at multiple levels during his final M. Tech. presentation dated 25/06/2020.

The different account of breach observed by us:

1. **Misreporting of the external guide:** The student has reported that he has worked with Dr. Rita Tandon, (CPPRI, Scientist G, and Head) during the duration of his M. Tech thesis. Upon my confirmation from Dr. Rita, she has vehemently stated in writing that she has **not guided** the student in consideration, Mr. Vivek at any point in time and has requested serious action against the student for tarnishing the image of CPPRI and herself.

2. **Plagiarism:** We have observed large scale plagiarism in the thesis submitted by the student. The student has directly plagiarized the results from the thesis which has already submitted under the guidance of Dr. Rita and has copied the same results in his thesis.

Dr. Rita has raised her serious reservations against the misuse of her name and the research work.

3. **False reporting of facts:** The student in consideration has repeatedly lied to the expert committee and the institute panel that he has worked with Dr. Rita and has also misreported the duration of his work and also about the work done during his M.Tech thesis. His performance in the final presentation on the questions asked by the expert was also dismal further indicating that it was not his own work.

As coordinator and HOD, I firmly believe that this student has breached the required academic integrity of IIT Roorkee at multiple levels and has also tarnished the academic relationship with our partner organization, CPPRI.

I have attached my email correspondence with Dr. Rita for your kind reference.

Your suggestions in this regard would be highly valuable to help me take the next steps.

Best regards

Chhaya Sharma

---

----- Forwarded message -----

**From:** Rita tandon <ritacppri@gmail.com>  
**Date:** Wed, Jun 24, 2020 at 5:40 PM  
**Subject:** Re: Your comments and suggestions on dissertation  
**To:** Dr. Chhaya Sharma <chhaya.iitr@gmail.com>

You are welcome.

On Wed, 24 Jun, 2020, 2:04 PM Dr. Chhaya Sharma, <[chhaya.iitr@gmail.com](mailto:chhaya.iitr@gmail.com)> wrote:

Dear Dr. Rita

Thanks for your response.

Chhaya

On Wed, Jun 24, 2020 at 12:08 PM Rita tandon <[ritacppri@gmail.com](mailto:ritacppri@gmail.com)> wrote:

Dear Dr. Chhaya,

Refer to above mail, please find herewith my comments -

1. *Any letter or email communication by the Institute to take you as a supervisor and your consent for the same.*

No.

2. *During the communication, the student has conveyed that he has carried out most of work at CPPRI*

He has not carried out any work at CPPRI. He just came twice.

- First to get permission for working in the CPPRI laboratory on a request letter from Dr. Negi. I acknowledged the receipt on the letter itself and advised him to get the permission from Director CPPRI, which he never did.
- Second time in January 2020 he came with a few chemicals & pulp and handed it over to my staff, thereafter he never came to start his work in our lab.

3. *I am enclosing the dissertation copy for your comments, and suggestions please.*

Having gone through his dissertation work, it was found that the results of three tables on soapstone which he has inserted in his dissertation work are copied from the project work of one of our old M.Sc. student. Rest of the content of the total dissertation has been manipulated from somewhere else. Apparently no experiments have been conducted in CPPRI. You can have his details of his entry in CPPRI from the in and out register of CPPRI.

It is indeed extremely regretful that he has misused the name of CPPRI and myself & my colleague's name, as well as tarnishing the institute's image and my image specifically, which is highly objectionable.

Thanks & Regards

Rita

On Tue, Jun 23, 2020 at 11:15 PM Dr. Chhaya Sharma <[chhaya.iitr@gmail.com](mailto:chhaya.iitr@gmail.com)> wrote:

Dear Dr. Rita

One of our M.Tech. students Mr. Vivek Kumar Mishra mentioned your name as one of the supervisors for his M.Tech. dissertation work. In this regards can you please provide the following information at the earliest as his presentation is due tomorrow at 4.30 PM onward:

1. Any letter or email communication by the Institute to take you as a supervisor and your consent for the same.
2. During the communication, the student has conveyed that he has carried out most of work at CPPRI
3. I am enclosing the dissertation copy for your comments, and suggestions please.

Early response will help us to evaluate the student.

regards

Chhaya Sharma

Co-ordinator of Dissertation and HOD (Paper Technology)

*Prof. Chhaya Sharma*

Head, Department of Paper Technology ([Department Web Page](#))  
Indian Institute of Technology Roorkee, Saharanpur Campus

Official Email: [chhaya.sharma@pt.iitr.ac.in](mailto:chhaya.sharma@pt.iitr.ac.in) ([Personal Web Page](#))

Contact No. : +(91)9412233111, 0132-2714346 (O)



## Appendix 2

**From:** "ritacppri" <ritacppri@gmail.com>

**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>

**Sent:** Thursday, July 2, 2020 5:46:51 PM

**Subject:** Re: Reg. MTech Thesis of Mr. Vivek Kumar Mishra (Enr. No: 18546009)

Dear Mr. Daniel,

Refer to your mail regarding M.Tech. thesis of Mr. Vivek Kumar Mishra (Enr. No: 18546009). Please find herewith my comments on the issues raised by you.

**1. Have you given your consent to be the co-supervisor of Mr. Vivek Mishra's M.Tech. dissertation? Have you read and approved the report before submission?**

No, I have not given any consent to be the co-supervisor of Mr. Vivek Mishra's M.Tech. dissertation. I have not read and approved the report before submission.

**2. Was any experiment reported in the dissertation conducted in your laboratory/Institute with/without your knowledge?**

The experiment reported in the dissertation work of Mr. Vivek Kumar Mishra is not conducted by him in my laboratory/Institute.

**3. Is it true that portions of the report were reproduced from a thesis submitted earlier under your guidance without giving proper citation? If so, please identify these portions in the MTech dissertation mapping them to the elements in the source document. Kindly submit a copy of the source document.**

The experimental work and results in Mr. Vivek Kumar Mishra's M.Tech Thesis was reproduced from the dissertation work of one of my students Mr. Kunal (M.Sc. Cellulose and Paper Technology, FRI Deemed University, 2017-2019 Batch).

The copy of dissertation report of Mr. Kunal on "Evaluation of Soapstone and GCC as a filler and their impact on Strength and Optical Properties" is attached herewith for your reference. Please take note of page no. 26 to 53 of the report.

This is for your reference and further necessary action please.

Thanks & Regards

Rita

On Wed, Jul 1, 2020 at 8:35 PM Chairperson IAEC <[chairperson.iaec@iitr.ac.in](mailto:chairperson.iaec@iitr.ac.in)> wrote:

Dr. (Mrs.) Rita Tandon, Scientist-G & Head,  
PCPB and SPPM Division  
Central Pulp & Paper Research Institute

Dear Dr. (Mrs.) Tandon,

This is with reference to the MTech Thesis of Mr. Vivek Kumar Mishra (Enr. No: 18546009). I am inquiring into the matter for alleged Academics Ethics violation and would appreciate your cooperation. There are a few issues regarding this case where I need your assistance. I have articulated these issues in a question-form below and would appreciate your response

with documentary proof wherever possible. A copy of the dissertation is attached for your reference.

1. Have you given your consent to be the co-supervisor of Mr. Vivek Mishra's MTech dissertation? Have you read and approved the report before submission?
2. Was any experiment reported in the dissertation conducted in your laboratory/ Institute with/without your knowledge?
3. Is it true that portions of the report were reproduced from a thesis submitted earlier under your guidance without giving proper citation? If so, please identify these portions in the MTech dissertation mapping them to the elements in the source document. Kindly submit a copy of the source document.
4. Is there any other observation/remarks you would like to make regarding this matter?

Thank you for your cooperation in this matter.

Sincerely,  
-daniel

+++

B.S.S. Daniel / B.S.S. डैनियल

Chairperson, Institute Academics Ethics Committee / अध्यक्ष, संस्थान शैक्षणिक आचार समिति

Indian Institute of Technology Roorkee / भारतीय प्रौद्योगिकी संस्थान रुड़की

Roorkee 247667, Uttarakhand, INDIA / रुड़की - 247667, उत्तराखंड, भारत

Ph: +91-1332-285751 (o); Mob: +91-9410164898

21/11/19

M. T. Khan  
IIT Roorkee  
Saharanpur Campus

Obj: Regarding permission for doing project work  
in CPRI, Saharanpur

necessary  
d

expected side.

Dr. Vivek Kumar Mishra, Student of M.Tech-II  
(Pulp and Paper) doing project in study of  
different fillers used in paper making. For  
my project related work, I want to work  
in CPRI under "Dr. Rita Tandon" Mam.

Kindly grant me permission to work in CPRI

Thanking You

Yours Sincerely

Vivek Kumar  
VIVEK KUMAR MISHRA

ENROLLMENT NO-18546009

M.Tech-II (Pulp and Paper)

Allowed

Dr. M. T. Khan  
21/11/19  
Saharanpur/24/11/19

91. सादर, शुभकामनाओं सहित
92. आप तदनुसार आवश्यक कार्यवाही करें
93. भवदीय/भवदीया/भवदीय

## Report of the Fact-finding Committee

**On the plagiarism complaint against Mr. Elyas Khairandish (Enrol No: 18548006), WRDM**

### **1. Introduction:**

Mr. Taha Aawar (Enrol No.: 17548013), who passed out in 2019 with an MTech degree from WRDM, IIT Roorkee submitted a plagiarism complaint on 08.07.2020 (**Annexure 1**) after checking the paper on his Google Scholar alert (**Annexure 2**).

In his complaint, he has alleged that more than 70% of the paper published by Elyas Khairandish (Enrol No: 18548006), Prof. S.K. Mishra (WRDM) and Dr. A.K. Lohani (Scientist G, NIH) in the *Modeling Earth Systems and Environment* journal is reproduced from his MTech thesis "*Hydrological Modelling in Kabul river basin: a case study of Afghanistan*" submitted in June 2019 under the guidance of Prof. Deepak Khare (WRDM). The paper in question is:

Khairandish, E., Mishra, S.K. & Lohani, A.K. Modeling on Long-term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques. *Model. Earth Syst. Environ.* (2020). <https://doi.org/10.1007/s40808-020-00823-9>

Received: 30 January 2020; Accepted: 21 May 2020; Published: 06 June 2020

The Director constituted the following committee on 20.07.2020 to establish the facts of the case and submit its report within two weeks (**Annexure 3**).

### **Committee Members:**

- |                                 |                   |
|---------------------------------|-------------------|
| 1. Prof. B.S.S. Daniel          | Chairperson, IAEC |
| 2. Prof. C.S.P. Ojha            | Expert Member     |
| 3. Prof. D. Nagesh Kumar (IISc) | Expert member     |

The committee met on two occasions over webex and carried the discussion further over email.

Mr. Taha Aawar (Enrol No.: 17548013) is the MTech student of Professor Deepak Khare (WRDM). He submitted a MTech thesis titled "*Hydrological Modelling in Kabul river basin: A case study of Afghanistan*" in June 2019. Mr. Elyas Khairandish (Enrol No: 18548006) is the MTech student of Prof. S.K. Mishra (WRDM) and Dr. A.K. Lohani (NIH), and one year junior to Mr. Taha Aawar. On January 30, 2020 Elyas Khairandish, S.K. Mishra and A.K. Lohani submitted a paper titled "*Modeling on Long-term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques*" to the Journal of Modelling Earth Systems and Environment (MESE) with Elyas Khairandish as corresponding author. Elyas Khairandish also submitted his MTech thesis titled "*Impact assessment of climate change on water availability in Kabul river basin, Afghanistan*" with Professor S.K. Mishra and Dr. A.K. Lohani as joint supervisors.

In his email complaint to the Director, Mr. Taha Aawar has alleged that the paper published by another MTech student matches more than 70% with his MTech thesis. He also included a copy of the paper with the matching text highlighted and a link to the paper published online.

## 2. Comparison of the documents

A comparison of Mr. Taha Aawar's MTech thesis with the Journal of MESE and MTech thesis of Mr. Elyas Khairandish revealed the following:

- There is considerable overlap in text which is evidenced by the Turnitin reports.
- Even the work reported is quite similar in the following aspects
  - The same software is used for the land use land cover (LULC) classification
  - Many remote sensing imageries used are the same
  - Same case study of Kabul river basin in Afghanistan
  - Analysis of the results is quite similar
  - Results reported in increased built-up area are very much similar
  - Same hydrologic model (SWAT) and calibration approach (SWAT-CUP) are used
  - Rainfall and other data used are almost similar
  - SWAT results are quite similar
  - Conclusions drawn from the study are quite similar.
- Some of the differences between the two works are
  - In TA thesis, images used are for years 1972, 1979, 1990, 2000, 2008 and 2018. In EK thesis, images used are for years 1972, 1979, 1989, 1999, 2009 and 2019. Thus, the last four images used are different.
  - Recent satellite images of 2019 are also used for LULC classification
  - The period of model calibration and validation used are different. Although direct comparison is difficult as the symbols used by Taha Aawar are clear, the same is not the case with Elyas Khairandish.
  - After calibrating the SWAT (ArcSWAT) model, it was used to assess the water resources of the Kabul river basin for six different climate change scenarios and the corresponding flow duration curves are developed. Thus Chapter 5 in the thesis by Mr Elyas Khairandish is different from that of Mr. Taha Aawar.
- There is a *prima facie* case of plagiarism in the MTech thesis as well as in the resulting publication by Mr. Elyas Khairandish.

## 3 Findings of the enquiry

The reply given by Mr. Elyas Khairandish on 26.07.2020 via email included as **Annexure 4**. Mr. Khairandish states that he got the MTech dissertation from Mr. Aawar himself. Mr. Khairandish explains the similarity match in the text as “... *Mr. Taha gave me his dissertation for my guidance, he was my senior and he suggested me the topic of my dissertation. He also gave me some of the data of the same basin for my dissertation work (through e-mail I have it with me as proof I can show it at any time), which means he understood all about my*

*dissertation work from start to end. He never informed me that he is publishing papers from his dissertation.*

*Our study area was the same because of data availability, there might be some texts from his dissertation which I cannot reject. I was not aware that I cannot take text or data from any dissertation, I was thinking that it was helpful material which I can use, but with a simple paraphrasing, it could not be a problem if I understood....”*

The following inference can be drawn from the above submissions:

1. Elyas Khairandish has admitted to copying data and text from Taha Aawar’s dissertation.
2. Elyas Khairandish, who did not have any understanding of plagiarism was allowed to be the corresponding author of the journal paper.

It was decided to call for all communications with the journal by Mr. Elyas Khairandish as the corresponding author. From the communications the following sequence of events was established:

June 2019	Taha Aawar defended his MTech thesis
30 Jan, 2020	Paper (MESE-D-20-00042) submitted to Journal of MESE by Elyas Khairandish
02 Mar 2020	Reviewer comments shared with the corresponding author
24 Apr 2020	MESE-D-20-00042R1 – Revised submission Confirmation
11 May 2020	Acceptance communication from Exec. Editor, MESE-D-20-00042R1
21 May 2020	Acceptance and DOI assignment DOI: 10.1007/s40808-020-00823-9
06 Jun, 2020	Online Publication of the article in Journal of MESE
09 Jun 2020	Taha Aawar received a Google Scholar alert on Khairandish et al., MESE publication
09 Jun 2020	Taha Aawar email to authors, copy to supervisor and editors claiming plagiarism of his thesis
16 Jun 2020	Ron Doering (Publishing Editor) email to authors highlighting matching text and seeking explanation
25 Jun 2020	MTech project presentation and evaluation of Elyas Khairandish
08 July 2020	Taha Aawar’s plagiarism complaint to the Director, IIT Roorkee
09 July 2020	Provisional degree certificate issued to Elyas Khairandish
13 July 2020	Editor decides to retract paper

A copy of the Editorial retraction is included as **Annexure 5**. It may be noted that Prof. S.K. Mishra and Dr. A.K. Lohani have agreed to the Editor’s decision while Elyas Khairandish has not. The publication of the Editor’s retraction is certainly detrimental to the reputation of the Department and the Institute and could have been avoided if the authors had acted on Taha Anwar complaint of 09.06.2020.

#### 4. Concluding remarks

1. Elyas Khairandish, Prof. S.K. Mishra and Dr. A.K. Lohani published a paper titled “*Modeling on Long-term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques*” in the Journal of Modelling Earth Systems and Environment (MESE) with Elyas Khairandish as the corresponding author, who does not understand plagiarism.
2. Elyas Khairandish has admitted that the paper is copied from the MTech thesis of Taha Aawar titled “*Hydrological Modeling in Kabul river basin: A case study of Afghanistan*” submitted in June 2019.
3. The Editor retracted the paper and published a retraction notice in the journal of MESE. Prof. S.K. Mishra and Dr. A.K. Lohani have agreed to the Editor’s retraction while Elyas Khairandish has not.
4. The MTech thesis of Elyas Khairandish titled “*Impact assessment of climate change on water availability in Kabul river basin, Afghanistan*” has data and text plagiarized from Taha Aawar’s thesis, which is a serious academic ethics violation warranting punitive action.

\*\*\*

## Appendix 1

**From:** "Taha Aawar" <maawar@wr.iitr.ac.in>  
**To:** "Director IIT Roorkee" <director@iitr.ac.in>  
**Cc:** "Deputy Director IITR" <ddirector@iitr.ac.in>, "Deepak Khare" <kharefwt@gmail.com>  
**Sent:** Wednesday, July 8, 2020 8:43:31 PM

Dear Prof. A. k. Chaturvedi

With warm greetings!

This is Taha Aawar from Afghanistan, I did master's degree at IIT Roorkee, WRDM department in 2019.

Recently one of the IIT Roorkee M. Tech fellow published an article in modeling earth systems and environment journal, which has copied from my thesis. ( plagiarized more than 70%).

For your kind information, I am attaching the highlighted lines of the article and my thesis. As IIT Roorkee is important to me, therefore I mailed you to be informed about the plagiarized published article.

I have claimed the issue with editorial board of the journal and the appeal letter is under processes. For further information please do not hesitate to contact me.

Thanking you sir for your kind consideration.

Best regards

Taha Aawar

Note:

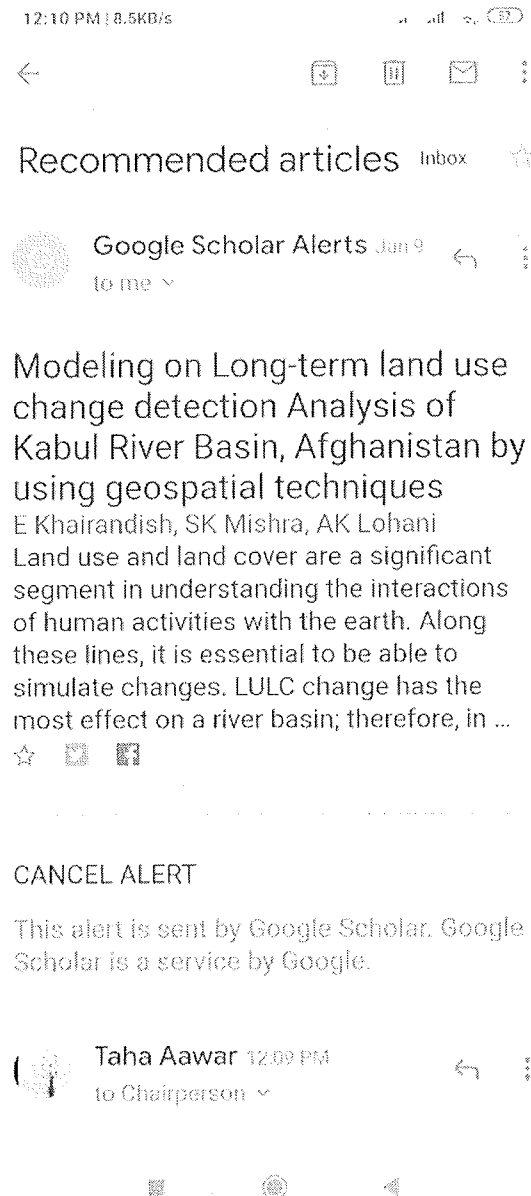
1. The link of article is as follow:

<https://doi.org/10.1007/s40808-020-00823-9>.

2. My article with same content is under review in the Indian society and remote sensing journal since October 2019, while the plagiarized published paper submitted in Feb 2020 in modeling earth system and environment by IIT Roorkee student and two coauthors from IIT Roorkee and NIH.



## Appendix 2



### Appendix 3

**From:** "Director IITRoorkee" <director@iitr.ac.in>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Sent:** Monday, July 20, 2020 3:56:36 PM  
**Subject:** Re: IAEC: Constitution of fact-finding committee

Committee is approved. The committee is requested to submit its report in 2 weeks.

Ajit

----

अजित कुमार चतुर्वेदी/Ajit Kumar Chaturvedi  
निदेशक/Director  
भारतीय प्रौद्योगिकी संस्थान रुड़की  
Indian Institute of Technology Roorkee  
रुड़की - 247667, उत्तराखंड, भारत  
Roorkee - 247667, Uttarakhand, INDIA  
Tel (O) : +91 1332 272742 / 285500  
Tel (O) : +91 9837070794  
Email: director@iitr.ac.in, dir\_office@iitr.ac.in  
[https://www.iitr.ac.in/~ECE/Ajit\\_K\\_Chaturvedi](https://www.iitr.ac.in/~ECE/Ajit_K_Chaturvedi)  
<https://www.iitr.ac.in>

**From:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**To:** "Director IIT Roorkee" <director@iitr.ac.in>  
**Sent:** Monday, July 20, 2020 3:27:17 PM  
**Subject:** IAEC: Constitution of fact-finding committee

**Professor A.K. Chaturvedi**

The Director  
IIT Roorkee

Ref. No.: IAEC/2020/EK/02

Dear Sir,

The Institute has received a plagiarism complaint on 08.07.2020 from Mr. Taha Aawar (Enrol No.: 17548013) who passed out in 2019 with an MTech degree from WRDM, IIT Roorkee.

In his complaint, he has alleged that more than 70% of the paper published by Elyas Khairandish (Enrol No: 18548006), Prof. S.K. Mishra (WRDM) and Dr. A.K. Lohan (Scientist G, NIH) in the *Modeling Earth Systems and Environment* journal is reproduced from his MTech thesis "Hydrological Modelling in Kabul river basin: a case study of Afghanistan" submitted in May 2019 under the guidance of Prof. D. Khare (WRDM).

Considering the gravity of the complaint involving both research groups of the same Department, it is proposed that the subject expert from the concerned Department be avoided. Instead, an expert from another Institute may be included in accordance with the approved policy (IITR/ES(Wing 'A')/4499/E-4759 dated 20.12.2019).

In this regard, the following committee is proposed to establish the facts of the case.

- |                                 |               |
|---------------------------------|---------------|
| 1. Prof. B.S.S. Daniel -        | Chairman      |
| 2. Prof. C.S.P. Ojha -          | Expert Member |
| 3. Prof. D. Nagesh Kumar (IISc) | Expert Member |

This is presented to you for your kind approval, please.

Sincerely,  
-daniel

+++

B.S.S. Daniel / B.S.S. डैनियल

Chairperson, Institute Academics Ethics Committee / अध्यक्ष, संस्थान शैक्षणिक आचार समिति

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Ph: +91-1332-285751 (o); Mob: +91-9410164898

## Annexure 4

**From:** "elyaskhairandish" <elyaskhairandish@gmail.com>  
**To:** "Chairperson IAEC" <chairperson.iaec@iitr.ac.in>  
**Cc:** "Surendra KumarMishra" <s.mishra@wr.iitr.ac.in>, "aklnih" <aklnih@gmail.com>, "lohani nihr" <lohani.nihr@gov.in>, "skm61fwt01" <skm61fwt01@gmail.com>  
**Sent:** Sunday, July 26, 2020 12:49:31 AM  
**Subject:** Re:

Dear Sir,

My dissertation topic is "Impact Assessment of Climate Change on Water Availability in Kabul River Basin, Afghanistan".

One of my objectives is to evaluate the impact of land use land cover changes on water availability in the Kabul river basin. In my study, the impact of land use land cover of (1972, 1979, 1989, 1999, 2009, 2019) years were prepared and SWAT model was utilized for its impact evaluation on water availability. Where Mr. Taha dissertation one objective was land use land cover preparation of different years (1972, 1979, 1990, 2000, 2008, and 2018) of the same catchment. Both of us objectives were totally different you can refer to dissertations, and one part of my objective publication doesn't mean plagiarism of his dissertation.

Mr. Taha gave me his dissertation for my guidance, he was my senior and he suggested me the topic of my dissertation. He also gave me some of the data of the same basin for my dissertation work (through email I have it with me as proof I can show it at any time), which means he understood all about my dissertation work from start to end. He never informed me that he is publishing papers from his dissertation.

Our study area was the same because of data availability, there might be some texts from his dissertation which I cannot reject. I was not aware that I cannot take text or data from any dissertation, I was thinking that it was helpful material which I can use, but with a simple paraphrasing, it could not be a problem if I understood. Similarly, some of the texts were taken from other papers which were used by both of us, it doesn't mean that I cannot cite the paper which is cited in his dissertation.

