INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE
ROORKEE-247 667 (INDIA)

Minutes for the 59th meeting of the Senate held on 27th February 2015 at 04.00 P.M. in the Senate Hall of the Institute.

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MEETING SECTION
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Minutes of the 59th Meeting of the Senate held on 27.02.2015 in the Senate Hall of the Institute.

Following were present:

1.	Prof. Pradipta Banerji	Director & Chairman
2.	Prof. (Mrs.) Pushplata	(Architecture & Planning)
3.	Prof. V. Devdas	(Architecture & Planning)
4.	Prof. (Mrs.) Ila Gupta	(Architecture & Planning)
5.	Prof. G.S. Randhawa	(Biotechnology)
6.	Prof. R.P. Singh	(Biotechnology)
7.	Prof. Ramasare Prasad	(Biotechnology)
8.	Prof. Vikas Pruthi	(Biotechnology)
9.	Prof. Bikash Mohanty	(Chemical Engineering)
10.	Prof. Shri Chand	(Chemical Engineering)
11.	Prof. Vijay Kumar Agarwal	(Chemical Engineering)
12.	Prof. C.B. Majumdar	(Chemical Engineering)
13.	Prof. R.N. Goyal	(Chemistry)
14.	Prof. Anil Kumar	(Chemistry)
15.	Prof. (Mrs.) Mala Nath	(Chemistry)
16.	Prof. A.K. Singh	(Chemistry)
17.	Prof. U.P. Singh	(Chemistry)
18.	Prof. M.R. Maurya	(Chemistry)
19.	Prof. K.C. Gupta	(Chemistry)
20.	Prof. Bina Gupta	(Chemistry)
21.	Prof. S.S. Jain	(Civil Engineering)
22.	Prof. Deepak Kashyap	(Civil Engineering)
23.	Prof. P.K. Garg	(Civil Engineering)
24.	Prof. C.S.P. Ojha	(Civil Engineering)
25.	Prof. Pradeep Bhargava	(Civil Engineering)
26.	Prof. S.K. Ghosh	(Civil Engineering)
27.	Prof. Mahendra Singh	(Civil Engineering)
28.	Prof. M.Parida	(Civil Engineering)
29.	Prof. N.K. Samadhiya	(Civil Engineering)
30.	Prof. K.S. Hari Prasad	(Civil Engineering)
31.	Prof. Akhil Upadhyay	(Civil Engineering)

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32.	Prof. Kamal Jain	(Civil Engineering)
33.	Prof. B.R. Gurjar	(Civil Engineering)
34.	Prof. Vipul Praiash	(Civil Engineering)
35.	Prof. Manoj Mishra	(Computer Science & Engineering)
36.	Prof. M.L.Sharma	(Earthquake Engineering)
37.	Prof. Ashok Kumar	(Earthquake Engineering)
38.	Prof. (Mrs.) Amita Sinvhal	(Earthquake Engineering)
39.	Prof. Yogendra Singh	(Earthquake Engineering)
40.	Prof. Bal Krishna Maheshwari	(Earthquake Engineering)
41.	Prof. Manish Shrikhande	(Earthquake Engineering)
42.	Prof. D.K. Mukhopadhyay	(Earth Sciences)
43.	Prof. A.K. Saraf	(Earth Sciences)
44.	Prof. Sandeep Singh	(Earth Sciences)
45.	Prof. Anand Joshi	(Earth Sciences)
46.	Prof. R. Krishnamurthi	(Earth Science)
47.	Prof. S.P. Gupta	(Electrical Engineering)
48.	Prof. Pramod Agarwal	(Electrical Engineering)
49.	Prof. G.K. Singh	(Electrical Engineering)
50.	Prof. Sajjan Pal Singh	(Electrical Engineering)
51.	Prof. R.P. Maheshwari	(Electrical Engineering)
52.	Prof. S.P. Srivastava	(Electrical Engineering)
53.	Prof. Rajendra Prasad	(Electrical Engineering)
54.	Prof. M.V. Kartikeyan	(Electronics & Communication Engg.)
55.	Prof. Dharmendra Singh	(Electronics & Communication Engg.)
56.	Prof. Himanshu Joshi	(Hydrology)
57.	Prof. Pushupati Jha	(Humanities & Social Sciences)
58.	Prof. Sukh Pal Singh	(Humanities & Social Sciences)
59.	Prof. Nagendra Kumar	(Humanities & Social Sciences)
60.	Prof. Dharam Dutt	(Paper Technology)
61.	Prof. S.C. Sharma	(Paper Technology)
62.	Prof. S.P. Sharma	(Mathematics)
63.	Prof. (Mrs.) Rama Bhargava	(Mathematics)
64.	Prof. V.K. Katiyar	(Mathematics)
65.	Prof. Kusum Deep	(Mathematics)
66.	Prof. Tanuja Srivastava	(Mathematics)
67.	Prof. N. Sukavanam	(Mathematics)
68.	Prof. S.C. Sharma	(Mechanical & Industrial Engg.)
69.	Prof. P.K. Jain	(Mechanical & Industrial Engg.)
70.	Prof. Dinesh Kumar	(Mechanical & Industrial Engg.)
71.	Prof. B.K. Gandhi	(Mechanical & Industrial Engg.)
72.	Prof. Ravi Kumar	(Mechanical & Industrial Engg.)
73.	Prof. D.K.Dwivedi	(Mechanical & Industrial Engg.)
74.	Prof. Navneet Arora	(Mechanical & Industrial Engg.)
75.	Prof. P.K. Ghosh	(Metallurgical & Materials Engg.)
76.	Prof. S.K. Nath	(Metallurgical & Materials Engg.)
77.	Prof. Anjan Sil	(Metallurgical & Materials Engg.)