During my paperwork, Mr. Lakhwinder Singh (Deepak Khare sir, Ph. D Scholar IIT Roorkee) suggested and guided me constantly, who guided Mr. Taha also on the same topic. Thus the similarity might exist, because of Mr. L. Singh gave me some reference videos, papers, and other materials that I have followed, which might be followed by Mr. Taha during his dissertation. Thus, referring the same material doesn't mean I have copied from his dissertation. This is the link used in methodology for LULC preparation <https://www.udemy.com/course/land-use-land-cover-classification-gis-erdas-arcgis-envi/> given by Mr. Lakhwinder Singh, as Mr. Taha claimed his methodology was used in my dissertation as it is a common methodology anyone can use it. According to his claim, the flowchart is also not the same you can see it and in the same objective the analyzing dataset was totally different

As you also know that in M. Tech no one is developing his/her own methodology, but utilizing common existing methodologies. I accept that some minor texting is taken from his

dissertation which I have not done intentionally as I was unaware of such rules. If there is more to clarify in this matter I am ready to clear doubt. I am ready to abide by the rule if I have gone against it.

In the end, I came to know that Mr. Taha has already emailed to chief in editor of the journal of MESE and springer publisher, they have decided to withdraw my paper and I accept it. Moreover, we have settled these issues between us.

Thank you for your time.

Regards,

ORIGINAL ARTICLE



# RETRACTED ARTICLE: Modeling on Long term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques

Elyas Khairandish<sup>1</sup> · Surendra Kumar Mishra<sup>1</sup> · Anil Kumar Lohani<sup>2</sup>

Received: 30 January 2020 / Accepted: 21 May 2020

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The Editor-in-Chief has retracted this article [1] because it shows significant overlap of both text and data with the Master's thesis of Taha Aawar, "Hydrological modeling in Kabul river basin: a case study of Afghanistan.", which was defended at the Department of Water Resources Development and Management, Indian Institute of Technology, Roorkee, in June 2019.

Authors Surendra Kumar Mishra and Anil Kumar Lohani agree with this retraction. Author Elyas Khairandish does not agree to this retraction.

[1] Khairandish, E., Mishra, S.K. & Lohani, A.K. Modeling on Long-term land use change detection Analysis of Kabul River Basin, Afghanistan by using geospatial techniques. Model. Earth Syst. Environ. (2020). <https://doi.org/10.1007/s40808-020-00823-9>

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s40808-020-00823-9>) contains supplementary material, which is available to authorized users.

✉ Elyas Khairandish  
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Surendra Kumar Mishra  
skm61fwt01@gmail.com

Anil Kumar Lohani  
aklnih@gmail.com

<sup>1</sup> Department of Water Resources Development and Management, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India

<sup>2</sup> National Institute of Hydrology, Roorkee, Uttarakhand, India

**Item No. 86.11: To report the approvals accorded by the Chairman, Senate:**

**(a) Recommendations of 79<sup>th</sup>, 80<sup>th</sup>, 81<sup>st</sup> (emergency), 83<sup>rd</sup>, 84<sup>th</sup> (emergency), 85<sup>th</sup> (emergency), 86<sup>th</sup>, 87<sup>th</sup> (emergency), 88<sup>th</sup>, 89<sup>th</sup> (emergency), 90<sup>th</sup> (emergency), 91<sup>st</sup>, 92<sup>nd</sup> (emergency), 93<sup>rd</sup> (emergency), 94<sup>th</sup>, 95<sup>th</sup>, 96<sup>th</sup>, 97<sup>th</sup> and 98<sup>th</sup> meetings of IAPC.**

1. Requests of students regarding name restoration after name struck off due to non-registration, addition/deletion of course(s) after the last date, name restoration, completion of Dissertation I & II in the current semester and continuation of program after a gap. (Item No.: 79.2.1, 80.1, 80.2, 81.3, 81.4, 79<sup>th</sup> IAPC dt: 28.01.2020, 80<sup>th</sup> (emergency) IAPC dt: 19.02.2020 and 81<sup>st</sup> (emergency) IAPC dt: 02.03.2020)
2. Strategy to complete Spring semester, 2019-20 in view of lock-down due to COVID-19 outbreak. (Item No.: 83.2.2, 83<sup>rd</sup> IAPC dt: 15.04.2020)
3. Conduct of Interview of sponsored candidates for admission to M.Tech. Programmes-2020 in the wake of Covid-19 pandemic. (Item No.: 83.2.6, 83<sup>rd</sup> IAPC dt: 15.04.2020)
4. Strategy for evaluation process (Spring 2019-20) for the graduating students. (Item No.: 85.1, 85<sup>th</sup> (emergency) IAPC dt: 19.05.2020)
5. To defer evaluations of laboratory-based courses of B Tech (III yr) practical problems to the first four weeks of Autumn Semester 2020-21. (Item No.: 86.2.1, 86<sup>th</sup> IAPC dt: 09.06.2020)
6. Proposal to make Internship Credits optional for the current pre-final year students due to the unprecedented situations caused by COVID 19. (Item No.: 86.2.10, 86<sup>th</sup> IAPC dt: 09.06.2020)
7. Request of a student Mr. Prashashta Srivastava (Enr No 16118059), B.Tech. (MT) IV Yr, for allowing BTP- I and II in the current spring sem 2019-20. (Item No.: 86.3.1, 86<sup>th</sup> IAPC dt: 09.06.2020)
8. Revised structure and syllabi, seat matrix and eligibility criteria of new M.Tech. programme in

Polymer Science and Engineering. (Item No.: 86.2.7, 86<sup>th</sup> IAPC dt: 09.06.2020)

9. Requests of name restoration of part-time students. (Item No.: 86.2.5, 86<sup>th</sup> IAPC dt: 09.06.2020)
10. Request of Mr. Labhesh Dudi (Enr. No. 12114037), B.Tech. (CS) IV Yr to award degree. (Item No.: 79.2.8, 79<sup>th</sup> IAPC dt: 28.01.2020)
11. Request of Mr. Arbaz Kaleem Ansari (Enr. No. 19525003), M.Tech. (EQ) I Yr to allow Dissertation along with Course work. (Item No.: 86.2.4, 86<sup>th</sup> IAPC dt: 09.06.2020)
12. Requests of students regarding addition/change of course. (Item No.: 87.1.1, 87<sup>th</sup> (emergency) IAPC dt: 23.06.2020)
13. Request of Mr. Lokesh Kumar Uikey, B.Tech (ME), IV yr, Enr No. 13117040 regarding extension of the program for six months (i.e. 8<sup>th</sup> year) beyond the permissible limit to complete the degree requirement. (Item No.: 87.1.2, 87<sup>th</sup> (emergency) IAPC dt: 23.06.2020)
14. Request of Mr. Sachin Dev, B.Tech (BT), IV yr, Enr No. 16111029, for registration and evaluation in BTP (BTN-400B) in the Spring semester 2019-20 and to allow the evaluation to complete the degree requirement. (Item No.: 87.1.3, 87<sup>th</sup> (emergency) IAPC dt: 23.06.2020)
15. Syllabi of DBT supported new M.Sc. Biotechnology program. (Item No.: 88.2.2, 88<sup>th</sup> IAPC dt: 30/31.07.2020)
16. Term wise revised Structure, Syllabi of Term 1 & Term 2 and Academic Calendar of MBA program of Department of Management Studies. (Item No.: 86.2.9(1) and 88.2.3(1), 86<sup>th</sup> IAPC dt: 09.06.2020 and 88<sup>th</sup> IAPC dt: 30/31.07.2020)
17. Revision in the regulation of slow pace programme. (Item No.: 88.2.4, 88<sup>th</sup> IAPC dt: 30/31.07.2020)
18. Revision in regulation of Additional Courses (Audit/Credit Courses). (Item No.: 88.2.5, 88<sup>th</sup> IAPC dt: 30/31.07.2020)



19. To consider extending the provision of switching over to IDD programs for all MTech programs. (Item No.: 88.3.3, 88<sup>th</sup> IAPC dt: 30/31.07.2020)
20. Requests of students regarding continuation of programme, extension of programme and semester withdrawal. (Item No.: 88.2.8, 88<sup>th</sup> IAPC dt: 30/31.07.2020)
21. Proposal for conducting re-examination of graduating students. (Item No.: 89.1, 89<sup>th</sup> (emergency) IAPC dt: 31.08.2020)
22. Requests of students regarding name restoration/ extension of programme/ registration after the last date/ addition/deletion of courses after last date. (Item No.: 90.1, 90<sup>th</sup> (emergency) IAPC dt: 07.09.2020)
23. Request of Mr. Himanshu Agarwal (Enr. No. 18810030), MBA, II Yr to award degree on the basis of completion of total credits. (Item No.: 90.2, 90<sup>th</sup> (emergency) IAPC dt: 07.09.2020)
24. Revision in the existing regulation on NPTEL with respect to other related regulations. (Item No.: 91.2.8, 91<sup>st</sup> IAPC dt: 01.10.2020)
25. Request of Mr. Naseeb (Enr. No. 16121017), B.Tech. (Polymer Sc. & Engg.) to provide relief in C.G.P.A. (Item No.: 91.3.1, 91<sup>st</sup> IAPC dt: 01.10.2020)
26. Proposal of Department of Humanities & Social Sciences regarding conduct of screening test of 1<sup>st</sup> year HS-001A (Communication skill basic course) for the Session 2020-21. (Item No.: 92.1, 92<sup>nd</sup> (emergency) IAPC dt: 10.10.2020)
27. Semester completion plan (Autumn 2020-21) for UG first year students. (Item No.: 92.2, 92<sup>nd</sup> (emergency) IAPC dt: 10.10.2020)
28. Proposal of Department of Management studies to conduct online ETE of Term 1 of MBA 2020-21. (Item No.: 92.3, 92<sup>nd</sup> (emergency) IAPC dt: 10.10.2020)
29. Representation of Lt. Col. Avaneesh Pratap Singh towards M.Tech. Admission in the Centre of Disaster

Mitigation and Management. (Item No.: 93.1, 93<sup>rd</sup> (emergency) IAPC dt: 17.10.2020)

30. Request of Mr. Alhaj Yagoub Aldow Ahmed (Enrl. No. 20527002), M Tech (EE) for late admission-registration for the session 2020-21. (Item No.: 93.2, 93<sup>rd</sup> (emergency) IAPC dt: 17.10.2020)
31. Requests received from the Department of Chemistry, Electrical Engg. and Civil Engg. for addition/change of courses for Ph D after the last date. & Remaining applications of Ph D students received for addition/change courses after the compilation of agenda items for 91st meeting of IAPC. (Item No.: 94.2.3 and 94.2.4, 94<sup>th</sup> IAPC dt: 07.11.2020)
32. End Term Examination (ETE) of Autumn Sem 2020-21 for all students (excluding UG 1st year). (Item No.: 96.2.1, 96<sup>th</sup> IAPC dt: 28.12.2020)
33. Provision to extend the last date to submit the remaining documents by newly admitted students during the session 2020-21 (except for UG 1st Yr). (Item No.: 96.2.3, 96<sup>th</sup> IAPC dt: 28.12.2020)
34. Request of Mr. Anurag Meena, M.Tech. (CE, I year) (Enr. No. 18519002) regarding the continuation of programme. (Item No.: 96.2.5, 96<sup>th</sup> IAPC dt: 28.12.2020)
35. Report of the committee constituted to examine the request of Prof. Garima, Deptt. of Paper Technology to include her name in the list of Supervisors of an M.Tech. thesis. (Item No.: 96.2.6, 96<sup>th</sup> IAPC dt: 28.12.2020)
36. Academic Calendar for MBA (I Year)- Term 3 (Session 2020-21). (Item No.: 96.2.8, 96<sup>th</sup> IAPC dt: 28.12.2020)
37. Academic Calendars for the Spring Semester session 2020-21-for all students (excluding UG I year) and for UG (I year) students and MBA (I Year)- Term 4. (Academic Calendar Committee)
38. End Term Examination (ETE) of Autumn Semester 2020-21 for UG 1st year. (Item No.: 97.2.1, 97<sup>th</sup> IAPC dt: 11.01.2021)

39. Extension of ETE duration for three courses of Deptt. of Arch. & Planning. (Item No.: 96.2.1, 96<sup>th</sup> IAPC dt: 28.12.2020)
40. Request of Mr. Vinay Yadav (Enr. No. 20548013) M.Tech. (WR), I Yr to add NPTEL course in the Current Autumn Sem 2020-21. (Item No.: 97.2.4, 97<sup>th</sup> IAPC dt: 11.01.2021)
41. Proposal to provide provision for S grade for Autumn Semester 2020-21 End Term Examination. (Item No.: 97.3.4, 97<sup>th</sup> IAPC dt: 11.01.2021)
42. Seat Matrix for admission to M.Tech./M.Arch./ MURP Programme 2020.

Approved Seat Matrix given at **Appendix-A**.

Reference: HoDs and Chairpersons-DRC/CRC & DAPC/CAPC 2020-21 meeting held on 22 Jan.2020.

43. Schedule and mechanism for conduct of interview for sponsored candidates for admission to M.Tech. Programmes-2020 in the wake of Covid-19 pandemic.

Reference: 83<sup>rd</sup> IAPC meeting (item no.83.2.6).

44. Eligibility criteria of new M.Tech. Polymer Science and Engineering.

Reference: 86<sup>th</sup> IAPC meeting (item no.86.2.7)

45. Revised admission-registration plan w.r.t. M.Tech. / M.Arch. / M.U.R.P. Admission-2020.

46. M. Tech. Admission to Ms. Pallavi Chaudhary.

Reference: 95<sup>th</sup>IAPC meeting (Item No.95.3.5)

47. Inclusion of MCA as a qualifying degree to existing eligibility criteria for M.Tech. (Geomatics).

Reference: 86<sup>th</sup>IAPC (item no.86.2.11).

48. Educational eligibility criteria for the officers of Indian Army towards M.Tech./M.Arch./MURP admission.

Reference: 83<sup>rd</sup> IAPC (item (83.2.7).

49. Revised shortlisting/selection criteria on the CAT Score basis due to nation-wide Covid-19 pandemic for the year 2020.

50. Preparation of final merit list based on CAT percentile only as per the standard formula towards MBA Admission-2020.
51. Modification / change in the policy of offer release-2020 towards MBA Admission-2020.
52. Revised proposal for 'MBA Admission Process 2021-23'.
- Reference: 96<sup>th</sup> IAPC (item no.96.2.9).
53. The 'Seat Matrix for admission to MBA Programmes 2021'.
- Reference: 95<sup>th</sup>IAPC (item No.95.3.4).
54. MBA Seat Matrix (2021-23 batch).
- Reference: 95th IAPC (Item No.95.3.4).
55. The M.Sc. Seat Matrix through JAM 2021-22.
- Reference: 88<sup>th</sup> IAPC (item no.88.2.11).
56. Postponement of the dates towards online admission-registration of M.Sc. Programs-2020 from 18-19 August 2020 to 22-23 August 2020.
57. Removal of 'Mathematics' paper from JAM Seat Matrix-2021-22.
- Corrected seat-matrix table is attached at **Appendix-B**.
58. Removal of MEQs for Engineering Candidates and M.Sc. admission to be given on their JAM rank only.
59. Fee payment extension and admission-registration of M.Sc. 2020-21.
60. For adding the 'B.Sc. / B.S. degree' in the eligibility qualification for M.Sc. Physics w.r.t. non-engineering candidates.
61. M.Sc. Biotechnology admission through DBT organized centralized exam process from 2021 onwards and to discontinue M.Sc. Biotechnology admission through JAM.
- Reference: 85<sup>th</sup> emergent IAPC (item no. 85.2).
62. For conducting the online UG Admission-Registration 2020 from 18 to 19 Nov. 2020.
63. UG Seat Matrix 2020-21 towards admission to B.Tech. Programmes.

Reference: 90<sup>th</sup> emergent IAPC (item no.90.3). UG seat-matrix is attached at **Appendix-C**.

64. Ph.D. Seat-Matrix (Autumn Semester 2020-21).

Reference: recommendation of joint meeting of HoDs and Chairpersons-DRC/CRC & DAPC/CAPC held on 22<sup>nd</sup> January 2020. Ph.D. Seat Matrix (Autumn Semester 2020-21) is given at **Appendix-D**.

65. Change(s) in the minimum academic qualification of Ph.D. Programme in the departments of Civil Engineering, Mathematics, Physics, Earthquake Engineering and Chemistry.

Reference: 37<sup>th</sup> IRC (item no.37.2.10)

66. The schedule towards the Ph.D. Admission process (Spring Semester 2020-21) along with the decision on requirement of rolling advertisement of Ph.D. Admission process.

Reference:41<sup>st</sup> IRC (item no.41.2.1)

67. Revised eligibility criteria w.r.t. Ph.D. admission in the department of Water Resource Management and Development.

Reference:41<sup>st</sup> IRC (item no.41.2.2).

68. Ph.D. admission of a project staff (namely Ms. Monika Gandhi) working in a project 'Development of Thermo Catalytic Technique for Gas Production from Hydrate Bearing Sediments', No. ONG-1160-CHD.

Reference: 41<sup>st</sup> IRC (item no.41.2.3).

69. The educational eligibility criteria towards Ph.D. admission in the department of Polymer and Process Engineering.

Reference: 42<sup>nd</sup> (item no.42.2.9).

70. Seat-Matrix for Ph.D. Admission under PMRF (May 2020) proposed by Academic Affairs Office in line with the final PMRF guidelines.

Reference: Seat Matrix attached **Appendix-E**.

71. Schedule of Online admission-registration towards M.Tech. / M.Arch. / M.U.R.P., M.Sc. Programs-2020 and Ph.D. (Autumn Semester 2020-21).

72. The updated CGPA/Percentage Conversion Table.

Updated CGPA/Percentage Conversion Table given at **Appendix-F.**

73. Providing additional timeline for completing online admission-registration towards M.Tech. / M.Arch. / M.U.R.P., M.Sc. Programs-2020 and Ph.D. Autumn Semester 2020-21.

**(b) On the recommendations of 37<sup>th</sup>, 38<sup>th</sup>, 39<sup>th</sup>, 40<sup>th</sup>, 41<sup>st</sup> and 42<sup>nd</sup> meeting of IRC.**

74. Request of students regarding name restoration after name struck off due to non-registration/ non-submission of fee within time/ not requested for extension within the allowed time for thesis submission. (37<sup>th</sup> IRC dt: 04.03.2020, 40<sup>th</sup> IRC dt: 08.08.2020, 41<sup>st</sup> IRC dt: 30.09.2020 and 42<sup>nd</sup> IRC dt: 07.11.2020) Items No.: 37.2.1, 40.2.1, 41.2.6, 41.2.7, 42.2.4 and 42.2.6, respectively.

75. Requests of Mr. Soumya Nandan Mishra (En. No.: 19911010) and Mr. Garvit Singh (En. No.: 18920051) were not recommended. (37<sup>th</sup> IRC dt: 04.03.2020 and 39<sup>th</sup> IRC dt: 13.06.2020) Items No.: 37.2.5 and 39.2.1, respectively.

76. To consider lock-down period as NULL period for the time limits related to various requirements in the Ph.D. programme. (Item No.: 38.1.1, 38<sup>th</sup> IRC dt: 04.04.2020).

77. The MoA for Joint Doctoral Degree Programme between IIT Roorkee and Asian Institute of Technology, Thailand. (Item No.: 39.2.2, 39<sup>th</sup> IRC dt: 13.06.2020)

78. For additional 04 weeks extension to Ph.D. students beyond the extension granted in Semester Completion Plan of Spring Semester 2019-2020 for presentation of 02 credit seminar. (Item No.: 41.2.9, 41<sup>st</sup> IRC dt: 30.09.2020)

79. For last date of viva-voce examination upto 31.10.2020 for Ph.D. students, to whom the degrees are to be awarded in the Convocation 2020 and later extended upto 10.11.2020. (41<sup>st</sup> IRC dt: 30.09.2020 and 42<sup>nd</sup> IRC dt: 07.11.2020) Items No.: 41.2.8 and 42.2.1 respectively.

- 80.The MoU between IITR and National Council for Cement and Building Materials (N.C.C.B.M.), Ballabgarh for the recognition of the N.C.C.B.M., Ballabgarh as the IITR research centre for collaborative research and development.(Item No.: 42.2.5, 42<sup>nd</sup> IRC dt: 07.11.2020)
- 81.To modify the certificate, which Institute issues to Ph.D. students after completion of degree, in accordance with the UGC (minimum standard and procedure for the award of Ph.D. degree) Regulations 2009.(Item No.: 42.2.2, 42<sup>nd</sup> IRC dt: 07.11.2020).
- 82.The modification in existing Ph.D. Rule & Regulation R.3.3(Table- 1).(Item No.: 42.2.7, 42<sup>nd</sup> IRC dt: 07.11.2020)
- 83.To take additional course(s) by Ph.D. students, over and above the requirement for candidacy, as credit course even after completion of the candidacy.(Item No.: 40.2.3, 40<sup>th</sup> IRC dt: 08.08.2020).

**(c) Recommendations of SCSP :**

- 84.**Manmohan Das Seth Gold Medal** : Mr Arun Seth along with his brother and sisters has established to start this Gold Medal for the UG topper in Civil Engineering. The Department Gold Medal for Civil Engg Department will be named as “Manmohan Das Seth Department Gold Medal”.
- 85.**1968 Batch Donation Merit Cum Means (MCM) Scholarship**: 1968 Batch has created a fund to sponsor seven MCM scholarships of Rs10,000/- each. These MCMs will be given to seven different departments namely, Civil Engg., Electrical Engg., Mechanical & Industrial Engg., Electronics & Communication Engg., Chemical Engg., MMED and A&P. Eligible students getting full fee waiver will be given this MCM on the basis of merit.
- 86.**1968 Batch Donation Best Athlete (Female)**: 1968 batch has established a fund for awarding Rs10,000/- to the best female student.
- 87.**1993 Batch Donation MCM Scholarships**: 1993 batch has established a fund for awarding five MCM

scholarships of Rs10,000/- each. Students will be selected on the basis of merit. These scholarships will be given to those eligible students who are not getting any other donor based MCM.

88.**B K Chaturvedi Scholarship:** Sh B K Chaturvedi has established a fund for one MCM scholarship of Rs10,000/- for the deserving student of Department of Mechanical and Industrial Engineering.

89.**B K Chaturvedi Award:** Sh B K Chaturvedi has established a fund for awarding a cash prize of Rs10,000/- for the student of MBA II Year who gets highest CGPA in the first year of MBA.

90.**Smt Leelawati Agarwal Scholarship:** Mr Sumer Kumar Agarwal has established a fund to award a MCM of Rs10,000/- to the deserving student of MIED III year on the basis of performance of II year.

91.**1978 Batch Donation MCM Scholarship:** 1978 batch has created a fund to for awarding two MCM scholarships of Rs10,000/- each. Students will be selected on the basis of merit. These scholarships will be given to those eligible students who are not getting any other donor based MCM.

92.**Vimal Preet Singh Kohli Scholarship:** Mr Trilochan Singh Kohli has established a fund for awarding one MCM scholarships of Rs10,000/- per annum. Student will be selected on the basis of merit. This scholarship will be given to an eligible student who is not getting any other donor based MCM.

93.**Himanshu Kumar Pande Scholarship:** Mrs Abha Pande has established a fund to support one MCM scholarship of Rs10,000/- per annum to a deserving student of Department of Architecture & Planning. This student will not be receiving any other MCM.

94.**Dr Sushil Sharma Excellence in Doctoral Research Award:** Dr Sushil Sharma has established a fund for 10 years to give one excellence in doctoral research award. This will be within five awards (maximum) given at the time of annual convocation. This award will be given preferably in area of Physics.

95.**Kulbhushan Swarup Raizada Scholarship:** Mr Rajeev Mukul has established a fund to support two MCM



scholarships of Rs10,000/- per annum, one to a male student and one to a female student. This scholarship will be given to an eligible student who is not getting any other donor based MCM.

96. **Viney K and Sunita Jain Award for Excellence in Information and Communication Technologies:** Mr Viney K Jain has desired to discontinue Rai S Jain Cash prize and Rai Singh Jain & Smt Shakuntala Devi Jain Cash Prize. Now two awards of Rs10,000/- each will be given every year to student of III Year CSE for their academic performance upto II year. One award will be given to a student getting highest CGPA upto II year in the CSE and the second award will be given to a student of CSE who gets the highest CGPA amongst the woman students of the batch. In case, highest CGPA in the entire CSE class is obtained by a woman student, the second prize will go to a student who scores second highest CGPA in the class irrespective of gender.
97. **Rai Bahadur Sohan Lal Bhatia Cash Prize:** Donor has desired to rename Rai Bahadur Sohan Lal Bhatia Memorial Prize as Rai Bahadur Sohan Lal Bhatia Cash Prize. The award of Rs10,000/- per annum will be given to graduating student of CSE who scores highest CGPA.
98. **Saraswati MCM Scholarship:** Shri Sukhbir Kumar Maggu has established a fund to support one MCM scholarship of Rs10,000/- per annum. This scholarship will be given to an eligible student who is not getting any other donor based MCM.
99. **Shrimati Pyaari Bai and Shri Badri Prasad Memorial Scholarship:** Shri Ramesh Chandra has established a fund to support one MCM scholarship of Rs10,000/- per annum. This scholarship will be given to an eligible student who is not getting any other donor based MCM.
100. **Smt Chandravati Gold Medal:** Prof Dr N K Garg has created a fund for 10 years to award Smt Chandravati Gold Medal” to the topper of B Arch. Department of Architecture & Planning will put a display board containing names of winner of this award.

101. **Shri Subhash Chandra Tyagi MCM Scholarship:** Mrs Priti Tyagi has established a fund to support one MCM scholarship of Rs12,000/- per annum for a deserving student of Civil Engg. This scholarship will be given to an eligible student who is not getting any other donor based MCM.
102. **1994 Batch MCM Scholarships:** 1994 batch has supported ten MCM scholarships of Rs10,000/- each per annum. Students will be selected on the basis of merit. These scholarships will be given to those eligible students who are not getting any other donor based MCM.

The above is reported to the Senate.

Sub: Approval of Chairman, Senate towards Seat Matrix of (1) M.Tech. / M.Arch. / MURP – 2020-21 and (2) Ph.D. - Autumn Semester 2020-21.

The approved minutes of the meeting held on 22<sup>nd</sup> January 2020 at 4.00 p.m. in the Senate Hall to finalize the seat matrix of (1) M.Tech. / M.Arch. / MURP – 2020-21 and (2) Ph.D. - Autumn Semester 2020-21 is enclosed at Flag-1.


All the HoDs and the Chairpersons – DRC / CRC & DAPC/CAPC were invited to attend the said meeting.

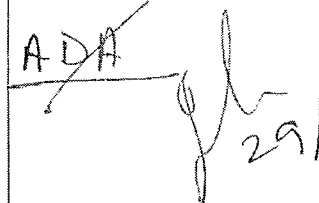
In this regard, approval of the Chairman, Senate may be obtained towards the recommended seat matrix of (1) M.Tech. / M.Arch. / MURP 2020-21 (enclosed at Flag-2) and Ph.D.- Autumn Semester 2020 -21 (enclosed at Flag-3).

As the online applications for Ph.D. (Autumn Semester) admission needs to be started in last week of February, 2020 and for M.Tech. / M.Arch. / MURP in the second week of March 2020. This will help us to expedite the admission process.

The same shall be reported in the next Senate meeting.


Submitted as above please.

  
29/01/2020  
AR (Acad-Admission)

→ ADA  
  
29/1/2020

Do/It

May please approve.

  
G. Vard  
29/01/2020

Chairman  
Senate

  
29/1/2020

ADA  
ARA

The above approval need to be reported in the next Senate.

Proposed Seat Matrix for M.Tech./M.Arch./MURP Admission 2020-21

Proposed Seat Matrix for M.Tech./M.Arch./MURP Admission 2020-21																		
S.No	Academic Department/ Centre & (Code)	Academic Programmes	Main Gate Discipline(s)					Other GATE Disciplines					EWS 10%	PD 5% horizontal	Spl. Wise Intake	Total seats in Dept/Centre		
		Name	Code	GATE Discipline Code	UR	OBC	SC	ST	GATE Discipline Code	UR	OBC	SC					ST	
1	Architecture and Planning (ARD)	M.Arch.	10	AR(12)	5	4	2	1		-	-	-	-	1	1	13	26	
		M.U.R.P.	11	AR(10)	4	3	2	1	CE(2)	1	1	0	0	1		13		
2	Hydro and Renewable Energy Centre (HRE)	M.Tech. Alternate Hydro Energy Systems	12	CE(2)	1	1	0	0	AG/CH/EE/EC/ME/ PIXE/IN (12)	6	3	2	1	2	1	16	27	
		M.Tech. Environmental Management of Rivers and Lakes	13	CE(3)	1	1	1	0	AG/CH/EE/ME/PI/ XE/AR/CY/BI/PH/M AX/LE/Y(7)	3	2	1	1	1		11		
3	Chemical Engineering (CHO)	M.Tech. Chemical Engineering	14	CH(10)	6	6	3	2	-	-	-	-	-	2	1	21	21	
4	Civil Engineering (CED)	M.Tech. Environmental Engg.	16	CE(10)	4	3	2	1	CH(2)	1	1	0	0	1	5	13	91	
		M.Tech. Geomatics Engg.	17	CE(7)	3	2	1	1	AR/CS/EC/EE /AG/MN(6)	3	2	1	0	1		14		
		M.Tech. Geotechnical Engg.	18	CE(12)	6	3	2	1	MN (2)	1	1	-	-	2		16		
		M.Tech. Hydraulic Engg.	19	CE(11)	5	3	2	1	-	-	-	-	-	1		12		
		M.Tech. Structural Engg.	20	CE(21)	9	6	4	2	-	-	-	-	-	2		23		
		M.Tech. Transportation Engg.	21	CE(12)	6	3	2	1	-	-	-	-	-	1		13		
5	Earthquake Engineering (EQD)	M.Tech. Soil Dynamics	22	CE(11)	5	3	2	1	-	-	-	-	-	1	2	12	41	
		M.Tech. Structural Dynamics	23	CE(17)	8	5	3	1	-	-	-	-	-	2		19		
		M.Tech. Seismic Vulnerability and Risk Assessment	24	CE(9)	4	3	1	1	-	-	-	-	-	1		10		
6	Electrical Engineering (EED)	M.Tech. Electric Drives & Power Electronics	25	EE(13)	6	4	2	1	-	-	-	-	-	2	3	15	60	
		M.Tech. Instrumentation and Signal Processing	26	EE(9)	4	3	1	1	EC/IN(4)	2	1	1	0	2		15		
		M.Tech. Power System Engg.	27	EE(13)	6	4	2	1	-	-	-	-	-	2		15		
		M.Tech. Systems and Control	28	EE(10)	4	3	2	1	EC/IN(3)	1	1	1	0	2		15		
7	Electronics and Communication Engineering (ECD)	M.Tech. Communication Systems	29	EC(11)	5	3	2	1	-	-	-	-	-	1	2	12	34	
		M.Tech. R.F. & Microwave Engg.	30	EC(10)	5	3	1	1	-	-	-	-	-	1		11		
		M.Tech. Microelectronics and VLSI	31	EC/PH(10)	4	3	2	1	-	-	-	-	-	1		11		
8	Computer Science and Engineering (CSD)	M.Tech. Computer Science & Engg.	32	CS(29)	13	9	5	2	-	-	-	-	-	3	2	32	32	
9	Hydrology (HYD)	M.Tech. Hydrology	33	CE/AG(17)	8	5	3	1	GG/XE/PH/ EY(3)	1	1	0	1	2	1	22	22	
10	Mechanical and Industrial Engineering (MED)	M.Tech. CAD, CAM & Robotics	34	ME/PI(11)	5	4	1	1	-	-	-	-	-	1	3	12	60	
		M.Tech. Machine Design Engg.	35	ME/PI(11)	5	3	2	1	-	-	-	-	-	1		12		
		M.Tech. Production & Industrial Systems Engg.	36	ME/PI(11)	5	3	2	1	-	-	-	-	-	1		12		
		M.Tech. Thermal Engg.	37	ME/PI(11)	5	3	2	1	-	-	-	-	-	1		12		
		M.Tech. Welding Engg.	38	ME/PI(11)	5	3	2	1	-	-	-	-	-	1		12		
11	Metallurgical and Materials Engineering (MTD)	M.Tech. Industrial Metallurgy	39	MT(3)	2	1	0	0	ME/PI/XE (7)	3	2	1	1	1	1	11	23	
		M.Tech. Materials Engg.	40	MT(4)	2	1	1	0	PH/ME/PI/CY/XE (7)	3	2	1	1	1		12		
12	Paper Technology Saharanpur Campus (PPD)	M.Tech. Pulp & Paper	41	CH(7)	3	2	1	1	ME/BI/TF/IEY (5)	2	2	1	0	1	1	13	26	
		M.Tech. Packaging Technology	42	CH(6)	2	2	1	1	BT/CY/ME/TF (6)	3	2	1	0	1		13		
13	Water Resources Development and Management (WRD)	M.Tech. Irrigation Water Management	43	CE/AG(7)	3	2	1	1	-	-	-	-	-	1	1	8	21	
		M.Tech. Water Resources Development	44	CE/EE/ME (12)	5	4	2	1	-	-	-	-	-	1		13		
15	Physics (PHD)	M.Tech. Solid State Electronic Materials	46	PH(7)	3	2	1	1	EE/EC/MT (3)	1	1	1	0	1	1	11	22	
		M.Tech. Photonics	47	PH(7)	3	2	1	1	EE/EC/MT/IN (3)	1	1	1	0	1		11		
16	Nanotechnology (NTC)	M.Tech. Nanotechnology	48	MT/ME/EC/CH/BI/ CE (4)	2	1	1	0	CY/PH/XL (6)	2	2	1	1	1	1	11	11	
17	Disaster Mitigation and Management (DMC)	M.Tech. Disaster Mitigation and Management	49	CE(5)	2	1	1	1	ME/PI/CS/CH/AR/G G/PH/MA/XL/XE/IEY /BT (5)	2	2	1	0	1	1	11	11	
18	Transportation Systems (TSC)	M.Tech. Infrastructure Systems	50	CE(3)	1	1	1	0	ME/PI/CH/EE/EC/C SI/AR (7)	3	2	1	1	1	1	11	11	
19	Biotechnology (BTD)	M.Tech. Bioprocess Engineering	51	CH (4)	2	1	1	0	BT/AG/XE/TF (6)	2	2	1	1	1	1	11	11	
		Total			179	119	68	36		41	31	16	8	52	29	550	550	

24/01/2020

24/01/2020

**Proposed Intake for M.Sc. Through JAM-2021**

S.No.	DEPTT	CODE	JAM Paper	PROGRAMME	Total intake	GEN	GEN-EWS	OBC-NEW	SC-NEW	ST-NEW	PD (distribution to be followed by rotation)
1	Earth Science (ES)	1801	GG	M.Sc. (Applied Geology)	19	8	2	5	3	1	1 OBC
3	Chemistry (CY)	1803	CY	M.Sc. (Chemistry)	44	18	4	12	7	3	2 (1 GEN, 1 OBC)
4	Mathematics (MA)	1804	MA	M.Sc. (Mathematics)	38	15	4	10	6	3	2 (1 SC, 1 ST)
5	Physics (PH)	1805	PH	M.Sc. (Physics)	35	14	4	9	5	3	2 (1 GEN, 1 OBC)
6	Humanities & Social Sciences	1806	EN	M.Sc. (Economics)	33	13	3	9	5	3	2 (1 SC, 1 ST)
	<b>Total</b>				<b>169</b>	<b>68</b>	<b>17</b>	<b>45</b>	<b>26</b>	<b>13</b>	<b>9</b>

Admission to M.Sc. Biotechnology Programme is not done through JAM from the year 2021 onwards.

UG Seat Matrix for the Session 2020-21 (including 10% EWS and 20% Minimum Female Supernumerary)

Prog.		GE	GE-PwD	OBC	OBC-PwD	SC	SC-PwD	ST	ST-PwD	GE-EWS	GE-EWS-PwD	Total		S. No.		Program	Super numerary	Final Female Only	Final Gender Neutral
BT	Gender Neutral	14	1	10	1	5	0	3	0	4	0	36	46	1	BT	Biotech	2	10	36
	Female	3	0	3	0	2	0	1	0	1	0	10		2	CH	Chemical	8	24	96
														3	CE	Civil	25	39	155
CH	Gender Neutral	39	2	26	1	14	1	7	1	10	1	96	120	4	CSE	Comp. Sc.	15	22	87
	Female	10	1	6	0	4	0	2	0	2	0	24		5	EE	Electrical	15	33	132
														6	ECE	Electronics	9	22	87
CE	Gender Neutral	63	3	42	2	23	1	12	1	15	1	155	194	7	EPH	Engg. Physics	3	8	32
	Female	16	1	10	1	6	1	3	0	4	0	39		8	ME	Mechanical	25	30	120
														9	MT	Metallurgical	12	23	89
CSE	Gender Neutral	35	2	23	1	13	1	7	0	9	0	87	109	10	PSE	Polymer	3	8	32
	Female	9	1	6	0	3	0	2	0	2	1	22		11	IN	Production	8	12	46
														12	AR	Architecture	0	7	30
EE	Gender Neutral	53	3	36	2	20	1	10	1	13	1	132	165	13	GT	Geological	0	8	30
	Female	13	1	10	1	5	1	2	0	3	0	33		14	GPT	Geophysical	3	9	32
														15	MSM	Mathematics	5	8	34
ECE	Gender Neutral	35	2	23	1	13	1	7	0	9	0	87	109	16	MSC	Chemistry	0	5	20
	Female	9	1	6	0	3	0	2	0	2	0	22		17	MSP	Physics	2	6	21
															Total		135	274	1079
EPH	Gender Neutral	13	1	9	1	5	0	2	0	3	0	32	40						
	Female	3	0	2	0	1	0	1	0	1	0	8			GN	1079		53.95	
															F	274		13.7	
ME	Gender Neutral	49	2	32	2	18	1	9	1	12	1	120	150						
	Female	12	1	8	1	5	0	2	0	3	0	30							
															Gender Neutral				
MT	Gender Neutral	36	2	24	1	13	1	7	0	9	1	89	112			GE	436.995		437
	Female	10	0	6	1	3	0	2	1	2	0	23				OBC	291.33		291
																SC	161.85		162
PSE	Gender Neutral	13	1	9	1	5	0	2	0	3	0	32	40			ST	80.925		81
	Female	3	0	2	0	1	0	1	0	1	0	8				EWS	107.9		108
																Total		1079	
PI	Gender Neutral	19	1	12	1	7	1	3	0	5	0	46	58			Female Only			
	Female	5	0	3	0	2	0	1	0	1	0	12				GE	110.97		111
																OBC	73.98		74
AR	Gender Neutral	12	1	8	0	5	0	2	0	3	0	30	37			SC	41.1		41
	Female	3	0	2	0	1	0	0	0	1	0	7				ST	20.55		21
																EWS	27.4		27
GT	Gender Neutral	12	1	8	1	5	0	2	0	3	0	30	38			Total		274	
	Female	3	0	2	0	1	0	1	0	1	0	8							
																Gender Neutral PwD			

Category wise vacancy for admission to Ph.D program for Autumn Semester of the session 2020-21 under Institute Assistantship

Deptt/ centre	Faculty Position (13.01.20)	Total seats @4.0 x no. of faculty	Total seats increased with 6.37%	Category wise Total Seats					Seats Filled						Vacancy							
				Unreserved	Gen-EWS	OBC	SC	ST	Unreserved	Gen-EWS	OBC	SC	ST	Total filled	Unreserved	GEN-EWS	OBC	SC	ST	Total vacancy		
(Roorkee Campus)																						
Hydro and Renewable Energy	7	28	30	12	3	8	5	2	9	0	5	2	1	17	3	3	3	3	1	13		
Arch & Plng	17	68	72	29	7	20	11	5	31	1	15	11	0	58	1	6	5	0	5	17		
Biotechnology	24	96	102	41	10	28	15	8	41	0	10	3	1	55	1	10	18	12	7	48		
C-Trans	4	16	17	7	2	5	2	1	10	0	5	1	1	17	1	2	0	1	0	4		
Dis. Mil. & Magnt	4	16	17	7	2	5	2	1	8	0	2	2	1	13	1	2	3	0	0	6		
Nanotechnology	4	16	17	7	2	5	2	1	7	0	2	2	0	11	1	2	3	0	1	7		
Chemical Engg	20	80	85	34	9	23	13	6	24	0	23	12	3	62	10	9	0	1	3	23		
Chemistry	25	104	111	45	11	30	17	8	29	0	11	8	0	48	16	11	19	9	8	63		
Civil Engg	47	188	200	81	20	54	30	15	73	0	33	17	6	129	8	20	21	13	9	71		
Computer Sc. & Engg	14	56	60	24	6	16	9	5	19	0	6	2	0	27	5	6	10	7	5	33		
Earth Sciences	21	84	89	36	9	24	13	7	35	0	8	5	0	48	1	9	16	8	7	41		
Earthquake Engg	13	52	55	22	6	15	8	4	23	0	11	2	3	39	1	6	4	6	1	18		
Electrical Engg	31	124	132	53	13	36	20	10	56	1	27	9	1	94	1	12	9	11	9	42		
E&CE	25	100	106	43	10	29	16	8	31	1	13	4	0	49	12	9	16	12	8	57		
Hum & Soc. Sciences	16	64	68	28	7	18	10	5	26	2	16	7	3	54	2	5	2	3	2	14		
Hydrology	7	28	30	12	3	8	5	2	11	1	5	2	0	19	1	2	3	3	2	11		
Inst. Instr. Centre	1	4	4	2	0	1	1	0	1	0	0	0	0	1	1	0	1	1	0	3		
Management Studies	15	60	64	26	6	17	10	5	24	1	7	5	0	37	2	5	10	5	5	27		
Mathematics	25	100	106	43	10	29	16	8	20	2	14	9	0	45	23	8	15	7	8	61		
Mech&Indl Engg	44	176	187	76	19	50	28	14	65	2	40	22	8	137	11	17	10	6	6	50		
Met & Mat Engg	23	92	98	40	10	26	15	7	30	0	17	10	0	57	10	10	9	5	7	41		
Physics	34	136	145	59	14	39	22	11	48	3	28	7	1	87	11	11	11	15	10	58		
WRD & M	7	28	30	12	3	8	5	2	8	1	8	1	0	18	4	2	0	4	2	12		
Total	429	1716	1825	739	182	494	275	135	629	15	306	143	29	1122	110	167	188	132	106	703		
(Saharanpur Campus)		Total Seat @ 8 x no. of faculty													127						72	
Applied Sc. & Engg	4	32	34	14	3	9	5	3	14	0	6	1	1	22	1	3	3	4	2	13		
Paper Technology	5	40	43	17	4	12	7	3	16	0	4	4	0	24	1	4	8	3	3	19		
Polymer & Process Engg	10	80	85	34	9	23	13	6	35	0	13	9	0	57	1	9	10	4	6	30		
Total	19	152	162	65	16	44	25	12	65	0	23	14	1	103	3	16	21	11	11	62		

Note: -As per the record, the Unreserved category vacancy as highlighted with "Blue" colour is "0" or "Negative" therefore it is counted as "1"  
-PwD seats are 5% horizontal

*[Handwritten Signature]*  
24/01/2020

**Department /Centre PMRF Seat Distribution-May 2020**  
**(With Inter-disciplinary Programmes in line with the PMRF Final Guidelines)**

Dept	Total students	3.5% of total students	Rounded off 3.5% of total students	Direct Entry 25%	Direct Entry 25% Rounded off	Lateral Entry 75%	Lateral Entry 75% Rounded off
Architecture and Planning	95	3.33	3	0.75	1	2.25	2
Biotechnology	153	5.36	5	1.25	1	3.75	4
Chemical Engineering	77	2.70	3	0.75	1	2.25	2
Chemistry	143	5.01	5	1.25	1	3.75	4
Civil Engineering	209	7.32	7	1.75	2	5.25	5
Computer Science and Engineering	64	2.24	2	0.50	1	1.50	1
Interdisciplinary Programs in Science and Engineering (AHC, ASE, TSC, DMC, NTC, ESD, EQD, HYD, PPD, PPE, WRD)	487	17.05	17	4.25	4	12.75	13
Electrical Engineering Electronics and Communication Engineering	269	9.42	9	2.25	2	6.75	7
Mathematics	112	3.92	4	1.00	1	3.00	3
Mechanical and Industrial Engineering	216	7.56	8	2.00	2	6.00	6
Metallurgical and Materials Engineering	78	2.73	3	0.75	1	2.25	2
Physics	147	5.15	5	1.25	1	3.75	4
<b>Total</b>	<b>2050</b>	<b>71.75</b>	<b>71</b>	<b>17.75</b>	<b>18</b>	<b>53.25</b>	<b>53</b>



Zimbra

aradmission@iitr.ac.in

**Revised Conversion Table.****From :** Dileep KumarToppo <aradmission@iitr.ac.in>

Thu, Jul 02, 2020 06:56 PM

**Subject :** Revised Conversion Table.

**To :** Dr.G.N Pillai <gn.pillai@ee.iitr.ac.in>, Prabhjot SinghChani <chanifap@iitr.ac.in>, Ashwani KumarSharma <aksbsfbs@iitr.ac.in>, Shishir Sinha <shishir@ch.iitr.ac.in>, K. R. Justin Thomas <krjt8fcy@iitr.ac.in>, S K.Ghosh <scangfce@iitr.ac.in>, dharmendra singh <dharmfec@ece.iitr.ac.in>, Pankaj Agarwal <panagfec@iitr.ac.in>, Bajpai Sunil <sunilfes@iitr.ac.in>, Sudeb Dasgupta <sudebfec@iitr.ac.in>, Nagendra Kumar <nagenfhs@iitr.ac.in>, Manoj K.Jain <mjainfhy@iitr.ac.in>, Singhal Sunil Kumar <sunilfah@iitr.ac.in>, Nagarajan Sukavanam <nsukvfma@iitr.ac.in>, Bhupendra K.Gandhi <bkgmfme@iitr.ac.in>, Gajanan Chaudhari <chaudfnt@iitr.ac.in>, Chhaya Sharma <chayafpt@iitr.ac.in>, Sujay Chattopadhyay <sujayfpt@iitr.ac.in>, Kanhaiya Lal Yadav <klalyfph@iitr.ac.in>, M L Kansal <mlkfwf@iitr.ac.in>, M L Kansal <mlk@wr.iitr.ac.in>, Mahua Mukherjee <mahua.mukherjee@ar.iitr.ac.in>, Raj KumarDutta <duttafey@iitr.ac.in>, Durga Toshniwal <durgafec@iitr.ac.in>, Saini Rajeshwarprasad <rajsafah@iitr.ac.in>, AkhilUpadhyay <akhilfey@iitr.ac.in>, Narayan Jay Prakash <jaypnfec@iitr.ac.in>, valanfap <valanfap@iitr.ac.in>, Deep kusum <kusumfma@iitr.ac.in>, Ghanshyam Das Verma <gdvarfph@iitr.ac.in>, krimufme <krimufme@iitr.ac.in>, Prasad Ramasare <rapdyfbs@iitr.ac.in>, ghoshfey <ghoshfey@iitr.ac.in>, Joshi Himanshu <joshifhy@iitr.ac.in>, Ramesh Chandra <ramesfic@iitr.ac.in>, Mukesh Kumar Barua <baruafdm@iitr.ac.in>, R D Garg <garg\_fce@iitr.ac.in>, Ravi Kumar <ravikfme@iitr.ac.in>, Singh Sandeep <sandpfes@iitr.ac.in>, P. Jeevanandam <jeevafey@iitr.ac.in>, Ujjwal Prakash <ujwalfnt@iitr.ac.in>, S. P. Singh <singhfhs@iitr.ac.in>, Surendra Kumar Mishra <skm61fwf@iitr.ac.in>, N P Pathak <nagppfec@iitr.ac.in>, RajdeepNiyogi <rajdpfec@iitr.ac.in>, N. C. Mishra <misrafpt@iitr.ac.in>, DharmDutt <dduttfpt@iitr.ac.in>, BarjeevTyagi <btayagfee@iitr.ac.in>, V C.Srivastava <vimal.srivastava@ch.iitr.ac.in>

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**PG Admission Office  
Indian Institute of Technology Roorkee**

**NOTIFICATION****No.IITR/PG Admn/Revised Conversion Table/2020****Date: 2 July 2020**

Superseding the previous CGPA/Percentage Conversion Table (Senate minutes, item no.16.2.8), the below given revised CGPA/Percentage Conversion Table shall be effective from immediate date. All the Departments/Centers may take further necessary action accordingly towards the admission to PG (including Ph.D.) Programmes.

Revised Conversion Table													
10-Point Scale		9-Point Scale		8-Point Scale		7-Point Scale		6-Point Scale		5-Point Scale		4-Point Scale	
CG	%	CGP	%	CG	%	CG	%	CG	%	CGP	%	CGP	%

<https://mapi.iitr.ac.in/h/printmessage?id=41110&t=Asia/Kolkata&xim=1>

1/2

PA	Mar ks	A	Mar ks	PA	Mar ks	PA	Mar ks	PA	Mar ks	A	Mar ks	A	Ma rks
4	40	3.6	40	3.2	40	2.8	40	2.4	40	2	40	1.6	40
4.5	45	4.05	45	3.6	45	3.15	45	2.7	45	2.25	45	1.8	45
5	50	4.5	50	4	50	3.5	50	3	50	2.5	50	2	50
5.5	55	4.95	55	4.4	55	3.85	55	3.3	55	2.75	55	2.2	55
6	60	5.4	60	4.8	60	4.2	60	3.6	60	3	60	2.4	60
6.5	65	5.85	65	5.2	65	4.55	65	3.9	65	3.25	65	2.6	65
7	70	6.3	70	5.6	70	4.9	70	4.2	70	3.5	70	2.8	70
7.5	75	6.75	75	6	75	5.25	75	4.5	75	3.75	75	3	75
8	80	7.2	80	6.4	80	5.6	80	4.8	80	4	80	3.2	80
8.5	85	7.65	85	6.8	85	5.95	85	5.1	85	4.25	85	3.4	85
9	90	8.1	90	7.2	90	6.3	90	5.4	90	4.5	90	3.6	90
9.5	95	8.55	95	7.6	95	6.65	95	5.7	95	4.75	95	3.8	95
10	100	9	100	8	100	7	100	6	100	5	100	4	100
<b>Note:</b> Conversion for intermediate values can be calculated by linear interpolation.													

This is issued with the approval of the competent authority.