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78. Prof. B.S.S. Daniel (Metallurgical & Materials Engg.)
79. Prof. R. Jayaganathan (Metallurgical & Materials Engg.)
80. Prof. A.K. Jain (Physics)
81. Prof. Davinder Kaur Walia (Physics)
82. Prof. M.L. Kansal (WRD&M)
83. Prof. Deepak Khare (WRD&M)
84. Prof. S.K.Mishra (WRD&M)
85. Prof. Ramesh Chandra (Institute Instrumentation Centre)
86. Dr. M.P. Sharma Alternate Hydro Energy Centre
87. Dr. R. Balasubramanian, Institute Computer Centre
88. Dr. P. Jeevanandam Associate Dean of Students' Welfare (Foreign Students)
89. Dr. Apurbba Kumar Sharma Associate Dean, Academic Studies
90. Dr. Yogendra Singh Librarian
91. Dr. Pravindra Kumar, Associate Professor, Biotechnology
92. Dr. Anil K. Gourishetty, Associate Professor, Civil Engineering
93. Dr. Inderdeep Singh, Associate Professor, Mechanical & Industrial Engineering
94. Dr. A. Swaminathan, Associate Professor, Mathematics
95. Lt. Col. (Retd.) A.K. Srivastava, Registrar & Secretary, Senate

The Chairman (Director) welcomed the members to the 59th Meeting of the Senate.

Before taking up the agenda, the Chairman thanked the under-mentioned outgoing Senate members and recorded its appreciation for their valuable contributions in the meetings of the Senate:

1. Prof. M.N. Viladkar, Department of Civil Engineering
2. Dr. R.P. Saini, A.H.E.C.

The Chairman also welcomed the under-mentioned new members to the Senate and hoped for their valuable contributions and active participation in its functioning:

1. Dr. M.P. Sharma, Head, Alternate Hydro Energy Centre
2. Dr. D.S.Arya, Head, Hydrology
3. Dr. R. Balasubramanian, Head, Institute Computer Centre

The Senate noted the communications received from the following members for not attending the current meeting:

1. Dr. R.K.Peddiniti, Associate Dean, Academic Research
2. Prof. Tashi Nautiyal, Department of Physics
3. Prof. Rajesh Srivastava, Department of Physics
4. Prof. G.J. Chakrapani, Department of Earth Sciences
5. Prof. Partha Roy, Department of Biotechnology

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6. Prof. Vinod Kumar, Department of Electrical Engineering
7. Prof. D.C.Srivastava, Department of Earth Sciences
8. Prof. Ravi Bhushan, Department of Chemistry

The Agenda was then taken up:

Item No. 59.1: **To confirm the minutes of the 58th meeting of the Senate held on 9th December 2014.**

The minutes of the 58th meeting of the Senate held on 9th December 2014 were confirmed.

Item No.59.2: **To receive a report on the actions taken to implement the decisions taken by the Senate in its 58th meeting held on 9th December 2014.**

The Senate noted the actions taken on the resolutions of the 58th meeting held on 9th December 2014.

Before taking up the agenda, the following were also resolved:

1) Answer copies of MTE must be shown and given to students within a week of last day of examination so that the students can withdraw from a subject, if required.

2) End Term Examination copies must also be shown to students within the stipulated time as per academic calendar and may be given to students.

3) Research scholars shall not be engaged in Lecture class.