Sd/-

(D.K. Toppo)

AR (Acad-Admission)

भारतीय प्रौद्योगिकी संस्थान रुड़की  
रुड़की – 247 667 (भारत)  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE  
ROORKEE - 247 667 (INDIA)



सीनेट की छियासीवीं बैठक हेतु अनुपूरक कार्यसूची  
SUPPLEMENTARY AGENDA FOR THE  
86<sup>th</sup> MEETING OF THE SENATE OVER WebEx

बैठक सं०	: छियासीवीं
MEETING NO.	: 86 <sup>th</sup>
स्थान	: वैबेक्स के द्वारा
VENUE	: Over WebEx
दिनांक	: 9 फरवरी 2021
DATE	: 9 <sup>th</sup> February 2021
समय	: 04.00 बजे अपरान्ह
TIME	: 04.00 P.M.

भारतीय प्रौद्योगिकी संस्थान रुड़की  
**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
रुड़की 247 667  
**ROORKEE – 247 667**



**अनुपूरक कार्यसूची / SUPPLEMENTARY AGENDA**

मुद्दा सं० / Item No.	विवरण / Particulars	पृष्ठ / Page(s)
86.12	निम्नलिखित एमटेक प्रोग्राम शुरू करने के लिए सेंटर फॉर आर्टिफिशियल इंटेलिजेंस एंड डेटा साइंस (सीएआईडीएस) के प्रस्ताव पर विचार करना: 1. एमटेक (आर्टिफिशियल इंटेलिजेंस) 2. एमटेक ( डेटा साइंस ) To consider the proposal to start following M.Tech. programs by the Centre for Artificial Intelligence and Data Science (CAIDS). 1. M.Tech. (Artificial Intelligence) 2. M.Tech. (Data Science)	213-235
86.13	निम्नलिखित मास्टर कार्यक्रम शुरू करने के प्रस्ताव पर विचार करना। 1. एमडेस (औद्योगिक डिजाइन) 2. एमआईएम (मास्टर इन इन्नोवेशन मैनेजमेंट) To consider the proposal to start following Master Programs: 1. M. Des. (Industrial Design) 2. MIM (Masters in Innovation Management)	236-255
86.14	मानविकी और सामाजिक विज्ञान विभाग के नए प्रस्तावित एकीकृत एमएस अर्थशास्त्र (पंचवर्षीय एकीकृत कार्यक्रम) शुरू करने पर विचार करना। To consider the proposal of Department of Humanities and Social Sciences to introduce New Integrated MS Economics (Five Year Integrated programme).	256-273
86.15	एग्जीक्युटीव एमबीए (ईएमबीए) शुरू करने के लिए प्रबंधन अध्ययन विभाग के प्रस्ताव पर विचार करना। To consider the proposal of Department of Management Studies to introduce Executive MBA (EMBA).	274-283
86.16	आटम सेमेस्टर 2020-21 की अन्तिम टर्म परीक्षा में सभी छात्रों को एस ग्रेड के प्रावधान के प्रस्ताव पर विचार करना। To consider the proposal for the provision of S grade for Autumn Semester 2020-21 End Term Examination for all students.	284

86.17	एमटेक/आईएमटी/आईडीडी की वर्तमान थीसिस मूल्यांकन प्रक्रिया की समीक्षा के लिए गठित समिति की संशोधन रिपोर्ट पर विचार करना। To consider the revised report of the committee constituted to review the current thesis evaluation process for M.Tech./IMT/IDD.	285-286
86.18	भारतीय सेना के अधिकारियों को एमटेक/एमआर्क/एमयूआरपी में प्रवेश के लिए 55 प्रतिशत और उससे अधिक अंक के साथ प्राप्त बी.ई./बीटेक में द्वितीय श्रेणी के डिग्री धारको पर विचार करना। To consider the acceptance of Second Class Degree of B.E./B.Tech with 55% and above score with respect to the officers of Indian Army for M.Tech./M.Arch./MURP admission.	287-288
86.19	संकाय पदों के लिए चयन समितियों में सीनेट नामितों पर विचार करना। To consider Senate Nominees for the selection committees for faculty positions.	289
86.20	उन छात्रों को अनंतिम पी0एच0डी0 उपाधि प्रदान करने की पुष्टि किया जाना, जिन्होंने विभिन्न पाठ्यक्रमों में 30 नवम्बर 2020 से अब तक उपाधि प्राप्त किए जाने की अर्हता प्राप्त की है। To ratify the award of provisional Ph.D. Degrees certificate to the students who have completed the requirements for the award of Ph.D. Degree in various disciplines w.e.f. 30.11.2020 to date.	290-292
86.21	समूह "ए" शैक्षणिक पदों की चयन समितियों पर सीनेट के नामितों के पैनल के विस्तार को रिपोर्ट करना। To report the extension of panel of Senate's Nominees on the Selection Committees for Group 'A' Academic positions.	293
अन्य मुद्दे/ Under any other items		
86.22	एमबीए प्रोग्राम (2021-22) में विदेशी नागरिकों के प्रवेश पर विचार करना। To consider the admission of foreign nationals in MBA programme (2021-22).	294
86.23	ईटीई आटम सेमेस्टर 2020-21 की दूसरी परीक्षा में शामिल होने की अनुमति देने के लिए छात्रों की प्रार्थना पर विचार करना। To consider the request of the students to allow them to appear in the second examination of ETE Autumn Semester 2020-21.	295

**Item No. 86.12: To consider the proposal to start following M.Tech. programs by the Centre for Artificial Intelligence and Data Science (CAIDS).**

- 1. M.Tech. (Artificial Intelligence)**
- 2. M.Tech. (Data Science)**

The IAPC in its 98<sup>th</sup> meeting held on 03.02.2021 acknowledged the significance and need for research activities in the field of Artificial Intelligence and Data Science. The proposed academic matters in concept note and need for the establishment of Centre to run the said M.Tech. programs have been recommended in principle by the IAPC **(Appendix-A)**.

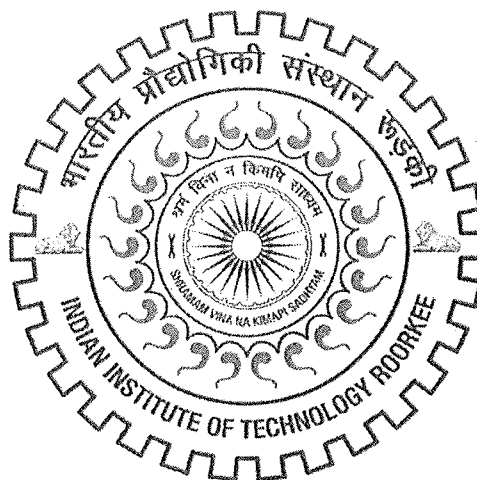
The IAPC suggested that the revised structure and syllabi for to be considered in the next meeting of the IAPC.

The above is submitted for the consideration and approval of the Senate.

# Concept Note

“Centre for Artificial Intelligence and Data Science”

“CAIDS”



INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

January 2021

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**A Proposal for**  
**“Centre for Artificial Intelligence and Data Science”**  
**“CAIDS”**

**Indian Institute of Technology Roorkee**

**Preamble**

The “Centre for Artificial Intelligence and Data Science” is a proposed virtual centre to organize and facilitate interdisciplinary research and teaching of Artificial Intelligence (A.I. ) and Data Science (DS) to address the overwhelming demand of A.I. and D.S. skills in research and industry across multiple disciplines. This collective venture is to be initiated with the establishment of two M Tech programmes - one in Artificial Intelligence and another in Data Science. It is also proposed that the Centre will offer Minor Specialization in A.I. and D.S. to UG students. The primary areas of research include application of A.I. and D.S. in computer vision, natural language processing, time series forecasting, big data, social network analysis, business intelligence, and in a number other fields of engineering and science.

The Centre will offer the M Tech Courses with collaboration from faculties from different Departments as well as from Industry. The CSE, ECE, EE and Mathematics Departments will initially contribute primarily for running the M Tech programmes at the Centre whereas other Departments such as CE, DoMS, Physics, Biotechnology, WRDM, etc. that are working in application of A.I. and D.S. in different disciplines will also participate in teaching of relevant Courses.

**Preliminaries**

What is A.I. ?

AI systems demonstrate the following behaviors associated with human intelligence: planning, learning, reasoning, problem solving, knowledge representation, perception, motion, and manipulation and, to a lesser extent, social intelligence and creativity.

What is D.S. ?

With an era of storage of Big Data at our doorstep, Data Science is the union of tools drawn from Mathematics, Statistic and Computer Science to process this Data by extracting meaningful insights from large and complex sets of data. Data Science is a blend of various

tools, algorithms, and principles, with strong mathematical and statistical basis, with the goal to visualize, discover, explain and predict hidden patterns from the raw data in an intelligent manner.

A.I. and D.S.

A.I. and D.S. have a non-empty intersection particularly in various tools like Machine learning, etc. However, the audience of A.I. is Computer Science, Mathematics, Electrical and Electronics, whereas the audience of D.S. includes not only the above but also business, finance, biotechnology. – and hence is much wider.

## **1. Background**

Artificial intelligence (A.I.) Technologies have seen tremendous growth in the last few decades. Across the world, the developed countries have been building up their A.I. capabilities to utilize large quantities of digital data and computing power abundantly available currently. The power of A.I. requires that people and intelligent technologies work together within and across nations.

Data Science (D.S.) is gaining popularity and importance not only in academics but also in the corporate world. It opens doors for research in diverse research specialization across science, engineering, business and finance with a view to solve real life problems. Industry is eagerly looking for new roles of Data scientists to fill the gap between number of opportunities and well qualified and trained personnel.

But India is not fully prepared to seize the enormous opportunities that A.I. and D.S. present. Even with a huge technical talent pool, renowned universities, big corporations in Indian markets, our country still lags in terms of A.I. According to some studies, A.I. has the potential to add US\$957 billion to India's economy in the next 15 years. By 2025, the global Artificial Intelligence market is expected to be almost \$60 billion. Global GDP will thereby grow by \$15.7 trillion by 2030. A.I. can increase business productivity by 40%. The number of A.I. start-ups grew 14 times over the last two decades. Investment in A.I. start-ups grew 6 times since 2000. Already 77% of the devices we use feature one form of A.I. or another.

To avoid missing out on the A.I. and D.S. driven opportunities, academia, policy makers and business leaders must work towards the A.I. revolution. The Neeti Aayog and Atma Nirbhar Abhiyaan in India presently lay a special focus to develop A.I. in the country. This will require Indian growth in following important dimensions:

- Intelligent automation of complex real work critical tasks
- Skill Enhancement and empowerment of Indian manpower
- Encouraging research and innovativeness

With all these goals, a Centre for A.I. and D.S. is proposed at IIT Roorkee. The Centre is perceived to evolve significant approaches for the study and application of A.I. and play a vital role in shaping the A.I. and D.S. landscape of the country by promoting teaching, training, manpower development, applied research, and entrepreneurship and innovation in the field of A.I. and D.S.

It will primarily be a multidisciplinary initiative with collective participation of engineers, scientists and researchers from different domains. The Centre will play a meaningful role in the areas such as – information technology, healthcare, transportation, electronics and communication, social well-being and social good such as joining the international cooperation network to share technology and research to achieve Sustainable Development Goals (SDGs) proposed by United Nations, earth science, business, etc.

The four Departments that contribute towards the primary activities related to A.I. include - CSE, ECE, EE and Mathematics and these are identified to contribute significantly initially to the M Tech Programmes proposed for the Centre for A.I. Various other departments at IIT Roorkee that are engaged in D.S. and applied A.I. research such as – Civil, Physics, Earth Science, Architecture & Planning, Mechanical, Metallurgy, Chemical, DoMS, WRDM, etc. may also participate in the teaching and research activities at the Centre.

## **2. Strengths of IIT Roorkee in A.I. and D.S.**

At IIT Roorkee, several faculty members are continuously engaged in A.I, Applied A.I., and D.S. research.

The core faculty to be associated with the proposed Centre for A.I. are listed as per Table 1:

S.No.	Name of Faculty	Department	Major A.I./ D.S. Research Area
1.	Abhishek Tiwari	MT	Discovery of novel functional materials combining machine learning and physics based simulations
2.	Alok Bhardvaj	CE	AI for Earth Observation, AI for Natural Disasters, AI for Geospatial Technology
3.	Durga Toshniwal	CSE	A.I. and ML, Data Mining and Big Data, Intelligent Transportation Systems, Natural Language Processing, A.I. for Earth Science Data, Deep Learning, Social Media Data Analysis, Data Privacy
4.	G. N. Pillai	EE	Machine Learning, Artificial Neural Networks and Learning Machines, Neural Architecture Search (NAS)
5.	Gaurav Dixit	DOMS	A.I. for Social Media & Internet Platforms, A.I. for E-Commerce, A.I. for Finance, A.I. for Supply Chain, A.I. for Operations
6	Kusum Deep	Maths	Nature Inspired Optimization, Soft Computing, Essential Mathematics for A.I.
7	Manoranjan Parida	CE	Design of Noise Barrier, Traffic Forecasting
8	Mayank Goswami	PHY	A.I. based Hardware and Software Designs for imaging applications.
9	Millie Pant	ASE	Numerical Optimization, Evolutionary Algorithms, A.I. assisted Decision Making, Image Processing
10	N. P. Padhy	EE	Soft Computing, Fuzzy Systems
11	R. Balasubramanian	CSE	A.I. in Computer Vision, A.I. in Image Processing
12	Raksha Sharma	CSE	Natural Language Processing, Machine Learning, Image Processing
13	Ravi Sharma	ES	3D reservoir property prediction, Seismic Inversion, Formation Evaluation, Remote Sensing and GIS, Geophysical Prospecting, Planetary Geosciences

14	Sanjeev Kumar	Maths	Applied Mathematics, Image Processing, Machine Learning
15	Sanjeev Manhas	ECE	Devices for Neuromorphic Computing, In memory computing
16	Shiladitya Sengupta	PHY	Statistical Physics
17	Sourajeet Roy	ECE	Statistical machine learning for uncertainty quantification of integrated circuits (ICs), Novel algorithm design for extremely fast training of ML metamodels in very high-dimensional spaces, ML based regression for uncertainty quantification of microwave devices and circuits, Sparse training algorithms for training ML metamodels for dynamic (time-varying systems)
18	Sparsh Mittal	ECE	A.I. on IoT devices, hardware accelerators for A.I. (e.g., FPGA/ASIC/GPU/CPU), A.I. on energy harvesting systems, A.I. on emerging memory using processing-in-memory

Table 1: Core Faculty to be associated with the Centre

Dozens of research papers have been already published in Journals and Conferences of repute and some of the recently most cited papers in A.I. and D.S. have been published by faculty and students of IIT Roorkee. Several research papers have also been published in the area of D.S. Numerous PhDs have been awarded in last five years in the topics related to A.I. and D.S. Besides this, many R&D Projects from external funding agencies such as – DST, SERB, Intel, Samsung, IBM etc. are going on or are completed by IIT Faculty in the area of A.I. and D.S. Further, many online Certification Courses in A.I. and D.S. are being offered by IIT faculty in collaboration with world renowned education agencies like – WileyNxt, Coursera, Times Learning etc. Some A.I. related subjects that are already being offered at UG/PG Levels include – Social Network Analysis, Digital Image Processing, Machine Learning, Information Retrieval, Data Mining and Warehousing, Computer Vision, Artificial Neural Networks and Applications, Soft Computing Techniques etc.

All these indicate that IIT Roorkee has sufficient foundation to consolidate these activities and to lead front ranking research and innovative activities in the area of A.I. and D.S.

### **3. Proposed Virtual Centre for A.I. and D.S.**

A virtual Centre for A.I. and D.S. is proposed to be set up at IIT Roorkee with the aim to eventually converge it into a physical Centre. The Centre will offer degree programmes in Artificial Intelligence (A.I.) and Data Science (D.S.). The departments that will significantly contribute initially to the M Tech programmes in the proposed Centre are – CSE, ECE, EE and Mathematics. Other Departments of IIT Roorkee that work in A.I. , Applied A.I. or Data Science and are also proposed to collaborate in the Centre include – CE, DoMS, Physics, etc.

### **4. Objectives**

- (i) To develop new and skilled manpower in the areas of A.I. and D.S.
- (ii) To empower existing manpower by offering focussed Trainings and Certifications in the area of A.I. and D.S.
- (iii) To promote research and consultancy in D.S. and A.I and Applied A.I. and D.S.
- (iv) To be at the forefront of providing technological support to national and international projects related to the growth of A.I. and D.S. at the national and international level.
- (v) To innovate in A.I. and D.S. and support the Make-in-India and Atma-Nirbhar initiatives of GoI by seeding entrepreneurship and start-ups in A.I. and D.S. .
- (vii) To create a resource centre for rapid D.S. and A.I information and knowledge dissemination.

### **5. Proposed Activities**

#### **5.1 Academic Degree Programmes and Online Certifications**

##### **5.1.1 Master of Technology Programme**

The proposed Centre for A.I. and D.S. will offer following two M Tech Programmes:

- M Tech in Artificial Intelligence (A.I.)
- M. Tech in Data Science (D.S.)

The details about the M. Tech. Schemes and admission eligibility are included as per Appendix 1 and Appendix 2.

### **5.1.2 PhD Programme**

PhD programmes will be undertaken in the identified areas in A.I. and D.S. and will be offered to aspiring and eligible students.

### **5.1.3 M Tech - PhD Dual Degree Programme**

The M Tech- Ph D dual degree programme will be open for meritorious M Tech students who aspire to obtain a Doctoral Degree in addition to the M Tech Degree in D.S. or A.I.

### **5.1.4 Minor Specializations for B. Tech. Programmes**

Minor specializations in A.I. and D.S. will be offered to B.Tech. students of the Institute. The details about the Minor Specializations are included as per Appendix 3 and Appendix 4.

### **5.1.5 Certification Courses**

Physical and online certification courses in D.S. and A.I. will be offered for working professionals, faculty and students of other institutes.

## **5.2 Research and Consultancy Activities**

### **5.2.1 Thrust Research Areas**

The identified Thrust Areas of the proposed Centre which are in lines with the current and future technological and socio-economic needs of the country are given as per those listed against the faculty names in Table 1.

### **5.2.2 Sponsored Research, Development Programmes and Consultancy Activities**

The proposed Centre will take up research and consultancy projects and R&D activities in the areas of Core and Applied A.I. and its applications in D.S. The potential funding sources include:

- DST

- SERB
- MeitY
- DAE
- Corporates with substantial interest in A.I. and D.S.

### **5.3 Implementation Mechanism**

#### **5.3.1 Joint Faculty Appointment**

To begin with, the faculty that have been identified as per Table 1, will be involved in the teaching activities of the M. Tech. and PhD Programmes at the Centre. The thrust areas are also listed as per Table 1. Other faculty members from the Institute who have expertise in D.S. or A.I. and are willing to participate in the Centre's teaching and research activities can also get associated with the proposed Centre.

The Virtual Centre will operate with Joint Faculty, the guidelines for which are enclosed as per Appendix 5.

#### **5.3.2 Engaging External Faculty / Experts from Industry**

Academia from foreign universities can be invited as Visiting or Adjunct Faculty to take up teaching assignments at the Centre. Industry experts can also be invited to teach few courses fully or partially at the Centre. Further, relevant courses at Senate approved online learning platforms such as NPTEL can also be utilized for the teaching requirements at the proposed Centre. Partnerships with reputed organizations involved in online executive certification courses and self-paced courses for working professionals can be utilized to augment the teaching activities at the proposed Centre.

#### **5.3.3 Support Manpower**

A minimal manpower consisting of - one Office Assistant, one Lab Technician and one ministerial staff will be required to take care of the day-to-day activities of CAIDS Virtual Centre.



### 5.3.4 Minimal Space Requirements

The Virtual Centre CAIDS is proposed to run in a minimal approximate space of **500 square metres** as per the following Table 2.

S.No.	Description	Sq. m
1	Office	50
2	HOD Room	50
3	M Tech Lab	80
4	Conference / Seminar Room	50
5	Lecture Hall 1	60
6	Lecture Hall 2	60
7	Lobby	80
8	PhD Scholars Lab	80
		510
	<b>Total</b>	<b>Approx. 500</b>

Table 2: Approximate Space Requirements

### 5.3.5 Operating Expenses - Recurring

A Centre Operating Cost of around ten lacs will be required to run the Virtual Centre. This will be utilized for meeting out the day-to-day expenses, maintenance of equipment, furniture, and other miscellaneous costs for smooth running of the Virtual Centre.

### 5.3.6 Development of Laboratory Infrastructure (Equipment/Furniture) – Non Recurring

The tentative costs for furnishing the Office areas, Lecture rooms and the Laboratories may be taken as follows in Table 3:

S.N.	Description	Approx. Cost in Lacs
1	Dept. Office	02
2	HOD Room	02
3	M Tech Lab	10
4	Conference / Seminar	05

	Room	
5	Lecture Hall 1	05
6	Lecture Hall 2	05
7	Lobby	01
8	PhD Scholars Lab	10
A	Total	40

Table 3: Approximate Costs

**B.** The tentative costs for computers/entry level workstations in the Office and the Laboratories may be calculated as:

2 Laboratories x 30 Machines @ One Lac per machine = Approx. 60 Lacs

**The grand total = A + B = 100 Lacs.**

### 5.3.7 Sponsorship and Funding

In addition to the support in form of Institute funds, efforts can be made to tap external funding agencies like the Mehta Foundation, USA, UNESCO, Ministry of Education, MeitY, and private organizations such as Microsoft, Google, IBM etc. to strengthen the proposed Centre.

## 6 . Projected Achievements

The unique nature of this proposed centre will allow interdisciplinary collaborations and cross-program intellectual capital expansion. A.I. and D.S. skill development would be the primary focus of the Centre. The generated talent pool is expected to make sufficient impact in research and industries so as to ensure continuous attraction of talented students and faculties towards the centre. Research publications, patents, start-ups etc. are some of the contributions expected from the Centre.

**Centre of Artificial Intelligence and Data Science (CAIDS)**  
**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
**Proposed M.Tech. in Data Science**

## **INTRODUCTION**

This proposal is related to starting a new M.Tech. Program in Data Science (DS) at IIT Roorkee. The proposal has been prepared by the committee constituted via letter no. ES(A) /I0070 /E-4759 dated October 15, 2020. This committee is having faculty members from multiple departments.

The necessity and justification of such a program at IITR for this proposal are as under:

- The Govt. of India expects IITs to generate their funds by initiating programs with a strong socio-economic impact. A full-fledged program in DS is one such course that can attract audiences from the various disciplines of science and engineering and be equally attractive to audiences from the industry and the corporate world (NEP 2020).
- The Govt. of India is encouraging research in fundamental science, which has an industry-academia liaison. With the concept of Big Data emerging in almost all scenarios, knowledge of Data Science is now necessary for a majority of projects. With a Centre dedicated to the study of DS, IITR can produce skilled and highly qualified personnel.
- DS is one of the latest “buzzwords” in the corporate world. It is important to keep pace with the current demands in cutting-edge technologies. With a course dedicated to DS, IITR will be keeping up with the current trends in the educational scenario.
- An on-campus MTech program will further pave the way for offering “BTech in DS” and self-financed “professional/executive (weekend) programs in DS” in future.
- Considering the growing trend and demand for expertise in DS courses, it is expected that IITR will attract motivated and brilliant faculty to join it.
- IITR is currently running many short term courses, FDPs, and executive courses on areas related to DS, and it is observed that such courses attract a lot of attention. This indicates the interest and demand for a full-fledged program in DS, which can be achieved by starting an M.Tech degree program in DS.
- The proposed M.Tech in DS will run under the umbrella of the proposed Centre for Artificial Intelligence and Data Science (CAIDS) – which plans to pool in a spectrum of faculty members from various departments, thus giving it a multi-disciplinary flavor.
- Many leading foreign universities worldwide offer DS programs, which are seen to be very popular among Indian students. Having a DS course provided by an eminent educational and research organization like IITR will be beneficial for the students who cannot afford to go abroad.
- Presently several CFTIs in India are running a DS program in various modes, including full-time/part-time/online/off-line/executive program courses. It is high time that IITR should also initiate a program on DS.
- After completing this course, a student will get a degree in “**Master of Technology in Data Science**”.

## **MARKETABILITY AND EMPLOYABILITY OF THE STUDENTS**

- With tons of data being generated in each and every sector of the society and with a growing need of analyzing that data to decide a future course of action, a Master's degree in DS is the need of the hour from the viewpoint of employability and marketability in different sectors of the society.
- Academically, there are very few organizations that offer a PhD degree in DS. A Master's degree in DS will be a launchpad for a PhD degree in DS.
- There is a gap between the demand and supply of DS experts, especially in India. Undergraduate and even graduate courses are too generic for addressing issues in the DS area in a focused manner.
- Generally, most entry-level DS jobs demand a bachelor's degree in Mathematics/Statistics/Computer Science/Information Technology. However, senior-level job roles (managerial/administrative or R&D roles) require a candidate to have a master's degree or a Ph.D. in the fields mentioned above or any other related field (Engineering).
- Most of the companies coming for recruitment look for candidates with an expertise in DS. In fact several of the highest-paying companies are DS based.

## **PROPOSED COURSE STRUCTURE (CURRICULUM): SEE ANNEXURE-**

## **ADMISSION CRITERION**

- The candidate should have either a B.Tech./B.E. degree in any engineering discipline, a BS degree in Mathematics and Computing, or a five year Integrated MSc degree in Mathematics or equivalent. The candidate must have a valid GATE score.
- The initial screening will be done on the basis of GATE score (or ranking). To further shortlist the candidates a written test and/or an interview will be conducted by the center.
- The proposed number of seats is 15 for the M.Tech (DS) Program, open to all branches.

**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
**Proposed M.Tech. in Data Science**

**Program Code** : TBD  
**Centre** : CAIDS  
**Year** : I

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>Autumn Semester</b>														
1.	TBD	Mathematics for DS	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2.	TBD	Principles of Database Systems	PCC	4	3	0	2	3		15-30	20	15-25	30-40	-
3.	TBD	Machine Learning	PCC	4	3	0	2	3		15-30	20	15-25	40	-
4.	TBD	Data Structures and Algorithms	PCC	4	3	0	2	3		15-30	20	15-25	40	-
5.	TBD	Programming for DS	PCC	2	0	0	4	0	2	-	25	25		50
6.	TBD	PEC-I	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
<b>Total</b>				<b>22</b>	<b>15</b>									
<b>Spring Semester</b>														
1.	TBD	PEC-II	PCC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
2.	TBD	PEC-III	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
3.	TBD	PEC-IV	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
4.	TBD	PEC-V	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
5.	TBD	Project in Data Science	PCC	2								30	70	
6.	TBD	SEMINAR	PCC	2	0	0	0	0	0			30	70	-
<b>Total</b>				<b>20</b>	<b>-</b>	<b>-</b>	<b>-</b>							
<b>The contact hours, exam duration and relative weight of PEC will be as per the respective course nature and syllabi</b>														

Centre : Artificial Intelligence and Data Science (CAIDS)

Year : II

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Autumn Semester														
1.	TBD	Dissertation Stage-I	PCC	12										
Total				12										
Spring Semester														
1.	TBD	Dissertation Stage-II	PCC	18										
Total				18										

There are two baskets for electives: “Core DS” and “Applications of DS”. A student needs to take 5 electives, of which, at least two electives should be from the Core DS basket and at least two electives should be from the Applications of DS basket.

B1:LIST OF CORE DS ELECTIVES			B2:LIST OF DS APPLICATIONS ELECTIVES		
S. No.	Course Title	Concerned Department	S. No.	Course Title	Concerned Department
1.	Data Visualization	CSE/DOMS	1.	Multi-Objective and Multi-Criteria Optimization	MATHS/ASE
2.	Deep Learning	DOMS/CSE/MATH	2.	Business Analytics	DOMS
3.	Nature-Inspired Optimization Techniques	MATHS/ASE	3.	Blockchain Technology	CSE/DOMS
4.	Natural Language Processing	CSE/DOMS	4.	Graphs Algorithms for Data Science	MATHS/CSE
5.	Operations Research	MATHS/ASE/DOMS	5.	Internet of Things	CSE/ECE
6.	Data Mining and Warehousing	CSE/DOMS/MATHS	6.	Parallel and Distributed Computing	CSE/MATHS/EE
7.	Statistical Inference	MATHS/ASE/DOMS	7.	Data Science in Health Care	DOMS/ASE/MATHS
8.	Soft Computing	MATHS/ASE/EE	8.	Data Science in Earth Science	ES

9.	Time Series Data Analysis	CSE/DOMS/MATHS	9.	Data Science in Bioinformatics	BT
10.	Spreadsheet Modeling and Simulation	DOMS/MATHS/HSS	10.	Data Science in Society	HSS/DOMS
11.	Cyber Security	CSE/ECE	11.	Decision Making through Data Science	ASE/DOMS/CSE/EE
12.	Bayesian Methods of Data Analysis	DOMS/MATHS	12.	Pattern Recognition	CSE/ECE
13.	Advanced Topics in Data Processing	CSE	13.	Social Network Analysis	DOMS/CSE
14.	Ethics in Data Science	ASE/DOMS	14.	Leveraging Data Science for Finance	DOMS
15.	Reinforced Learning	EE/CSE	15.	Data Science for investment	DOMS
16.	AI Strategy	DOMS	16.	Recommender Systems	CSE/DOMS
			17.	Image and Video Analytics	CSE/MATHS

**M.Tech. Thesis guide selection:** First supervisor has to be from the Center and second supervisor (if at all) may be from any other department (even if he is not a part of the Center). Joint supervisor from industry is also welcome.

### **MTech in Artificial Intelligence**

This is a proposal to start a new MTech Program in Artificial Intelligence (AI) at IIT Roorkee with an intake of **15** seats. The proposal has been prepared by the committee constituted via letter no. ES(A)/I0070 /E-4759 dated October 15, 2020. This committee is having faculty members from multiple departments.

The necessity of such a program at IITR campus along with some other points to justify this proposal are given as follows:

- ☐ As the government pushes IITs for generating their own funds, starting economically viable and popular programs is imperative, not just optional.
- ☐ Government is spending big on AI-related projects such as smart-city. We need skilled manpower to project IITR for getting funding from these projects.
- ☐ With recent hike in MTech fee, the MTech programs which don't attract students have to be closed. So, we cannot stick with old streams.
- ☐ Starting an on-campus MTech program will pave the way for offering "BTech in AI" and "professional (weekend) programs in AI" in future. It will also help us attract top faculty.
- ☐ IITR is already running short-courses, FDP etc. on AI. Short-nature of course is insufficient to train a student from bottom-up. There is a scope for more.
- ☐ We propose the MTech in AI to be jointly offered by the proposed center for AI, which has faculty members from multiple departments, so it will be a multi-disciplinary program.
  - ☐ Other IITs/IIITs/NITs have already launched such programs in the recent past.
- ☐ Many foreign universities also offer such online programs and they are in high-demand by Indian students.
- ☐ After completion of this course, a student will get a "**Master of Technology in Artificial Intelligence**" degree.

### **Marketability and Employability of the Students**

- ☐ There is a gap between the demand and supply of AI scientists and technologists, especially in India. Undergraduate and even graduate courses are too generic for addressing issues in AI area in a focused manner.
- ☐ Generally, most entry-level AI jobs demand a bachelor's degree in Mathematics/Statistics/Computer Science/Information Technology. However, senior-level job roles (managerial/administrative or R&D roles) require a candidate to have a master's degree or a PhD in the fields mentioned above or any other related field (Engineering).



- ☐ According to a 2018 report by Indeed [<https://www.hiringlab.org/2018/03/01/demand-ai-talent-rise/>], the need for AI skills has more than doubled in the past three years, with job postings in the domain going up by a whopping 119%.
- ☐ According to a study by Analytics India Magazine in collaboration with Great Learning, “over 4,000 positions in India remain vacant due to shortage of qualified talent at the mid and senior level.” [<https://www.upgrad.com/blog/artificial-intelligence-salary-india-beginners-experienced/>]
- ☐ Most companies coming for recruitment ask for AI expertise. The highest paying companies are all AI-based.

### **Admission Eligibility**

- ☐ The candidate should have a BTech/BE degree in Computer Science and Engineering/Electronics and Communication Engineering/Electrical Engineering/other disciplines or equivalent. The candidate must have a valid GATE score in his respective discipline.
- ☐ The initial shortlisting will be done using the GATE score (or ranking).
- ☐ There will be a written-test and/or interview for the shortlisted candidates.
- ☐ The proposed distribution of seats are as follows:

S. No.	Qualifying Discipline	Intake
1	BTech/B.E. in CSE/IT or equivalent	4
2	BTech/B.E. in ECE or equivalent	4
3	BTech./B.E. in Electrical Engineering or equivalent	4
4	BTech./B.E. in any other Engineering/Science disciplines other than S.No. 1, 2 and 3 or equivalent	3
TOTAL		15

**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
**Proposed M.Tech. in AI Structure**

Program Code : TBD  
 Centre : CAIDS  
 Year : I

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PR E
<b>Autumn Semester</b>														
1.	TBD	Advanced Data Structures and Algorithms	PCC	4	3	0	2	3	0	15-30	20	15- 25	30- 40	-
2.	TBD	Essential Mathematics for AI	PCC	4	3	1	0	3	0	25-30	0	25-30	40-50	-
3.	TBD	Machine learning	PCC	4	3	0	2	3	0	15-30	20	15- 25	30- 40	-
4.	TBD	Hardware architecture for AI	PCC	4	3	0	2	3	0	15-30	20	15- 25	30- 40	-
5.	TBD	Programming for AI	PCC	2	0	0	4		2	-	25	25		50
6.	TBD	PEC-I	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
<b>Total</b>				<b>22</b>										
<b>Spring Semester</b>														
1.	TBD	PEC-II	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
2.	TBD	PEC-III	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
3.	TBD	PEC-IV	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
4.	TBD	PEC-V	PEC	4	3	1/0	0/2	3	0	25/15-30	0/20	25/15-30/25	40/30-50/40	-
5.	TBD	AI project	PCC	2								30	70	
6.	TBD	Seminar	PCC	2								30	70	
<b>Total</b>				<b>20</b>										
<b>The Contact Hours, Exam Duration, Relative Weight of PEC will be as per course nature (3+1+0 or 3+0+2) and respective detailed syllabi</b>														

Centre : CAIDS

Year : II

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
<b>Autumn Semester</b>														
1.	TBD	Dissertation Stage-I	PCC	12										
<b>Total</b>				<b>12</b>										
<b>Spring Semester</b>														
1.	TBD	Dissertation Stage-II	PCC	18										
<b>Total</b>				<b>18</b>										

There are two baskets for electives: "Core AI" and "Applications of AI". A student needs to take 5 electives, of which, at least two electives should be from the Core AI basket and at least two electives should be from the Applications of AI basket.

B1:LIST OF CORE AI ELECTIVES			B2:LIST OF AI APPLICATIONS ELECTIVES		
S. No.	Course Title	Concerned Department	S. No.	Course Title	Concerned Department
1.	Reinforcement Learning	DOMS/CSE/EE	1.	Medical Physics for AI	PH
2.	Deep Learning	DOMS/CSE	2.	Statistical Machine Learning for Variation-Aware Electronic Device and Circuit Simulation	ECE
3.	Nature Inspired Optimization Techniques	MATHS/ASE	3.	Introduction to Machine Learning Regression for Electronic Design Automation	ECE
4.	Natural Language Processing	CSE/DOMS	4.	Materials Informatics	MME
5.	Numerical Optimization	MATHS/ASE	5.	Internet of Things	CSE
6.	Convex Optimization in Machine Learning	MATHS/ASE	6.	VLSI architectures for AI in CMOS technology	ECE
7.	Data Mining and Warehousing	CSE/DOMS	7.	Speech Processing	CSE
8.	Data Stream Processing	CSE	8.	AI for Earth Observation	Civil+PH

9.	Digital Image Processing	CSE/EE/MATHS	9.	Application of AI in physics	PH
10.	Fuzzy Systems and its Applications	EE/MATHS	10.	AI in decision making	DOMS
11.	Time Series Data Analysis	CSE/DOMS	11.	Pattern Recognition	CSE
12.	Neuromorphic computing with emerging memories and architectures	ECE	12.	Social Network Analysis	CSE
13.	Introduction to Compressive Sensing	ECE	13.	Game Theory	CSE/MATHS/DOMS
14.	Stochastic & Randomized Processes	ECE/MATHS/ASE	14.	AI for investment	DOMS
			15.	Computer Vision	CSE/MATHS

**M.Tech. Thesis guide selection:** First supervisor has to be from the center and second supervisor (if at all) may be from any other department (even if he is not a part of the CAIDS). Joint supervisor from industry is also OK.

**Item No. 86.13: To consider the proposal to start following Master Programs:**

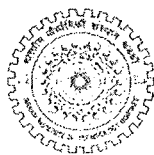
- 1. M. Des. (Industrial Design)**
- 2. MIM (Masters in Innovation Management)**

The IAPC in its 86<sup>th</sup> meeting, held on 09.06.2020, considered and recommended the proposal with minor modifications **(Appendix-A)**.

The above is submitted for the consideration and approval of the Senate.

A proposal on  
Establishment of a  
**Department of Design and Innovation**  
(DoDI)  
at  
IIT Roorkee

**CONCEPT PAPER**



Indian Institute of Technology Roorkee  
Roorkee – 247 667  
2020

## PREAMBLE

Education in Design enables the students to empathize the needs of people and to develop useful products to solve the problems related to human being and the society. In recent time, need of design professionals is on the rise due to the cutthroat competitions among the industries to launch innovative products to enhance the customer base. Various courses/departments/centers were established by different institutes of global repute world-wide to cater skilled professionals to fulfil the industrial needs. In the last few years, awareness about design and innovation has been leapfrogging in India due to various research programs conceptualized and initiated by the Government of India. In the year 2014, Ministry of Human Resource Development launched a scheme called 'National Initiative for Design Innovation' (NIDI) to boost design-centered innovation in the country with a motive to enhance the value chain, making Indian industry globally competitive. In order to realize the initiative, twenty Design Innovation Centres (DICs), one Open Design School (ODS) and a National Design Innovation Network (NDIN) have been established in the country. The prime objective of these centers, schools and the network is to ensure maximum reach of design education and practice in the country through various collaborative education programs (linking a broad spectrum of educational institutions), and free sharing of its courseware through the Internet. Under the scheme, Indian Institute of Technology Roorkee (IIT Roorkee) was awarded a DIC as the Hub Institute in May 2018 which was formally launched on September 17, 2018. The center is actively involved in continuing the saga of knowledge exchange among the well-known experts, young innovators and common man by providing a common platform for effective utilization of the available resources and addressing various issues associated with farmers and common man in the region around the institute, especially in the Himalayan region. The center proposed to run Elective Courses and two Masters Programs to impart design education and to develop manpower in the area of industrial design and innovation management.

IIT Roorkee has participated in such initiatives in the past to contribute in the growth of the nation as well as improving its own resources for quality education and research. The institute has been in the forefront in conceptualizing and executing many national projects for the nation and human being. The institute has the legacy of excellence in the diverse fields of technologies for addressing the issues related to social, environmental, elderly and physically disable people. In the recent years, the institute has established a number of Centers of Excellence and advanced research facilities to foster research among the students and faculty members. Keeping these in view and the existing strength of IIT Roorkee, there is a proposal to create a Department of Design and Innovation (DoDI) to sustain the activities of the DIC, to develop academic research programs in this area, to train manpower in a specific area, and to create a Design and Innovation culture in the society. Therefore, it was recommended at different fora (including an Institute Committee constituted for the purpose) that the faculty members engaged/working in the related areas be brought at one platform to further strengthen and enhance the outputs in a focused manner. In order to realize establishment of an appropriate platform – a Centre for Excellence in Design (CoED), a Core Group of eighteen Faculty Members from different Departments/Centers of the institute was formed. The Group deliberated at length on the relevance and operational aspects of the proposed platform. The Committee on CoED unanimously recognized the operational difficulties associated with an academic Centre and opined towards launching the new academic programs through a potentially more stable platform in the form of a Department; the concept was later strongly echoed by domain experts from IISc, IITs, NID and Industries in the 'Workshop on Academic Curriculum Development' organized by the DIC to develop the curricula of the proposed masters programs. The present Concept Paper has emerged from these deliberations.

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**ANNEXURES – I, II, III and IV**



## 1. BACKGROUND

Established in the year 1846, Indian Institute of Technology Roorkee (IIT Roorkee) is an institute of national importance. The Institute has twenty two academic departments covering engineering, architecture & planning, applied sciences, humanities and social sciences, and management programs, two academic centers and two centers of excellence. In the recent years, the institute has realized the need of a common platform which can accelerate the saga of knowledge exchange among the well-known experts, young innovators and common man in the domain of Design and Innovation. Accordingly, in order to promote design-centered innovation, the National Initiative for Design Innovation (NIDI) scheme of the Ministry of Human Resource Development (MHRD) was targeted. Under this initiative of the MHRD, twenty Design Innovation Centers (DICs), one Open Design School and a National Design Innovation Network have been established in India. The establishments under this scheme would raise the standards of design education and innovation in the country through various initiatives including the creation of fabrication labs and digital media zones across educational institutions. IIT Roorkee, being known for its contributions towards the national causes, submitted a proposal to set up a DIC under the NIDI scheme of the MHRD, Government of India. The Institute was awarded the DIC in the month of May, 2018 and the center was launched on September 17, 2018 as a Hub Institute with three other promising Institutions of the region – NIT Uttarakhand, IIM Kashipur and College of Technology, G B Pant University of Agriculture & Technology, Pantnagar as the Spokes. The center is thriving for developing design and innovation as a culture while primarily addressing the relevant problems of the Himalayan region, in particular, and other national priority areas in general. Apart from various outreach and research activities, the DIC has proposed two Masters Programs – M. Des. (Industrial Design) and MIM (Innovation Management) and development of a few elective courses related to design and innovation to the MHRD. The Institute has a pool of experienced as well as talented faculty members and researchers in the proposed area. The Institute has been offering number of UG and PG courses on Design and Innovation through different Departments and Centers. It is, therefore, proposed to provide a common platform to the faculty members working in the related areas to further strengthen and enhance this outputs in a focused manner. Thus, the Institute finds it apt to propose a Department of Design and Innovation (DoDI) to initiate the academic activities committed to the MHRD by the DIC for developing specialized professionals in the areas of design and innovation.

## 2. VISION AND OBJECTIVES

### 2.1 Vision

To evolve as a unique entity focusing on design and innovation culture based on human-environment engagement in collaborative partnership with society, industry and other stakeholders.

### 2.2 Objectives

The basic objectives of establishing a DoDI at IIT Roorkee is to:

- To create a culture of innovation and creative problem solving.
- To impart design based education and to create an ambience of systematic design practice.
- To facilitate interdisciplinary design-focused education, research and entrepreneurial activities with a focus to create commercial opportunities.
- To develop Documentation and Archival Repository of Design Innovation practices at grass-root level.
- To build an environment of handshaking between academia and the industry to address the relevant societal issues through co-creation and their transformation into products.

## 3. PROPOSED ACTIVITIES

### 3.1 Research

#### *a. Identified Areas of Research*

The DoDI will be involved in multi-disciplinary research activities; a few identified areas with expected participating departments/centres are given in Table. 1. These areas are in line with the innovative product development for societal and human needs.

Table 1: Potential Areas of Research

S. No.	Areas of Research	Participating Departments
<b>Short Term</b>		
1	Product Design	AP, MIE, MS, PT, PPE, CE, CTRANS
2	Rapid Prototyping	MIE, MME, PHY, PPE
3	Graphic Design	AP, CSE, MS
4	Product Styling and Perception	AP, HSS, CSE, PT, PPE
5	Product Innovation	MIE, MS, MME, ECE, EE, CE
6	Design Strategy and Management	MS, AP, MIE, CE, EQE
7	Human-Computer Interaction	CSE, ECE, MS, MATH, HSS
8	Computer Aided Design	MIE, CSE, CE, EE, AP, ECE
9	Space Design	AP, CE, CTRANS, MS, MIE ECE
10	Systems Design	CSE, ECE, EE, CE, MIE, MATH
11	Visual Cognition	AP
12	Ergonomics	AP, MIE, MS
13	Design for Society	MS, MIE, HSS, AP
14	Mobility Design	CSE, ECE, EE, AP, CTRANS, CE, MIE
15	User Centered Design	AP, MS, MIE
16	Animation	CSE, AP
17	Automotive Design	MIE, AP
18	Product form and Aesthetics	AP, MS
19	Environmental Design	CE, EQE, ES, CHE, ASE, HYDRO, CoEDMM, HRE, WRDM
20	Nature of Materials and Processes	CE, MIE, MME, CHE, CHEM, PHY, PT, CN, PT
21	Material and Manufacturing	CE, MIE, MME, CHE, CHEM, PHY, PT, CN
22	Harnessing Green Energy	HRE, WRDM, MIE, CE, EE
23	Industrial Design	MIE, CE
24	Facility Design	MIE, MS
25	Design for Disabled	MIE, BT, AP, CoEDMM
26	Bio-Inspired Design	AP, BT, MIE, CE, CN
27	Medical Product Design	AP, BT, MIE, CE, CN
28	Energy Storage Devices	MIE, MME, EE, CE
29	Web Programming	CSE, AP
30	Innovation Management	MIE, MS
31	Marketing of Innovation	MS, HSS
32	Human Centric Supply Chain	AP, MIE, MS
33	Data Analytics	CSE, MATH, MS
<b>Long Term</b>		
1	Digital Film-Making	AP, MS, HSS
2	Participatory Innovation	MS, AP, HSS
3	Innovation Knowledge Network	AP, MS, HSS
AP – Architecture and Planning, ASE – Applied Science and Engineering, BT – Biotechnology, CHE – Chemical Engineering, CHEM – Chemistry, CE – Civil Engineering, CSE – Computer Science and Engineering, EQE – Earthquake Engineering, ES – Earth Sciences, EE – Electrical Engineering, ECE – Electronics and Communication Engineering, HSS – Humanities and Social Sciences, HYDRO – Hydrology, MS – Management Studies, MATH – Mathematics, MIE – Mechanical and Industrial Engineering, MME – Metallurgical and Materials Engineering, PT – Paper Technology, PPE – Polymer and Process Engineering, PHY – Physics, WRDM – Water Resources Development and Management, HRE – Hydro & Renewable Energy, CN – Centre of Nanotechnology, CoEDMM – Centre of Excellence in Disaster Mitigation & Management and CTRANS – Centre for Transportation Systems		

### ***b. Ph.D./Post-Doctoral Program***

Ph. D. /Post-Doctoral Programs will be undertaken in the identified areas of the research. The bright and dedicated candidates will be admitted in the program as per the admission procedure of the institute. The candidates having research funding/scholarship from the funding sources such as DST, CSIR, UGC etc. will be allowed to take admission as per the norms of the institute.

### ***c. Sponsored Research and Development Programs and Consultancy Activities***

The sponsored research and consultancy projects will be undertaken in the related areas of the DoDI. There is a scope of potential funding from various Ministries/Departments of Government of India, Industries, and Organizations for Research & Development and Consultancy in Product Innovation. Some of the funding sources are below –

- *Government organizations/agencies of India:* Ministry of Human Resource and Development, Department of Science and Technology, Ministry of Urban Development, Airports Authority of India, Ministry of Railways, Ministry of Health, Council of Scientific & Industrial Research, Ministry of Culture, Technology Information Forecasting & Assessment Council, Digital India Corporation, Ministry of Textiles, Indian Space Research Organization, Defense Research and Development Organization, Electronics Corporation of India Limited, Ministry of Electronics and Information Technology, Ministry of Communications & Information Technology, Department of Biotechnology, All India Council for Technical Education etc.
- *Private organizations/agencies:* Dassault Systems, Microsoft Research, Nokia, Samsung Electronics, LG Electronics, Microsoft, Bill and Melinda Gates Foundation, Honeywell Corporation, Yahoo, IBM Research, Reliance, Hindustan Lever Research Centre etc.

## **3.2 Teaching Programs**

Two Masters Programs – M. Des. (Industrial Design) and MIM (Master in Innovation Management) are proposed to run from July 2020. The course structures of the proposed masters programs were debated in an interdisciplinary institute committee comprising faculty members of departments – Department of Architecture and Planning, Department of Electronics and Communication, Department of Management Studies and Department of Mechanical and Industrial Engineering after receiving inputs (Annexure - I) from their respective Departmental Faculty Committees (DFCs). The committee resolved that a workshop including experts in the area of Design should be organized to finalize the program structures/courses/syllabi of the proposed Masters Programs. Accordingly, a workshop on Curriculum Development was organized during December 6-7, 2019. Design experts from industries (including Vice President, Dassault Systems, President, Catalign Innovation Consulting, Senior Design Director and Strategic Design Director, Designit, Co-founder, Zenatix Solutions Pvt. Ltd. and Co-founder, Log9 Materials) and academia (including Chairperson, CPDM, IISc Bangalore, Heads, Department of Design (IIT Hyderabad, IIT Guwahati, IIT Delhi (through Skype)), faculty members from IIT Kanpur, IIT Guwahati, NID Ahmadabad and IIT Roorkee) participated in the workshop. Deliberations were carried out on the structures and courses of M Des and MIM programs in various sessions chaired by Associate Dean of Academic Affairs (Curriculum), Associate Dean of Academic Affairs (Evaluation), Associate Dean of Academic Affairs (Admission), Heads of Dept. of Mechanical and Industrial Engineering and Dept. of Electronics & Communication Engineering. The structures and courses were finalized and presented to the Director, IIT Roorkee during the valedictory session. The following are the outcomes of the workshop –

### ***3.2.1 Admission Procedure***

The following eligibility criteria and admission procedures will be adopted for admission (Table 2).

Table 2: Admission Proposed Master Programs

S. No.	Program	Number of seats	Eligibility Requirements	Eligibility Test
1.	M. Des. (Industrial Design)	20	Four-year Graduate Degree in any discipline with Mathematics as one of the subjects in 10+2.	Valid CEED/GATE score, followed by Aptitude Test (AT) and Personal Interview (PI)
2.	MIM (Master in Innovation Management)	20	Graduate Degree in any discipline with post-degree experience of 5 years	Valid CAT/GMAT/GATE score, followed by Group Discussion (GD) and Personal Interview (PI)

### 3.2.2 Program Structures

The draft program structures of Masters Programs in M. Des. (Industrial Design) and MIM (Masters in Innovation Management) finalized during the workshop are given in Annexure – II.

### 3.2.3 Syllabi of Courses and Instructors

The final courses, syllabi and potential instructors for the Proposed Masters Programs (M. Des. and MIM) are given in Annexure – III.

### 3.3 Training Program

It is proposed to organize Training Programs as well as specialist courses to train the manpower in various specialized areas of Design, Innovation, Intellectual Property Rights and related areas. Different academic institutes, research organizations, industry and NGOs will be approached directly/through Placement and Internship Cell, IIT Roorkee for possible training of the Masters Students.

## 4. STRENGTH OF DoDI

The proposed DoDI will have the following resources/facilities developed/being created by DIC, IIT Roorkee –

- Financial Support** – DIC has received financial support rupees ten crores (including one third share of spokes) from the MHRD, Government of India and the end date of the project is March 31, 2020.
- Laboratory and Office Space** – A 6400 Sq. feet space in ground floor and mezzanine of Hafiz Mohd. Ibrahim Building, IIT Roorkee has been allotted for DIC. Laboratories, offices and other relevant infrastructure which may be developed in tune with the requirements of the DoDI.
- Organizational structure** – A well-defined organizational structure including the Coordinators, Co-coordinators, and Project Monitoring Committee is functional under the mentorship of Dean SRIC, IIT Roorkee. One Coordinator & PI, DIC, two Co-coordinators and two Co-PIs are already looking after the activities of the DIC.
- Manpower** – Three Project Officers, one Office Attendant and three JRFs are working presently, the JRFs are registered in different departments under DIC Ph. D. Fellowship.
- Equipment** – Some laboratory equipment have been proposed in the DIC to improve research facilities in the institute. Purchasing of a Coordinate Measuring Machine (CMM) and two workstations has been initiated by the DIC as per institute rules through Material Management Department. Necessary office set-up including desktops, printer, stationary etc. has been created. Budgeted money is also available to create a fabrication laboratory; which is under process.

**f. Proposals for collaboration** – Some organizations such as Dassault System, BOSCH and Lucerne School of Engineering and Architecture are willing to collaborate with DIC for Masters Programs and future research work.

**g. DIC Activities (Ongoing/proposed)**

Some of the Design and Innovation centric activities which are being organized by the DIC are presented in Annexure – IV.

## **5. REQUIREMENT OF FACULTY MEMBERS AND STAFF**

For smooth functioning of DoDI activities, the following manpower will be required –

### **5.1 Faculty Members**

The DoDI will be needing eight dedicated faculty members having Ph. D. in the areas – Design, Engineering, Architecture, Management and Humanities/Social Sciences for conducting the teaching and research activities apart from joint/associated faculty members from other Departments/Centers. Requirements of the DoDI will be assessed from time to time and Professors, Associate Professors, Assistant Professor need to be appointed as per the institute rules on regular/contract/deputation/visiting terms. Faculty Members in different departments who have interest in the research activities of the department may be transferred and/or appointed as Joint Faculty as per the institute norms.

### **5.2 Technical/Office Staff**

In the proposed DoDI, the staff requirement will be as follows on the basis of minimum need –

- a. Technical Staff (04)
- b. Office superintendent (01)
- c. Office attendant (01)

### **5.3 Research Staff**

JRF/SRF/Research Associate/Post-doctoral candidates under CSIR/UGC/DST/Institute schemes will be attracted to join the research programs of the Department. In addition to the above, M. Tech. /Ph. D. Fellowships will also be sought from the different sponsors.

## **6. EQUIPMENT AND BUILDING SPACE**

### **6.1 Laboratory Requirement**

Some of the requirement and specifications of the major equipment have already been identified and steps are underway for their procurement. Other laboratory infrastructure available with the Departments/Centers – Architecture and Planning, Biotechnology, Chemical Engineering, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Electronics and Communication Engineering, Humanities and Social Sciences, Management Studies, Mechanical and Industrial Engineering, Metallurgical and Materials Engineering, Centre of Excellence in Disaster Mitigation & Management (DoEDMM) and Centre for Transportation Systems (CTRANS) will be used as per availability for research and teaching activities. Additionally, facilities available with other central facilities such as Mahatma Gandhi Central Library, Continuing Education Centre (CEC), Institute Computer Centre (ICC), Institute Instrumentation Centre (IIC) and Rethink! The Tinkering Lab shall also be used to maintain synergy among them. Additionally, as discussed in the Academic Curriculum Workshop, the Department will need the following infrastructure to start teaching, research, laboratory and studio activities –

- a. Books (approximately, 100)
- b. Journals (approximately, 10)
- c. Workshop Facilities including –
  - Cutters (thermacol and laser cutters)
  - Workstations: High end Mac Pros (10), Windows based systems (10)
  - Wacom digital Tabs (5)

- I-pads (5)
- d. Digital scanners (2)
- e. Digital Printers (Inkjet: 2 and Laser: 2)
- f. Basic tools and furniture for workshop
- g. Display panels and boards (8)
- h. Digital camera (DSLR: 5)
- i. LCD Projectors (5)

## 6.2 Building Space

An area of 6400 Sq. feet (ground and mezzanine floor) is allotted to DIC in Hafiz Mohammad Ibrahim building. Apart from this allotted space; additional need based space for laboratory(s), faculty, research scholars, library, conference/committee/seminar room, class rooms etc. need to be allocated by the institute.

It is proposed that the MIM program will be run at the Greater Noida Extension Center, IIT Roorkee.

## 7. FINANCIAL REQUIREMENT

The financial requirements, recurring and non-recurring, need to be met by the institute. However, some recurring expenses for laboratory/research/supporting staff as well as research related activities (such as, laboratory field studies and computational facilities etc.) will be met from the sponsored projects.

## 8. LONG-TERM PLANS

The DoDI will work on the following long-term plans to sustain –

### 8.1 Development/Growth Projection

The financial support model for the proposed DoDI is divided into two phases : Phase – I (Fig. 1a) will be a formative phase with support from the MHRD (funding for DIC) and Phase – II (Fig. 1b) will be a grown up stage partial/without support of the MHRD (funding for DIC). The DoDI would be receiving support from the MHRD for conducting DIC activities. However, it will need support from IIT Roorkee during its formative phase. It is understood that the Institute shall provide the basic infrastructure including faculty members, land, building and power. However, as the center would grow, it will try to generate revenue through the services provided (although ‘as is’ basis, i.e., no-profit-no loss), through the licensing/selling of probable IPR, if any, consultancy, funding from other agencies, training and skill development programs etc. Thus, financial dependency of the center on MHRD and the Institute will drop significantly.

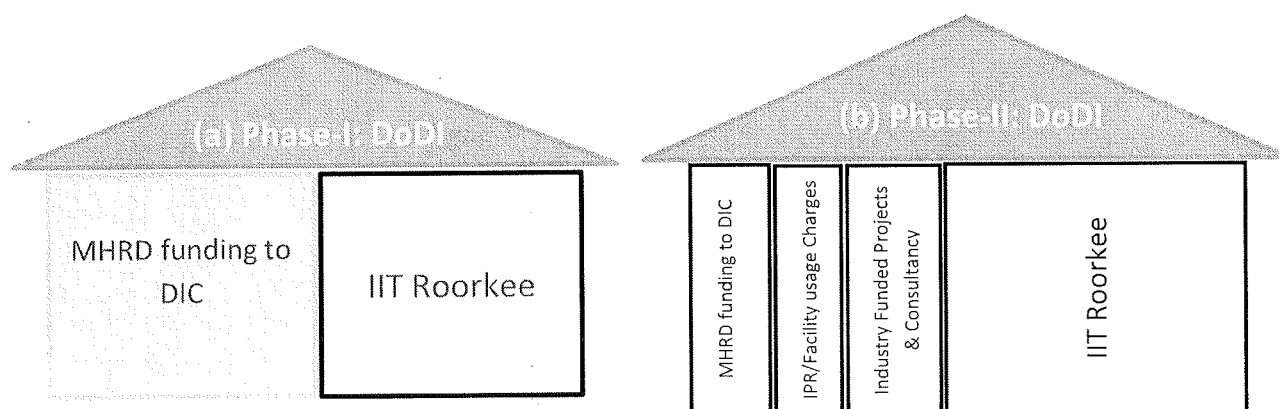


Fig. 1: Financial support to DoDI in (a) Phase – I and (b) Phase – II

The center will be an integral part of the IIT Roorkee. It is proposed to generate the resources through following ways –

**a. Fellowship for M. Tech. and Ph. D. Program**

Apart from Institute funding, Funding agencies such as DST, UGC, CSIR etc. shall also be approached for award of fellowships to Master students and Ph. D. research scholars.

**b. DST will be approached for funding in the FIST Program.**

**c. Sponsored R&D and Consultancy Projects**

The concerned ministries (Planning Commission, MHRD, Urban development, DST etc.) will be approached for granting funds for R&D Projects.

**d. Establishment of Professional Chairs**

The DoDI will approach relevant funding agencies and alumnus of IIT Roorkee for creating Professional Chairs.

Based on the contributions made by DoDI in R&D and Consultancy projects, it is expected that the proposed DoDI would generate funds through R&D and Consultancy Projects for its long term sustainability.

## **8.2 Future Programs and requirements**

The Department will start B. Des. in the next phase of development. In this program, admission of 30 students will be targeted in First year through the national level examination as followed by the other IITs/IISc. The projected strength of students will be 120 (B. Des) and 80 (M. Des and MIM). Accordingly, the space and faculty will be required as per the below details –

### **8.2.1 Faculty projection**

In addition to the available 8 faculty members, approximately, additional 12 faculty members will be required with expertise in the area of Design, Engineering, Architecture, Management and Humanities/Social Sciences.

### **8.2.2 Space projection**

The spaces for the following will be required to run the activities of Bachelor and Masters Programs in the Department. The exact floor area requirement may be calculated by appropriate authorities in consultation with the Department.

- Laboratories/workshops/studios such as Computer Lab, Model and Styling Lab, Digital Lab, Printing and Graphics Lab, Fab Lab, Photography Lab, Animation Lab etc.
- Class Rooms (08)
- Faculty Offices (20)
- Officer for Head of Department (01)
- Department Office (01)
- Committee Room (01)
- Library (01)
- Digital Spaces for Displace of Archival Stuff (01)
- Exhibition Space (01)
- Seminar Room (02)
- Sitting space for Research Scholars (30)

# **Annexure – II**



## PROGRAM STRUCTURES OF THE PROPOSED MASTERS PROGRAMS

## (a) M. Des. (Industrial Design)

Teaching SchemeI Year: Autumn Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage %				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IDN-501**	Introduction to Design and Prototyping	PCC	Audit	15	5	10	02	-	35	35	--	30	--
2	IDN-503	Design Thinking	PCC	3	1	0	4	2	0	20-35	20-30	20-30	40-50	-
3	IDN-505	Elements and Principles of Visual Design	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
4	IDN-507	Human Factor Design	PCC	3	1	2	0	2	0	20-35	-	20-30	40-50	-
5	IDN-509	Materials and Manufacturing	PCC	3	1	1	2	2	0	20-35	20-30	20-30	40-50	-
6	IDN-511	Effective Communication	PCC	2	1	1	0	2	0	20-35	-	20-30	40-50	-
7	IDN-513	Ideation Project	PCC	4	1	0	6	-	-	-	100	-	-	-
8		Program Elective I	PEC	3	-	-	-	-	-	-	-	-	-	-
		<b>Sub Total</b>		<b>21</b>										

\*\* This is a foundation course which will be running for 7-10 days to give orientation of Design course. It will be held before actual start of the semester teaching.

## Annexure- II: Structures of Masters Programs

### I Year: Spring Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IDN-502	Design Methodology	PCC	3	2	0	2	2	0	20-35	20-30	20-30	40-50	-
2	IDN-504	Form Design	PCC	3	1	0	4	0	4	20-35	20-30	-	-	40-50
3	IDN-506	Design for Sustainability	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
4	IDN-508	Creation Project	PCC	5	-	-	10	-	-	-	100	-	-	-
5	IDN-510	Design Seminar	PCC	2	-	-	4	-	-	100	-	-	-	-
6		Program Elective II	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
7		Program Elective III	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
Sub Total				22										

### II Year: Autumn Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credit	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IDN-702	Internship (Industrial Training/ Project/ Interaction)	SEM	4	-	-	-	-	-	-	-	-	-	100 <sup>ss</sup>
2		Program Elective IV	PEC	3	-	-	-	-	-	15-35	-	25-35	40-50	-
3		Program Elective V*	PEC	3	-	-	-	-	-	-	-	-	-	-
4	IDN-701A	Design Project (Phase – I)	DIS	5	-	-	-	-	-	-	-	-	-	100
Sub Total				15										

<sup>ss</sup> Evaluation scheme: (Industry: 40 + Institute: 60) Internship will be completed during summer break.

\*May be completed through online mode (for example, NPTEL).

II Year: Spring Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage %				
S No.	Course Code	Course Title	Subject Area	Credit	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1.	IDN-701 B	Design Project (Phase – II)	DIS	12	-	-	-	-	-	-	-	-	-	100
		<b>Sub Total</b>		12										
		<b>Total</b>		70										

## Basket of Elective Courses for M. Des. (Industrial Design)

## Basket 1 Engineering Group

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
	<b>First Semester</b>													
1	IDN-521	Sensors, Actuators and IOT	PEC	3	2	0	2	2	0	20-35	20-30	20-30	40-50	-
2	IDN-522	Computer Aided Design	PEC	3	2	0	2	2	0	20-35	20-30	20-30	40-50	--
3	IDN-523	Rapid Prototyping	PEC	3	2	0	2	2	0	20-35	20-30	20-30	40-50	--
	<b>Second Semester</b>													
4	IDN-524	Digital Systems Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
5	IDN-525	CAE in Product Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
6	IDN-526	Reverse Engineering	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
	<b>Third Semester</b>													
7	IDN-527	Artificial Intelligence and Data Science	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-

## Basket 2 Management Group

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
	<b>First Semester</b>													
1	IDN-528	Product Planning and Marketing	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
	<b>Second Semester</b>													
2	IDN-529	Valuation	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
3	IDN-530	Business and Service Innovation	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
	<b>Third Semester</b>													
4	IDN-531	Legal Standards/IPR	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
5	IDN-532	Systems Thinking												

## Basket 3 Design Group

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
	<b>First Semester</b>													
1	IDN-533	User Experience Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
	<b>Second Semester **</b>													
1	IDN-534	Interaction Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
2	IDN-535	Mobility Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
3	IDN-536	Service Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
1	IDN-537	Research into Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
2	IDN-538	Bio Inspired Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
	<b>Third Semester</b>													
1	IDN-539	Computer Game Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
2	IDN-540	Design for Society	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-

\*\* Student can take PEC either from first three or last two subjects.

## Basket 4 Visual Design Group

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
<b>First Semester</b>														
1	IDN-541	Graphic Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
<b>Second Semester</b>														
1	IDN-542	Product Detailing	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
2	IDN-543	Contemporary Visual Design	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
<b>Third Semester</b>														
1	IDN-544	Representation Techniques for Animation	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-
2	IDN-545	Visual Narrative	PEC	3	-	-	-	-	-	20-35	-	20-30	40-50	-

## Basket 5 On-line mode: NPTEL

A list of approved NPTEL courses by DAPC will be provided to students.

- Course duration: 20hrs

The courses will be PEC without laboratory work

(a)

## MIM (Masters in Innovation Management)

Teaching SchemeI Year: Autumn Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IMN-501	Design Thinking	PCC	3	1	0	4	2	0	20-35	-	20-30	40-50	-
2	IMN-503	Effective Communication	PCC	2	1	1	0	0	2	20-35	20-30	-	-	40-50
3	IMN-505	Business Valuation	PCC	3	2	1	0	3	0	20-35	-	20-30	40-50	-
4	IMN-507	Innovative Entrepreneurship Strategies	PCC	3	2	0	2	2	0	20-35	-	20-30	40-50	20-30
5	IMN-509	Legal Aspects of Business	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
6	IMN-511	Business Decision Making	PCC	3	3	0	0	3	0	20-35	-	20-30	40-50	-
7	IMN-513	Contemporary Management Practices	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
Sub Total				18										

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I Year: Spring Semester

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IMN-502	Technology Management	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
2	IMN-504	Contemporary Strategic Management	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
3	IMN-506	Intellectual Property Management	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
4	IMN-508	Process Innovation Management	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
5	IMN-510	Product Innovation Management	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
6	IMN-512	Innovative Services and Business Models	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
7	IMN-514	Financing and Marketing of Innovation	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
Sub Total				18										

**II Year: Autumn Semester**

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IMN-601	Summer Training	SEM	3	-	-	-	-	-	-	-	-	-	100
2	IMN-602	Project	RP	2	-	-	-	-	-	-	-	-	-	100
3		Elective I	PEC	3	-	-	-	-	-	-	-	-	-	-
4		Elective II	PEC	3	-	-	-	-	-	-	-	-	-	-
5		Elective III	PEC	3	-	-	-	-	-	-	-	-	-	-
6		Elective IV	PEC	3	-	-	-	-	-	-	-	-	-	-
7		Elective V	PEC	3	-	-	-	-	-	-	-	-	-	-
Sub Total				20										

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**II Year: Spring Semester**

Teaching Scheme					Contact Hrs Per Week			Exam Duration		Relative Weightage%				
S No.	Course Code	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1	IMN-603	Project (Continued from Sem III)	RP	18	-	-	-	-	-	-	-	-	100	-
Sub Total				18										
Grand Total				74										

## List of Elective Courses for MIM (Innovation Management):

S. No.	Course Code	Subject Name	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
							T	P	CWS	PRS	MTE	ETE	PRE
1	IMN-521	IP Portfolio Management	3	2	1	0	3	--	15	--	35	50	
2	IMN-522	Intellectual Capital and Corporate Value Creation	3	2	1	0	3	--	15	--	35	50	--
3	IMN-523	Licensing and Commercialization of IP	3	2	1	0	3	--	15	--	35	50	--
4	IMN-524	Diffusion of Innovations in Social networks	3	2	1	0	3	--	15	--	35	50	--
5	IMN-525	Design for Extreme Affordability	3	2	1	0	3	--	15	--	35	50	--

\* All the elective subjects for MBA and M Des Course are also available for the students of MIM as PECs.



**Item No. 86.14: To consider the proposal of Department of Humanities and Social Sciences to introduce New Integrated MS Economics (Five Year Integrated programme).**

The IAPC in its 98<sup>th</sup> meeting held on 03.02.2021 considered the proposal to introduce new Integrated MS Economics (Five Year Integrated programme). The IAPC recommended the modified proposal **(Appendix-A)**.

The above is submitted for the consideration and approval of the Senate.

**Indian Institute of Technology Roorkee**  
**Department of Humanities and Social Sciences**

**MSE (BS+MS in Economics)**  
**(Five Year Integrated Programme)**

**Programme Overview**

MSE (MS in Economics) programme will be of particular interest if one envisages a career which calls for advanced analytical skills, draws on advanced knowledge of economics, and shall ensure exposure to contemporary and emerging economic policy issues at the national and international levels. The programme is unique as it would help the students to apply various economic principles, theories and models, and understand the technical foundations behind them. This would enable students to alter, amend, empirically test and adapt them to the changing economic environment.

**Programme Features**

The MSE (MS in Economics) programme will be an in-depth programme that will equip students with the tools a professional economist needs to work in government or in international organisations, or to carry out economic research. This programme will give students rigorous training in the core areas of economics to make them proficient in the latest analytical and quantitative techniques. Students will also receive a firm grounding in mathematical and econometric techniques, microeconomics and macroeconomics, including their application to new economic problems.

Students want to have an exit degree may get it as BS (Economics) in completion of 4th year of the Programme.

**Admission Eligibility/ Mode of Admission**

Through IIT JEE Entrance Examination.

**No. of Proposed Seats**

The total number of seats proposed for the 5yr MSE (MS in Economics) programme is 33.

The breakup of the seats for this programme is: 16 (GEN) + 8 (OBC) + 3 (EWS) + 4 (SC) + 2 (ST)

**Programme Duration**

The MSE (MS in Economics) programme would be a five-year full-time programme, with each year comprising the autumn and spring semesters with complete programme spread over total of ten semesters. (Teaching Scheme attached)

Note: Students want to have an exit degree may get it as BS (Economics) in completion of 4<sup>th</sup> year of the Programme.

Students want to have BS degree have to intimate to DAA about their Option before the commencement of the Autumn Sem of 3<sup>rd</sup> Year during their subject registration and they may exit the Programme at the end of 4<sup>th</sup> Year

Students want to have BS degree may exit the Programme at the end of 4<sup>th</sup> Year; Students with BS degree can opt for Project work as an elective under Department elective III and IV (total 6 credits, 3 credit each)

### Programme Structure

	Autumn Semester		Spring Semester	
1 <sup>ST</sup> YEAR	Semester I	Courses taught are of the same Structure like all other Branches (BSC, ESC, HSSMEC, GSC), One PCC (Introduction to the Discipline)	Semester II	Three PCC- Level 1 Microeconomics, Level 1 Macroeconomics, Basic Statistics along with BSC and ESC Courses
2 <sup>ND</sup> YEAR	Semester III	Four PCC Courses along with One ESC course	Semester IV	Three PCC Courses along with One BSC Course and One HSSMEC Course
3 <sup>RD</sup> YEAR	Semester V	PCC and PEC Courses (Programme Elective)	Semester VI	PCC and PEC Courses (Programme Elective)
	<ul style="list-style-type: none"> <li>Students will have Programme Electives starting this year (from Autumn Semester).</li> <li>Students will have Institute Open Elective (in Spring Semester).</li> <li>Students can start opting for Minor Specialization Course from Other Departments/Courses (from Spring Semester).</li> </ul>			
4 <sup>TH</sup> YEAR	Semester VII	PCC and PEC Courses (Programme Elective)	Semester VIII	PCC and PEC Courses (Programme Elective)
	<ul style="list-style-type: none"> <li>Students will have Programme Electives (in Autumn and Spring Semester).</li> <li>Students can opt for Minor Specialization Course from Other Departments/Courses (in Autumn and Spring Semester).</li> </ul>			

5 <sup>TH</sup> YEAR	Semester IX	PCC and PEC Courses (Programme Elective)	Semester X	PCC (Dissertation) and PEC Courses (Programme Elective)
	<ul style="list-style-type: none"> <li>Students will have Seminar (in Autumn Semester).</li> <li>Students will have Dissertation (in Spring Semester).</li> </ul>			

	<ul style="list-style-type: none"> <li>Students can start opting for Minor Specialization Course from Other Departments/Courses(in Autumn and Spring Semester).</li> </ul>
--	--

MSE (MS in Economics) Programme structure shall be according to minimum and maximum credit requirements in each semester. In each semester, the student shall require to fulfill maximum of 18-24 credits. Courses may be of credits ranging from 2 to 4.

### Programme Evaluation

The programme course(s) evaluation would be based on mid-term, end-term and coursework including seminar presentations, group discussions, term papers and summer internship as per institute evaluation scheme.

Total Credits: as per other MS/MSc programmes of the Institute)

### Career Prospects

Careers open to students who successfully complete the MS Economics degree include economic advisory at government and semi-government departments, financial analysts and advisors to national and international financial institutions, data analysts and researchers as well as consultancy. In addition, the programme may also offer a route into further study at the Ph.D. level at various international academic institutions. The institute placement and training Centre can arrange campus placements by prospective employers from:

*Financial Services*-Reserve Bank of India, American Express Bank, HSBC Bank, ICICI Bank, Roulac Global Investments, National Institute of Securities Markets (NISM), Fidelity Investments, Indian Credit Rating Association (ICRA), Industrial Development Bank of India (IDBI), Iflex Solutions, National Commodities & Derivatives Exchange Ltd., etc.

*Government Departments*-Planning Commission (NITI Aayog), Ministry of Finance, Indian Council for Social Science Research (ICSSR), etc.

*Research and Consultancy*-Crisil Research, Deloitte, Ernst & Young and PwC, Institute for Financial Management and Research, NCAER, etc.

*International Agencies*- Economic advisor and experts to World Bank, Asian Development Bank, International Monetary Fund, OECD, etc.

*Development*- Social sector, NGOs, MFIs, NABARD, etc.

## Teaching Scheme

Program Code: **MSE** (MS in Economics)

Department: Department of HSS, Code: ECO (Economics)

Year	Credits in Autumn Semester	Credits in Spring Semester	Credits (year-wise)
1	21	24	45
2	20	19	39
3	20	18/22	38/42
4	17/ 21	17/21	34/42
5	18/22	18/22	36/44
<b>Total</b>	<b>96/104</b>	<b>96/108</b>	<b>192/212</b>

Curricular Components	Credit Distributions	
	Credits as per Institute Structure	Credits for MS in Economics
<b>Institute Core Courses</b>		
HSSC	4	4
BSC	16	16
ESC	16	16
GSC	3	3
<b>Total</b>	<b>39</b>	<b>39</b>
<b>Programme Core Courses (PCC)</b>		
Class Contact Core Courses	104	102
Intro to Discipline	2	2
Tech Communication	2	2
Project	12	12
Seminar	2	2
Educational Tour	0	0
<b>Total</b>	<b>122</b>	<b>120</b>
<b>HSS and Management Electives (HSSMEC)</b>		
HSS	3	3
Management	3	3
<b>Total</b>	<b>6</b>	<b>6</b>
<b>Open Elective Course</b>	<b>Total</b>	<b>3</b>
<b>Programme Elective Courses</b>	<b>Total</b>	<b>24-32</b>
<b>Co-curricular Activities</b>		
(i) Discipline (To be awarded after Final Year)	2	2
(ii) NCC/NSO/NSS (First Year)	-	-
<b>Total</b>	<b>2</b>	<b>2</b>
<b>Grand Total</b>	<b>192-200</b>	<b>194</b>

Program Code: **MSE (MS in Economics)**

Department: Department of HSS

Year : I

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)			Relative Weight (%)			
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Autumn														
1	MAN-001	Mathematics-1	BSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2	HSN-101	Introduction to Economics	PCC	2	2	0	0	2	0	20-35	-	20-30	40-50	-
3	HSN-103	Computer Programming for Economists	ESC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
4	PHN-001	Mechanics	BSC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
5	HSN-002	Introduction to Psychology	HSSC	2	1	1	0	2	0	20-30	-	20-30	40-50	-
6	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
7	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	20-35	-	20-30	40-50	-
			Total	21										
Spring														
1	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2	HSN-102	Introductory Microeconomics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3	HSN-104	Introductory Macroeconomics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4	HSN-106	Basic Statistics	PCC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
5	MAN-010	Optimization Techniques	BSC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
6	CHN-112	Energy Engineering	ESC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
			Total	24										

Program Code: **MSE** (MS in Economics)  
 Department: Department of HSS  
 Year : II

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Autumn														
1	EEN-112	Electrical Sciences	ESC	4	3	1	2/2	3	0	15-30	20	15-25	30-40	-
2	HSN-201	Advanced Statistics	PCC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
3	HSN-203	Advanced Microeconomics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4	HSN-205	Advanced Macroeconomics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
5	HSN-207	Elementary Development Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
			Total	20										
Spring														
1	MIN-102	Basic Manufacturing Process	ESC	4	2	0	4	3	0	15	15	30	40	-
2	HSN-202	Monetary Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3	HSN-204	Advanced Development Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4	HSN-206	Introduction to Econometric Theory	PCC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
5	HSN-ELE	HSS Elective Course	HSSMEC	3	2	1	0	2	0					
			Total	19										

Program Code: **MSE** (MS in Economics)  
 Department: Department of HSS  
 Year : III

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)			Relative Weight (%)			
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Autumn														
1	HSN-301	Public Finance	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2	HSN-303	Principles of International Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3	HSN-305	Advanced Topics in Econometric Theory	PCC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
4	HSN-ELE1	Department Elective 1	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
5	BM-ELE1	Management Elective Course	HSSMEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
6	HSN-307	Technical Communication	PCC	2	1	0	2	2	0	20-35	-	20-30	40-50	-
		Total		20										
Spring														
1	HSN-302	Advanced Topics in International Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2	HSN-304	Growth Economics	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
3	HSN-306	Indian Economy	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4	HSN-ELE2	Department Elective 2	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
5		Open Elective I	OEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
6	MSC-1	Minor Specialization Course	MSC	4	3	1	0	3	0	-	-	-	-	-
7		Educational Tour	PCC	0	0	0	0	0	0					
		Total		18/22										

Department Elective Courses (HSN Elective-I and HSN Elective-II) to be chosen in III Year; Some of the PEC Courses will have Lab component.

Note: Students want to have BS degree have to intimate to DAA about their Option before the commencement of the Autumn Sem of 3<sup>rd</sup> Year during their subject registration and they may exit the Programme at the end of 4<sup>th</sup> Year



Program Code: **MSE (MS in Economics)**  
 Department: Department of HSS  
 Year : IV

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practica I	CWS	PRS	MTE	ETE	PRE
Autumn														
1	HSN-501	Industrial Organisation	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
2	HSN-503	Financial Economics: Theory & Applications	PCC	4	3	0	2	3	0	10-25	25	15-25	30-40	-
3	HSN-505	Environment Economics: Theory & Policy	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
4	HSN-507	Time Series Analysis and Applications	PCC	3	2	0	2	2	0	10-25	25	15-25	30-40	-
5	HSN-ELE3	Department Elective III	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
6	MSC-2	Minor Specialization Course	MSC	4	3	1	0	3	-	-	-	-	-	-
		Total		17/21										
Spring														
1	HSN-502	Public Policy	PCC	4	3	1	0	3	0	20-35	-	20-30	40-50	-
2	HSN-504	Econometrics Lab	PCC	4	2	0	4	3	0	10-25	25	15-25	30-40	-
3	HSN-506	Energy Economics	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
4	HSN-508	Institutional Economics	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
5	HSN-ELE4	Department Elective IV	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
6	MSC-3	Minor Specialization Course	MSC	4	3	1	0	3	0	-	-	-	-	-
		Total		17/21										

Department Elective Courses (HSN Elective-III and HSN Elective-IV) to be chosen in Fourth Year; **Some of the PEC Courses will have Lab component.**  
**Note: Students want to have BS degree may exit the Programme at the end of 4<sup>th</sup> Year; Students with BS degree can opt for Project work as an elective under Department elective III and IV (total 6 credits, 3 credit each)**

Program Code: **MSE** (MS in Economics)  
 Department: Department of HSS  
 Year : V

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Autumn														
1	HSN-601	Welfare Economics	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
2	HSN-603	History of Economic Thought	PCC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
3	HSN-605	Advanced Growth Theory	PCC	4	3	1	0	2	0	20-35	-	20-30	40-50	-
4	HSN-607	Seminar	PCC	2	0	0	0	-	-	-	-	30	70	-
5	HSN-600 A	Project (Stage-I)	PCC	3	0	0	0	-	-	-	-	30	70	-
6	HSN-ELE5	Department Elective V	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
7	HSN-ELE6	Department Elective VI	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
8	MSC-4	Minor Specialization Course	MSC	4	3	1	0	3	0	-	-	-	-	-
			Total	21/25										
Spring														
1	HSN-600 B	Project (Stage-II)	PCC	9	0	0	0	-	-	-	-	30	70	-
2	HSN-ELE7	Department Elective VII	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
3	HSN-ELE8	Department Elective VIII	PEC	3	2	1	0	2	0	20-35	-	20-30	40-50	-
5	MSC-5	Minor Specialization Course	MSC	4	3	1	0	3	0	-	-	-	-	-
			Total	15/19										

Department Elective Courses (HSN Elective-IV, V, VI, VII and VIII) to be chosen in Fifth Year  
 Note: Subject Code for 4<sup>th</sup> year and 5<sup>th</sup> years subjects are of 5 and 6 series keeping in view that since it is a master's programme students from other masters programme/PhD can take these courses as elective/pre-PhD courses.  
 Some of the PEC Courses will have Lab component.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

- |  |  |                     |                   |                   |               |
|--|--|---------------------|-------------------|-------------------|---------------|
| <b>1. Subject Code:</b> HSN-101  | <b>Course Title:</b> Introduction to Economics |                     |                   |                   |               |
| <b>2. Contact Hours:</b>   | <b>L:</b> 2                                    | <b>T:</b> 0         | <b>P:</b> 0       |                   |               |
| <b>3. Examination Duration (Hrs.):</b>   | <b>Theory:</b> 2                               | <b>Practical:</b> 0 |                   |                   |               |
| <b>4. Relative Weightage:</b>  | <b>CWS:</b> 20-35                              | <b>PRS:</b> 0       | <b>MTE:</b> 20-30 | <b>ETE:</b> 40-50 | <b>PRE:</b> 0 |
| <b>5. Credits:</b> 2   | <b>6. Semester:</b> Autumn                     |                     |                   |                   |               |
| <b>7. Pre-requisite:</b> Nil   | <b>8. Subject Area:</b> PCC                    |                     |                   |                   |               |
| <b>9. Objective:</b> To provide basic understanding of economic principles/analysis. |  |                     |                   |                   |               |

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>The Central Concepts of Economics:</b> The Concepts of Scarcity, Choice, Opportunity Costs and Efficiency; The Modern Mixed Economy-Market and Government	5
2.	<b>Microeconomic Concepts:</b> Demand, Supply and Markets; Equilibrium and Surplus; Quotas, and Price Ceilings; Compare and Contrast Monopoly, Perfect Competition and Other Market Structures.	7
3.	<b>Macroeconomic Concepts:</b> Circular Flow, Measuring Economic Activity-Gross Domestic Product; Macroeconomic Challenges: Unemployment, Inflation and Macroeconomic Performance-Business Cycles	8
4.	<b>Growth and Development:</b> Sources of Economic Growth: Human Resources, Natural Resources, Capital, Technological Change and Innovation, The Challenge of Economic Development	4
5.	<b>Global Economy:</b> International Trade: The Nature of International Trade, The Principle of Comparative Advantage; Protectionism: Supply-and-Demand Analysis of Trade and Tariffs	4
<b>Total</b>		<b>28</b>

## 11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Economics, Paul A. Samuelson, William D. Nordhaus, McGraw-Hill; 19 <sup>th</sup> Edition	2010
2.	Principles of Economics, N. Gregory Mankiw, Cengage Learning, 7 <sup>th</sup> Edition	2015
3.	Economics-A Very Short Introduction, Partha Dasgupta, Oxford University Press, 1 <sup>st</sup> Edition	2007
4.	Principles of Economics, Carl Menger, Ludwig von Mises Institute, 1 <sup>st</sup> Edition Reprint	2007
5.	Economics: Principles and Policy, William J. Baumol, Alan S. Blinder, Cengage Learning, 11 <sup>th</sup> Edition	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

- |  |  |                     |                   |                   |               |
|--|--|---------------------|-------------------|-------------------|---------------|
| <b>1. Subject Code:</b> HSN-102  | <b>Course Title:</b> Introductory Microeconomics |                     |                   |                   |               |
| <b>2. Contact Hours:</b>   | <b>L:</b> 3                                      | <b>T:</b> 1         | <b>P:</b> 0       |                   |               |
| <b>3. Examination Duration (Hrs.):</b>   | <b>Theory:</b> 3                                 | <b>Practical:</b> 0 |                   |                   |               |
| <b>4. Relative Weightage:</b>  | <b>CWS:</b> 20-35                                | <b>PRS:</b> 0       | <b>MTE:</b> 20-30 | <b>ETE:</b> 40-50 | <b>PRE:</b> 0 |
| <b>5. Credits:</b> 4   | <b>6. Semester:</b> Spring                       |                     |                   |                   |               |
| <b>7. Pre-requisite:</b> Nil   | <b>8. Subject Area:</b> PCC                      |                     |                   |                   |               |
| <b>9. Objective:</b> To provide an understanding of consumer and producer behavior, markets and competition, and tools of comparative statics and their application to price theory. |  |                     |                   |                   |               |

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Key concepts in Microeconomics; Concepts of Scarcity and Wants; Models and Methodology; Positive and Normative Analysis	2
2.	<b>Consumer Behaviour:</b> Theories of consumer behavior - Total and Marginal Utility; Cardinal and Ordinal Utility; Preference orderings and Indifference Curves; Marginal Rate of Substitution; Budget Constraint; Utility Maximisation; Derivation of demand; Concepts of Elasticity; Changes in prices and income and individual demand curve; Substitution and Income effects; Revealed preference approach; Aggregate demand	8
3.	<b>Producer Behaviour:</b> Short-run vs Long-run analysis; Technology and production sets; Production with single variable; Production with two or more variables; Production functions (for competitive firm) and Isoquants; Returns to Scale; Technological progress; Cost Concepts; Expansion path and long-run cost curves; Output and Profit maximization; Cost minimization; Duality theory in production; Multiproduct firms and cost dynamics	8
4.	<b>Competitive Market:</b> Perfect Competition-Assumptions; Demand and supply curves; Market equilibrium, stability and comparative static properties; Impact of taxes and subsidies on market equilibrium; Consumer and producers surplus; Firm equilibrium and supply curve in the short-run; Firm and industry equilibrium in the long-run; Constant, Increasing and decreasing cost industries; General equilibrium and Pareto optimality - fundamental theorems of welfare economics; Externalities and market failures	8
5.	<b>Imperfect Markets:</b> Imperfect competition and market structure; Pure monopoly; Short-run and long-run equilibrium; Profit maximization; Price discrimination; Bilateral monopoly; Single product monopoly; Durable goods monopolist; Multi-plant monopolist; Barrier to entry and natural monopoly; Welfare loss from monopoly; Dumping, tying and bundling; Monopsony	8
6.	<b>Monopolistic Competition and Oligopoly:</b> Characteristics of monopolistic and oligopolistic competition; Advertising and monopolistic competition; Output, price, and profit of a monopolistic competitor; Long-Run equilibrium in a monopolistically competitive industry; Models of oligopoly behavior –	8

	Cartel model, contestable markets; Oligopoly model with homogeneous products; Oligopoly model with differentiated products	
<b>Total</b>		<b>42</b>

# 11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Intermediate Microeconomics with Calculus, H. R. Varian, W. W. Norton & Company, International Student Edition	2014
2.	Microeconomics, D. Acemoglu, D. Laibson and J. List, Pearson Education, 1 <sup>st</sup> Edition	2019
3.	Microeconomics, P. Jeffrey, Pearson Education, 7 <sup>th</sup> Edition	2019
4.	Microeconomic Theory: Basic Principles and Extensions, W. Nicholson and C. Snyder, Cengage India	2017
5.	Microeconomics, R. Pindyck and D. Rubinfeld, Pearson Education, 8 <sup>th</sup> Edition	2017
6.	Microeconomics, E. Mansfield and G. Yohe, Viva-Norton, 11 <sup>th</sup> Edition	2010
7.	Microeconomics, H. Gravelle and R. Rees, Pearson India, 3 <sup>rd</sup> Edition	2007
8.	Microeconomics: Theory and Applications, A. Sen, Oxford University Press, 2 <sup>nd</sup> Edition	2006

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** Department of Humanities and Social Sciences

1. **Subject Code:** HSN-103                      **Course Title:** Computer Programming for Economists
2. **Contact Hours:**                      **L:** 3                      **T:** 0                      **P:** 2
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:** **CWS:** 10-25                      **PRS:** 25                      **MTE:** 15-25                      **ETE:** 30-40                      **PRE:** 0
5. **Credits:** 4    6. **Semester:** Autumn
7. **Pre-requisite:** Nil    8. **Subject Area:** ESC
9. **Objective:** To provide an understanding of different programming techniques and integrating it with Economics.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Programming concepts and paradigm; Development of programming languages; Structures of programming languages: Lexical structure, Syntactic structure, Contextual structure, Semantic structure; Understanding programming: Data types, Data structures, Automation basics ; Programming as social science.	8
2.	<b>Introduction to C/C++:</b> Getting started with C/C++; Control structures: Operators, Basic selection structures, Iteration structures; Complex types: Arrays and string, Pointer, Constants; Compound data types: Union, Array of structures using static memory allocation; Input and output: Standard input and output, Variable-length argument lists, File access; Recursive structures and applications.	10
3.	<b>Programming using Python:</b> Basic elements of Python; Conditional logic, Loops; Debugging Python code; Reading and writing to files: Working with database files, Text and CSV files; Obtaining data from the web: Using python to read from HTML files, JSON, API queries; Statistical calculations; Data visualization; Machine learning and text mining.	10
4.	<b>Programming using R:</b> Fundamentals of R; R and Rstudio: Working directory, Script, Vectors, Matrices, Data frames; Getting data into R; R for data science: Exploratory data analysis, Statistical simulation; R for machine learning: Lazy learning, Probabilistic learning, Forecasting numeric data.	7
5.	<b>MATLAB Programming:</b> Basic Matlab and introductory examples; Writing scripts and functions: Functions, Plotting curves, Root finding, Interpolation and extrapolation; Solving differential equations and Simulations; Data Input/Output: Importing from excel, text, and native Matlab files; User written functions: Function m-files, Anonymous functions.	7
<b>Total</b>		<b>42</b>

## 11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Brooker, Phillip. Programming with Python for Social Scientists, Sage.	2020
2.	Guttag, John. Introduction to Computation and Programming Using Python: With Application to Understanding Data, Second Edition, MIT Press.	2016
3.	Kaefer, F. & Kaefer, P. Introduction to Python Programming for Business and Social Science Applications, Sage.	2020
4.	Chen, Y. Introduction to Programming Languages, Sixth Edition, Kendall Hunt Publication Company.	2019
5.	Mueller, J., & Massaron, L. Machine Learning for Dummies, John Wiley & Sons.	2016
6.	Vries A., & Meys, J. R for Dummies, Second Edition, John Wiley and Sons.	2015
7.	Dayal, V. An Introduction to R for Quantitative Economics, Springer, India.	2015
8.	Kendrick, D., Mercado, R., Amman, H. Computational Economics, Princeton University Press.	2006

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** Department of Humanities and Social Sciences

1. **Subject Code:** HSN-104                      **Course Title:** Introductory Macroeconomics
2. **Contact Hours:**                      **L:** 3                      **T:** 1                      **P:** 0
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0
5. **Credits:** 4    6. **Semester:** Spring
7. **Pre-requisite:** Nil    8. **Subject Area:** PCC
9. **Objective:** To provide students a basic understanding of the principles of macroeconomics as they relate to how a country's economy works including the outputs, unemployment, inflation, fiscal policy, monetary policy and international trade of the economy.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>National Income Accounting:</b> Structure, Key concepts, Measurements, and Circular flow of Income- for Closed and Open Economy; Money, Fiscal and Foreign Sector Variables- Concepts, Measurements	6
2.	<b>Behavioural and Technological Functions:</b> Consumption Functions- Absolute Income Hypothesis, Lifecycle and Permanent Income Hypothesis; Investment Functions-Keynesian; Money Demand and Supply Functions; Production Function	9
3.	<b>Business Cycles and Economic Models:</b> Business Cycles-Facts and Features; The Classical Model of the Business Cycle; The Keynesian Model of the Business Cycle- Simple Keynesian Cross Model of Income and Employment determination and the multiplier (in closed economy);	10
4.	<b>Business Cycles and Economic Models:</b> IS-LM Model -Hicks' IS-LM Synthesis; Fiscal and Monetary Policy: Role of Fiscal Policy and Monetary Policy in taming Business Cycles	9
5.	<b>Inflation and Unemployment:</b> Inflation-Theories, Philips Curve; Monetary Policy; Government Debt and Ricardian Equivalence; Measurement, Causes, and Effects; Unemployment-Types, Measurement, Causes, and Effects	8
<b>Total</b>		<b>42</b>

### 11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Macroeconomics, N. Gregory Mankiw, 10 <sup>th</sup> Ed, Macmillan	2019
2.	Macroeconomics, Rudiger Dornbusch and Stanley Fischer and Richard Startz, 13 <sup>th</sup> Ed., McGraw-Hill	2018
3.	Macroeconomics, Robert J. Gordon, 12 <sup>th</sup> Ed., Pearson	2012
4.	Macroeconomics: Theories and Policies, Richard T. Froyen, 10 <sup>th</sup> Ed., Pearson	2013
5.	Macroeconomics: Theory and Applications, G.S. Gupta, 4 <sup>th</sup> Ed., McGraw Hill Education	2017



# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** Department of Humanities and Social Sciences

1. **Subject Code:** HSN-106                      **Course Title:** Basic Statistics
2. **Contact Hours:**                      **L:** 3                      **T:** 0                      **P:** 2
3. **Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0
4. **Relative Weightage:** CWS: 10-25                      PRS: 25                      MTE: 15-25                      ETE: 30-40                      PRE: 0
5. **Credits:** 4                      6. **Semester:** Spring
7. **Pre-requisite:** Nil                      8. **Subject Area:** PCC
9. **Objective:** To provide an understanding of interpretation of elementary statistics and analyze statistical data.

## 10. Details of the Course

S.No.	Contents	Contact hours
1.	<b>Introduction:</b> Samples versus Populations; Descriptive Statistics: Measures of Central Tendency; Measures of Dispersion, Measures of Position and Outliers; Graphical Summaries of Data and Some Related Issues: Relative Frequencies, Histograms, Boxplots; Distributions, Percentiles, and Percentile Ranks	6
2.	<b>Probability and Sampling Distribution:</b> The Meaning of Probability; Expected Values; Conditional Probability and Independence; The Binomial Probability Function; Discrete Probability Distributions; The Normal Probability Distribution: Properties of the Normal Distribution, The Standard Normal Distribution, Applications of the Normal Distribution; Sampling Distributions: Sampling Distribution of a Binomial Random Variable, Sampling Distribution of the Mean Under Normality, Non-Normality and the Sampling Distribution of the Sample Mean, Sampling Distribution of the Median	10
3.	<b>Estimation and Hypothesis Testing:</b> Hypotheses about Single Means ( $z$ and $t$ ); Estimation: Confidence Interval for the Mean: Known Variance, Confidence Intervals for the Mean: $\sigma$ Not Known, Confidence Intervals for the Population Median; Hypothesis Testing: Testing Hypotheses about the Mean of a Normal Distribution, $\sigma$ Known, Testing Hypotheses about the Mean of a Normal Distribution, $\sigma$ Not Known	8
4.	<b>Correlation and Regression:</b> Simple Linear Regression: Ordinary Least Squares Regression, Inferences about the Slope and Intercept, The Coefficient of Determination, Testing the Significance of the Least-Squares Regression Model; Correlation	10
5.	<b>Inferences on Two or More than Two Samples:</b> Comparing the Means of Two Independent Groups, Comparing Two Dependent Groups, The ANOVA F Test for Independent Groups, Two-Way ANOVA; Chi-Square Goodness of Fit Test: Chi-Square Test for Independence and Homogeneity of Proportions	8
<b>Total</b>		<b>42</b>

**11. Suggested Books:**

<b>S.No.</b>	<b>Name of Authors/Book/Publisher</b>	<b>Year of Publication / Reprint</b>
1.	Basic Statistics, Rand R. Wilcox, Oxford University Press, 1 <sup>st</sup> Edition	2009
2.	The Basic Practice of Statistics, David S. Moore, W. H. Freeman and Company New York, 1 <sup>st</sup> Edition	2010
3.	Introduction to Mathematical Statistics, Robert V. Hogg, Joseph W. McKean, Allen T. Craig. Pearson Education, 7 <sup>th</sup> Edition	2013
4.	A Modern Introduction to Probability and Statistics: Understanding Why and How, F.M. Dekking, C. Kraaikamp H.P. Lopuhaa" L.E. Meester, Springer- London, 1 <sup>st</sup> Edition	2005
5.	Statistics-A Very Short Introduction, David J. Hand, Oxford University Press, 1 <sup>st</sup> Edition	2008

**Item No. 86.15: To consider the proposal of Department of Management Studies to introduce Executive MBA (EMBA).**

The IAPC in its 91<sup>st</sup> meeting held on 01.10.2020 considered the proposal to introduce EMBA and recommended it with minor modifications **(Appendix-A)**.

The above is submitted for the consideration and approval of the Senate.

**Department of Management Studies**  
**Indian Institute of Technology Roorkee, Roorkee**

**Proposal to Start Executive MBA at IIT Roorkee**

**Introduction:**

It is a matter of pride that DoMS, IIT Roorkee is one of the top ten B-School of the country as per NIRF 2017, 2018 and 2019. Department is offering only two programmes, MBA and PhD. It is a very appropriate time for the department to leverage its ranking, particularly by starting a new programme. Over last 20 years of its existence, department has acquired sufficient resources for moving into executive education programmes. Therefore, it is proposed to initiate Executive-MBA programme for working professionals. This programme is designed to attract working professionals who want to learn modern management principles for their career growth as well as for developing competitiveness of their organizations.

All peer institutions (IITs offering MBA and IIMs) offer EMBA programmes. Some of them offer E MBA in their permanent campus while some others offer in different campus. Considering the resources and availability of candidates, it is proposed to start E MBA.

Under the rapid infrastructure development plan around NCR and Uttarakhand, it is expected that commercial and industrial activities will further grow in NCR and Uttarakhand. This will require more persons who are well trained in managerial skills. Therefore, it is expected that this course will have a good potential right from the beginning.

The programme will be done in weekend mode with online and offline classes.

**Programme Objective:** At the outset, following objectives are decided for this proposed course:

- (1) To create visibility of the department among the working professionals.
- (2) To provide stronger linkages of department with industries.
- (3) To extend academic offerings from the department
- (4) To leverage good ranking of the department
- (5) To offer the course as “degree” so that it can be used by participants for pursuing future studies.

**Programme Duration and Mode:**

24 months. It will have blend of Online and offline classes. In each term/ semester, two sessions of 2-3 days each should be organized as boot camp at Roorkee/ Greater Noida campus.

**Eligibility for Admission**

A candidate seeking admission for the Programme must possess Bachelor's Degree with 65 % marks or equivalent grade points (for SC/ST 60% marks or equivalent grade points) with four years' relevant Work Experience after graduation.

Further, she/he should also fulfil one of the following condition:

- (i) The experience should be in a company having turnover of more than INR 300 crore for last three years continuously. OR in state, central government departments. OR in a reputed NGO having PAN India or Global operations.
- (ii) Graduation is completed from any Statutory University (Within top 500 NIRF in latest ranking data) or any other recognized Foreign University (Within 1000 QS latest ranking).
- (iii) Qualified CAT/GMAT/ XAT (latest examination is applicable).

**Selection Procedure:** The selection of the students shall be on the basis of Personal Interview only.

**Intake:** 30 seats

**Programme Duration:** The programme structure consists of 8 terms.

**Programme Fees:** Rs. 11 lacs payable in two instalments yearly.

**Programme Commencement:** January 2021.

## Course Structure

### Department of Management Studies

#### Executive Master of Business Administration (EMBA)

Course No.	Course Title	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)									
							T	P	CWS	PRS	MTE	ETE	PRE					
1 <sup>st</sup> Year							1 <sup>st</sup> Term											
BMN-501	Principles and Practices of Management	PCC	1.5	3	0	0	2		50	---	---	50	--					
BMN-502	Micro Economics	PCC	1.5	3	0	0	2	-	50	---	---	50	--					
BMN-503	Operations Research	PCC	2	3	1	0	3	-	50	---	---	50	--					
BMN-505	Financial Accounting I	PCC	1.5	3	0	0	2	-	50	---	---	50	--					
BMN-506	Business Environment	PCC	2	4	0	0	3	-	50	---	---	50	--					
BMN-507	Innovation and Entrepreneurship	PCC	1.5	3	0	0	2	-	50	---	---	50	--					
BMN-508	Marketing Management I	PCC	2	4	0	0	3	-	50	---	---	50	--					
	Sub Total		12	23	1	0												

	<b>2<sup>nd</sup> Term</b>												
BMN-510	Macro Economics	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-511	Marketing Management 2	PCC	2	4	0	0	3	-	50	---	---	50	--
BMN-512	Managerial Communication	PCC	2	3	0	2	2	-	50	20	---	30	--
BMN-513	Organization Behaviour	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-514	Data Analysis for Managers	PCC	2	3	0	2	2	-	50	20	---	30	---
BMN-515	Management Accounting	PCC	2	4	0	0	3	-	50	---	---	50	--
BMN-518	Production and Operations Management 1	PCC	1.5	3	0	0	2	-	50	---	---	50	--
<b>Sub Total</b>			12.5	23	0	4							
	<b>3<sup>rd</sup> Term</b>												
BMN-517	IT and Organization	PCC	1.5	3	0	0	2	---	50	---	---	50	
BMN-519	Production and Operations Management- 2	PCC	2	4	0	0	3	-	50	---	---	50	--
BMN-520	Human Resource Management	PCC	2	4	0	0	3	-	50	---	---	50	--
BMN-521	Financial Management -1	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-525	Digital Transformation and Business	PCC	1.5	3	0	0	2	--	50	---	---	50	--
BMN-526	Project Management	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-527	International Business	PCC	1.5	3	0	0	2	-	50	---	---	50	--
	<b>Sub Total</b>		11.5	23	0	0							
	<b>4<sup>th</sup> Term</b>												
BMN-521	Financial Management -1	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-528	Data Science and Big Data Analytics	PCC	1.5	3	0	0	2	--	50	---	---	50	--
BMN-530	Marketing Research	PCC	2	3	1	0	3	-	50	---	---	50	--
BMN-531	Legal Aspects of Business	PCC	2	4	0	0	3	-	50	---	---	50	--
BMN-533	Strategy and Business Policy	PCC	2.0	4	0	0	3	-	50	---	---	50	--
BMN-534	Supply Chain Management	PCC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective I	PEC	1.5	3	0	0	2	-	50	---	---	50	--
<b>Sub Total</b>			12	23	1	0							

2 <sup>nd</sup> Year	5 <sup>th</sup> Term												
BMN-535	Business Simulation from Capstone I	PCC	6	--	--	--	--	--	--	--	--	--	--
BMN-536	New Product Development	PCC	1.5	3	0	0	2	-	50	---	---	50	--
BMN-602	Summer Training	PCC	2	--	-	--	--	-	---	--	---	---	100
	Elective II	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective III	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective IV	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective V	PEC	1.5	3	0	0	2	-	50	---	---	50	--
Sub Total			15.5	15	0	0							
	6 <sup>th</sup> Term												
	Elective VI	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective VII	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective VIII	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective IX	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective X	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective XI	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Term Paper/ Seminar Presentation	PEC	6	--	-	--	--	-	--	---	---	---	100
Sub Total			15	18	0	0							
	7 <sup>th</sup> Term												
	Elective XII	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective XIII	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective XIV	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective XV	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Elective XVI	PEC	1.5	3	0	0	2	-	50	---	---	50	--
	Capstone II	PCC	6	--	-	--	--	-	---	---	---	---	---
Sub Total			13.5	15	0	0							
	8 <sup>th</sup> Term												
BMN-610	Major Project	RP	7	--	-	--	--	-	---	---	---	---	---
Sub Total			7										
TOTAL			99										

### Important Points :

- (1) Summer Training will be evaluated area wise. Students need to submit a report and presentation will be made by them.
- (2) Students will start working for their final year project during 7<sup>th</sup> term. They can spend some time in industry for project completion in 8<sup>th</sup> term. Project evaluation will also be done after making presentation in front of a duly constituted committee.
- (3) To complete specialization in one area, a student has to earn minimum 12 credits in that area.

### Open Electives

S.No.	Subject Code	Subject Name	Subject area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-611	Knowledge Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
2	BMN-612	Entrepreneurship Development	PEC	1.5	3	0	0	2	-	50	---	---	50	--
3	BMN-613	Industrial Waste Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
4	BMN-614	Management of Large Systems	PEC	1.5	3	0	0	2	-	50	---	---	50	--
5	BMN-615	Environment Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
6	BMN-616	Advanced Optimization Techniques for Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
7	BMN-617	Basics of Management of Information	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
8	BMN-618	Soft Computing Techniques for Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
9	BMN-619	Technology Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--



## Specialization Electives

### (1) Human Resource Management

S.No.	Subject Code	Subject Name	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-631	Human Resource Planning and Development	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
2	BMN-632	Organisational Development	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
3	BMN-633	Labour Legislation and Industrial Relations	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
4	BMN-634	Career Planning and Performance	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
5	BMN-635	Management of Training and Talent Development	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
6	BMN-636	Compensation Management and Reward System	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
7	BMN-637	Management of Change	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
8	BMN-638	Managing Innovation and Creativity	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
9	BMN-639	Management of Self and Interpersonal Dynamics	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
10	BMN-640	Strategic Human resource Management	PEC	1.5	3	0	0	2	-- -	50	---	---	50	--
11	BMN-641	H R Analytics		1.5	3	0	0	2	-- -	50	---	---	50	--

## (2) Operations

S.No.	Subject Code	Subject Name	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-651	Manufacturing Strategy	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
2	BMN-652	Service Operations Management		1.5	3	0	0	2	- - -	50	---	---	50	--
3	BMN-653	Supply Chain Analytics		1.5	3	0	0	2	- - -	50	---	---	50	--
4	BMN-654	Computer Integrated Manufacturing	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
5	BMN-655	Operations Planning and Control Systems	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
6	BMN-656	Total Productive Maintenance	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
7	BMN-657	Productivity Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
8	BMN-658	Quality Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--

## (3) Information Technology

S.No.	Subject Code	Subject Name	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-661	Management of Information Technology	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
2	BMN-662	Enterprise Business Applications	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--
3	BMN-663	Information Technology Project Management	PEC	1.5	3	0	0	2	- - -	50	---	---	50	--

4	BMN-664	Software Engineering and Management of Software Development	PEC	1.5	3	0	0	2	-	50	---	---	50	--
5	BMN-665	Design of On-Line Systems	PEC	1.5	3	0	0	2	-	50	---	---	50	--
6	BMN-666	Decision Support and Experts Systems	PEC	1.5	3	0	0	2	-	50	---	---	50	--
7	BMN-667	Business Process Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
8	BMN-668	Electronic Commerce and Electronic Governance	PEC	1.5	3	0	0	2	-	50	---	---	50	--

#### (4) Marketing

S.No.	Subject Code	Subject Name	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-671	Internet Marketing	PEC	1.5	3	0	0	2	-	50	---	---	50	--
2	BMN-672	Product and Brand Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
3	BMN-673	Integrated Marketing Communications	PEC	1.5	3	0	0	2	-	50	---	---	50	--
4	BMN-674	Sales and Distribution Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
5	BMN-675	International Marketing	PEC	1.5	3	0	0	2	-	50	---	---	50	--
6	BMN-676	Industrial Marketing	PEC	1.5	3	0	0	2	-	50	---	---	50	--
7	BMN-677	Services Marketing	PEC	1.5	3	0	0	2	-	50	---	---	50	--

8	BMN-524	Consumer Behaviour Analysis	PEC	1	2	0	0	2	-	50	---	---	50	--
9	BMN-691	Marketing Metrics	PEC	1.5	3	0	0	2	-	50	---	---	50	--

### (5) Financial

S.No.	Subject Code	Subject Name	Subject Area	Credit	L	T	P	Exam Dur. (Hrs)		Relative Weightage (%)				
								T	P	CWS	PRS	MTE	ETE	PRE
1	BMN-681	Quantitative Analysis for Financial Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
2	BMN-682	Working Capital Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
3	BMN-683	Security Analysis and Portfolio Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
4	BMN-684	Indian Financial System	PEC	1.5	3	0	0	2	-	50	---	---	50	--
5	BMN-685	International Financial Management	PEC	1.5	3	0	0	2	-	50	---	---	50	--
6	BMN-686	Financial Management Control Systems	PEC	1.5	3	0	0	2	-	50	---	---	50	--
7	BMN-687	Taxation and Tax Planning	PEC	1.5	3	0	0	2	-	50	---	---	50	--
8	BMN-688	Merchant Banking and Financial Services	PEC	1.5	3	0	0	2	-	50	---	---	50	--
9	BMN-689	Financial Statement Analysis and Reporting	PEC	1.5	3	0	0	2	-	50	---	---	50	--
10	BMN-690	Banking and Bank Finance	PEC	1.5	3	0	0	2	-	50	---	---	50	--

**Item No. 86.16: To consider the proposal for the provision of S grade for Autumn Semester 2020-21 End Term Examination for all students.**

The IAPC in its 97<sup>th</sup> meeting held on 11.01.2021 considered the proposal i.e. provision to opt S grade by the students who pass however, not satisfied with their letter grades after the ETE of Autumn Sem 2020-21.

The IAPC did not recommend the proposal and the same has been approved by the Chairman, Senate.

However, the proposal has been received again from the students' community via mail dated Feb 05, 2021 as under: -

"Recently concluded online ETE of UG students has brought forward various inevitable concerns. Students faced disturbances during ETE because of the unstable network/ lack of proper resources, and as a result, most of them are not satisfied with their performance. Apart from this, ensuring a fair amount of integrity through online proctoring is difficult, and this problem was aggravated by the lack of proper infrastructure on the students' side. This has given a chance for some students to follow unfair means. Since grading is relative, this could be distressing for those students who have worked hard but did not get their due share. All these issues would affect the CGPA of a student. So, it is a request from the student community that students should be given a chance to maintain their CGPA this semester with the "S-grade" provision."

The above is submitted for the consideration and approval of the Senate.

**Item No. 86.17: To consider the revised report of the committee constituted to review the current thesis evaluation process for M.Tech./IMT/IDD.**

The Senate in its 78<sup>th</sup> meeting considered the revised guidelines for the evaluation of UG and PG project/ dissertation. On the recommendation of Senate, a five-member committee to review the current thesis evaluation process was constituted by the Chairman, Senate.

The IAPC in its 76<sup>th</sup> and 86<sup>th</sup> meeting held on 07.11.2019 and on 09.06.2020, respectively considered and recommended the report submitted by the committee to review the current thesis evaluation process for M. Tech./IMT/IDD with minor modifications **(Appendix-A)**.

The above is submitted for the consideration of the senate.

**Revised Report: Thesis Evaluation Process for M.Tech./ IMT/IDD**

The revised report of the Committee on thesis evaluation process is as under:

1. The grades of thesis and course work should be separately mentioned.
2. The Chair person should be PG specialization wise. If there are more than 10 students in the specialization, then DAPC may appoint more than one chair person.
3. A soft copy of the M.Tech./IMT/IDD may be sent to all the members of the board at least one week prior the date of evaluation.
4. [A] Distribution of marks should be as under :

a. Supervisor	40 marks
b. Report	15 marks
c. Presentation	15 marks
d. Viva-Voce exam.	20 marks
e. Publication	10 marks

The marks for part “b” to “e” should be awarded by the examination board which should not include the supervisor. The total marks should be converted into grade by absolute grading system.

[B] Publication marks will be as under :

- i) Accepted or published in reputed journals/conferences as decided by DAPC of the Department/Centre - 10 marks
- ii) Published or accepted in a conference organized or supported by National/ International Society – 05 marks

**NOTE :** DAPC should decide in the beginning of each second semester the reputed journals/conferences for awarding 10 marks to the students.

5. Minimum passing grade points should be 05. If a student fails, then he should register for next semester and submit the theses at the end of the semester.

(Ujjwal Prakash)

(Thanga Raj Chelliah)

(Vipul Rastogi)

(B.K. Gandhi)  
Chairman

**Item No. 86.18: To consider the acceptance of Second Class Degree of B.E./B.Tech with 55% and above score with respect to the officers of Indian Army for M.Tech./M.Arch./MURP admission.**

IAPC in 83<sup>rd</sup> its meeting (item no.83.2.7) deliberated towards acceptance of Second Class Degree of B.E./B.Tech with 55% and above score with respect to the officers of Indian Army for M.Tech./M.Arch./MURP admission.

As per the request letter received from Col. Pankaj Geetey, Col, MT-10 for DCOAS (IS&T) NO. A/63062/PGT Policy/GS/MT-10 dated 13 December 2019, it will be applicable to the army officers clearing the selection process and interview conducted by Indian Army & DRDO. Copy is attached at **Appendix-A**.

However, IAPC did not recommend the agenda.

The above is submitted for the consideration of the Senate.



Tele: -2301 6455

Directorate General of  
Military Training (MT-10)  
General Staff Branch  
Integrated HQ of MoD (Army)  
DHQ PO, New Delhi- 110 011

A/63062/PGT Policy/GS/MT-10

✓ Dec 19

**Prof Ajit Kumar Chaturvedi**  
**Director, IIT Roorkee**  
**Roorkee-247 667**

**QUALIFICATION OF SPONSORED CANDIDATES FOR M TECH**

Dear Sir,

1. Indian Army officers are being sponsored for M Tech Courses at your institute each year.
2. These officers are selected through a tough and competitive written entrance exam followed by interview by subject matter experts under aegis of DRDO & eminent experts / scientists from IISc/IIT conducted for Indian Army officers each year.
3. In order to increase the competition and provide greater opportunities as well as motivation to our officers it is proposed that a Second Class Degree of BE/ B Tech with 55% and above score may also be accepted by your institute in case officer has cleared the selection process & interview conducted by India Army & DRDO.
4. Your assistance in this regard will help us motivate officers to achieve higher technological thresholds & assist Indian Army to transcend future battlefields.
5. For consideration please.



(Pankaj Geetey)  
Col  
Col, MT-10  
for DCOAS (IS&T)

Copy to:-

**Registrar IIT Roorkee**  
**Roorkee-247 667**



**Item No. 86.19: To consider Senate Nominees for the selection committees for faculty positions.**

A selection committee for faculty selection includes two BoG nominees and one Senate nominee. The Board in its meeting dated 6<sup>th</sup> March 2019 has resolved that “Academics/Scientists with at least five years of experience of the level of Professor, or equivalent, from the following academic/research institutes be considered part of the list of BoG Nominees, in addition to the names in the Senate list: IITs, IISc, IIMs, SPAs, AIIMS, BHU, JNU, Delhi University, University of Hyderabad and DAE/DoS/DRDO/CSIR/ICAR/ICMR labs/institutes.”

As per Notification Estt. (A)/304/E-1765(II) dated 20<sup>th</sup> August 2008, the Senate has approved that: “Senior Professor/Professors having at least 05 years’ experience as Professor or Scientists ‘G’/Directors of a CSIR, DRDO and other National Level Labs or eminent personalities from the relevant field be nominated by the Senate as experts on the Selection Committees.”

It is proposed that “Academics/Scientists with at least five years of experience of the level of Professor or equivalent from the following academic/Research Institutes be considered part of the list of Senate nominees:

“IITs, IISc, IISERs, IIMs, SPAs, AIIMs, BHU, JNU, Delhi University, University of Hyderabad and DAE/DoS/DRDO/CSIR/ICAR/ICMR labs/institutes.”

The above is submitted for the consideration and approval of the Senate.

**Item No.86.20: To ratify the award of provisional Ph.D. Degree certificates to the students who have completed the requirements for the award of Ph.D. Degree in various disciplines w.e.f. 30.11.2020 to date.**

The list is presented in **Appendix 'A'**.

### Senate approved PDC List

Appendix 'A'

Sl.No.	Name	Deptt.	Topic	Supervisor	Examiner (For./Ind.)	ODC Approval Date
1	Ms. Astha Chauhan	ASE	ANALYTICAL AND NUMERICAL SOLUTIONS OF SELECTED NON-LINEAR PDEs	Prof. Rajan Arora	Prof. Abdul-Majid Wazwaz, saint Xavier Univ., USA Prof. V. D. Sharma, IIT Gandhinagar Prof. Lal Pratap Singh, IIT Varanasi	03.02.21
2	Mr. Manish Kumar	BT	ROLE OF NF-KAPPAB DIMER DYNAMICS IN NF-KAPPAB DRIVEN TRANSCRIPTION	Prof. S. P. Mukherjee	Prof. Tom Huxford, San Deigo State Univ., USA Dr. Soumen Basak, NII Dew Delhi	24.12.20
3	Mr. Mohammad Suhaib Ahmad	CE	BOND BEHAVIOUR OF STEEL IN CONCRETE UNDER FLEXURE WHEN EXPOSED TO FIRE	Prof. Pradeep Bhargava	Prof. Sriman Kumar Bhattacharyya, IIT Kharagpur Prof. J. M. Chandra Kishen, IISc Bangalore Prof. Konjengbam D. Singh, IIT Guwahati	21.01.21
44	Mr. Muskan Mayank	CE	EXPERIMENTAL STUDY OF SOLUTE TRANSPORT THROUGH THREE-DIMENSIONAL POROUS MEDIA	Prof. P. K. Sharma	Prof. J. H. Pu, University of Bradford, UK Prof. Anirban Dhar, IIT Kharagpur	02.02.21
5	Ms. Gunjan Joshi	DoMS	EMPLOYABILITY OF HANDICRAFT WORKERS: MEDIATING ROLE OF SKILL DEVELOPMENT	Prof. R. L. Dhar	Prof. Pooja Purang, IIT Bombay Prof. Rupashree Baral, IIT Madras	10.12.20
6	M. Rahul Kumar Jaiswal	ECE	TERAHERTZ INTEGRATED CIRCUITS USING SPOOF SURFACE PLASMON POLARITONS	Prof. N. P. Pathak	Prof. Shibam K. Koul, IIT Delhi Prof. M. Jaleel Akhtar, IIT Kanpur Prof. Girish Kumar, IIT Bombay	12.01.21
7	Mr. Raj Kumar	ECE	INVESTIGATION ON RADIATING ELEMENTS FOR ELECTRONICALLY STEERED PHASED ARRAY ANTENNA FOR AIRBORNE SATCOM	Prof. M. V. Kartikeyan	Prof. D. Anagnostou, Heriot Watt Univ., Scotland Dr. Anil Kumar Singh, DRDO Hyderabad	12.01.21
8	Mr. Alok Raj Gupta	ES	A GRAIN CONDUCTIVITY APPROACH FOR WATER SATURATION ESTIMATION OF SHALY SANDS	Prof. Kamal	Prof. Andre Revil, Universite Savoie Mont-Blanc Edytem CNRS UMR, France Prof. Kumar Hemant Singh, IIT Bombay	14.01.21
9	Mr. Charmala Suresh	HRE	STUDY OF COMBINED SENSIBLE AND LATENT HEAT SOLAR THERMAL ENERGY STORAGE SYSTEM	Prof. R. P. Saini	Prof. K. Srinivas Reddy, IIT Madras Prof. P. Mathukumar, IIT Guwahati	19.01.21
10	Mr. Abdul Haq	MA	APPROXIMATE CONTROLLABILITY OF INFINITE DIMENSIONAL SEMILINEAR CONTROL SYSTEMS	Prof. N. Sukavanam	Prof. Dharendra Bahuguna, IIT Kanpur Prof. Subir Das, IIT Varanasi	28.12.20

11	Mr. T. Sudhakar	MIE	UNDERSTANDING INTERFACIAL EVOLUTION OF A TAYLOR DROP IN LIQUID FILLED PIPE JUNCTION USING LATTICE BOLTZMANN METHOD	Prof. Arup Kumar Das	Prof. Prasanta Kumar Das, IIT Kharagpur Prof. Gautam Biswas, IIT Kanpur	08.01.21
12	Mr. Aditya Kumar	MIE	NATURAL CONVECTION IN MAGNETIC NANOFLUIDS	Prof. Sudhakar Subudhi	Prof. Milind V. Rane, IIT Bombay Prof. Kirti Chandra Sahu, IIT Hyderabad	14.01.21
13	Mr. Ranjeet Singh Rathore	MIE	INVESTIGATIONS ON ULTRASONIC ASSISTED ELECTROCHEMICAL DISCHARGE MACHINING PROCESS	Prof. Akshay Dvivedi	Prof. J. Ramkumar, IIT Kanpur Prof. Somashekhar S. Hiremath, IIT Madras Prof. Pulak Mohan Pandey, IIT Delhi	29.01.21
14	Mr. Jimmy Karloopia	MIE	SOME STUDIES ON SYNTHESIS AND CHARACTERIZATION OF IN-SITU Al-12%Si-TiB <sub>2</sub> METAL MATRIX COMPOSITES	Prof. P. K. Jha	Prof. Somashekhar S. Hiremath, IIT Madras Prof. J. Ramkumar, IIT Kanpur	30.01.21
15	Mr. Surendra K. Chourasiya	MME	CHARACTERIZATION OF WARM ROLLED SPRAY FORMED ALUMINIUM-SILICON GRAPHITE COMPOSITE	Prof. S. K. Nath Prof. Devendra Singh	Prof. Sunil Mohan, IIT Varanasi Prof. Sudarsan Ghosh, IIT Delhi	19.01.21
16	Mr. Sumit Kumar	MME	HOT DEFORMATION AND PROCESSING MAPS OF ROTOR STEELS	Prof. S. K. Nath Prof. G. P. Chaudhari	Prof. R. Devesh K. Misra, Univ. of Texas at El Paso, USA Prof. Debalay Chakrabarti, IIT Kharagpur	04.02.21
17	Mr. Uma Shanker Tripathi	PH	LIQUID CRYSTAL BASED INTEGRATED OPTIC COMPONENTS AND DEVICES	Prof. Vipul Rastogi	Prof. Pascal Baldi, Univ. Nice-Sophia Antipolis, France Prof. Aloka Sinha, IIT Delhi	07.01.21
18	Mr. Shiv Dutt Purohit	PPE	NANOCOMPOSITE SCAFFOLDS FOR BONE TISSUE ENGINEERING	Prof. N. C. Mishra	Prof. Abhay Pandit, National Univ. of Ireland Galway Prof. Durba Pal, IIT Ropar	21.01.21
19	Prof. Anil Kumar	PPE	DESIGN, SYNTHESIS AND CHARACTERIZATION OF NOVEL LIGANDS AND CORRESPONDING METALLOPOLYMERS AND THEIR APPLICATION AS LUMINESCENT FUNCTIONAL MATERIALS	Prof. A. Bandyopadhyay	Prof. P. S. Mukherjee, IISc Bangalore Prof. Priyadarsi De, IISER Kolkata	01.02.21

**Item No. 86.21: To report the extension of panel of Senate's Nominees on the Selection Committees for Group 'A' Academic positions.**

The Chairman, Senate has approved the extension of panel of Senate's Nominees on the Selection Committees for Group 'A' Academic positions till the fresh panel of the Senate nominees is approved.

The above is reported to the Senate.

**Item No. 86.22 To consider the admission of foreign nationals in MBA programme (2021-22).**

The IAPC in its 98<sup>th</sup> meeting (vide its agenda item (98.3.1.) recommended the proposal with minor modifications.

The admission process towards the same is to be started from next academic year. Guidelines are given below:

1. There should be a fixed window for applying to MBA admission programme at IIT Roorkee. This will help to shortlist the potential candidates for next rounds.
2. Shortlisted candidates will go for WAT-PI rounds.
3. Requirements for shortlisting:
  - (a) Applicant should have minimum 600 score in GMAT.
  - (b) Applicant should have First class or equivalent marks (60%) or equivalent CGPA.
  - (c) Application should also have two letters of reference.
4. Selection will be based on GMAT Score (40%) weightage, academic background (15%), WAT (10%), PI (20%), geographical diversity (10%) and Work Experience (5%).
5. Admission of suitable foreign candidates will be done over and above sanctioned intake of 95 seats.

The above is submitted for the consideration of the Senate.

**Item No. 86.23: To consider the request of the students to allow them to appear in the second examination of ETE Autumn Semester 2020-21.**

Many students has informed through their Course-coordinator that they were unable to appear in the ETE of Autumn Semester 2020-21 due to poor internet connection and Internet Shutdown by the Haryana Government.

These students has also requested to allow them to appear in the Second Examination which will be held between 18-20<sup>th</sup> February 2021. It is proposed that such students be allowed to submit their request to AAO through respective Course Coordinator, Chairman DAPC/CAPC and HoD/HoC.

The above is submitted for the consideration and approval of the Senate.