4) The departments shall make efforts for the up-gradation of laboratories with the funds available with the department.

Item No. 59.3: **To consider the UG Electives as per Category I & Category II received from the following Departments:**

1. **Department of Chemical Engineering**
2. **Department of Computer Science and Engineering**
3. **Department of Electronics and Communication Engineering**
4. **Department of Mechanical & Industrial Engineering**
5. **Department of Metallurgical and Materials Engineering**

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As considered and recommended by the IAPC, the Senate decided that the UG Electives as per Category I & Category II received from the above Departments be approved with minor modification as given at **Appendix 'A'.**

Item No. 59.4: **To consider the syllabi of the following programme courses as proposed by Saharanpur campus:-**

1. **M.Tech. Packaging Technology**
2. **M.Tech. (Pulp & Paper)**
3. **Pre-Ph.D. course**
4. **Minor correction in the structure of Polymer Science & Technology**

As considered and recommended by the IAPC, the Senate decided that the syllabi of the under-mentioned courses of M. Tech. courses as proposed by the different Departments at Saharanpur Campus be approved:

(a) Packaging Technology
(b) Pulp and Paper
(c) Pre-Ph.D.

Further, the Senate decided that the syllabi of all these subjects after incorporating the minor modifications suggested by members be approved as given in **Appendix 'B'.**

Item No. 59.5: **To consider the revised syllabus of EE-580: Advanced Linear Control Systems and EE-582: Advanced System Engineering proposed by the Department of Electrical Engineering**

As considered and recommended by the IAPC, the Senate decided that the syllabi of the following subjects as proposed by Department of Electrical Engineering be approved:

1) **EE-580: Advanced Linear Control Systems**
2) **EE-582: Advanced System Engineering**

The approved syllabi are given in **Appendix-C.**

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Item No.59.6: **To consider the proposal of converting all DCC and DEC categories with PCC and PEC, respectively.**

The Senate decided that, henceforth, all UG and PG courses will be categorized either as Programme Core Course (PCC) or Programme Elective Course (PEC) to take care of interdisciplinary programmes as well as multiple programme being run by same department and accordingly all existing Departmental Core Course (DCC) and Departmental Elective Course (DEC) categories will be replaced by PCC and PEC categories, respectively.

Item No. 59.7: **To consider the payment of Rs. 500/- per subject in a semester (both for Mid Term Examination & End Term Examination) to the scribes and also to give a certificate to the scribes by the Dean (Academics) appreciating their work in helping to the Physical Challenged students.**

The Senate decided that scribes engaged in Mid Term and End Term Examination will be paid @ ₹.100/- per hour and a certificate will be given by the Dean, Academics appreciating their work in helping Physically Challenged Students.

Item No. 59.8: **To consider the request of Mr. Rakesh Kumar Yadav, B.Tech. (Civil), 3rd year regarding Merit-cum-Means scholarship criteria.**

As considered and recommended by the IAPC, the Senate decided that the merit list for deciding Merit-cum-Means scholarship will be prepared on the basis of either CGPA at that point or YGPA (Yearly Grade Point Average i.e., Average of previous two semesters SGPA taking all subjects registered in that year) whichever is higher.

Further, the Senate also decided that this will be applicable from the 2015-16 session.

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Item No. 59.9: To consider the request of Mr. Ashutosh Rungta, B.Tech. (Chemical), II Yr to reconsider the policy of lowering the grade on medical grounds.

The Senate decided, in principle, that grade of a genuine student who falls sick during ETE or MTE be not lowered but during discussion it was observed that the matter needs to be re-considered to decide whether a case is genuine or not. The matter was deferred for the next meeting of the Senate.

Item No. 59.10: To consider the structure and syllabus of 4-year B. Tech. programme in Polymer Science and Engineering proposed by the Department of Chemical Engineering as resolved in the ECS meeting held on January 05, 2015.

As considered and recommended by the IAPC, the Senate decided that that 4-year B. Tech. program in Polymer Science & Engineering as per decision of the ECS on January 05, 2015 will start from the session 2015-16 with an intake of 40 seats. The structure of the programme proposed by the 4 member committee and later recommended by IAPC is approved. The structure of the programme is given in **Appendix 'D'**

The Senate further decided that this programme being a multi-disciplinary programme will be coordinated by a coordinator. But the subjects will be taught by the faculty of the departments involved. Further, it was decided that the concerned departments be requested to prepare the syllabi of the subjects and send through coordinating committee so that the syllabi be considered by IAPC and Senate before the start of next session.

Item No.59.11: To consider the structure and syllabus of 4-year B.Tech. programme in Engineering Physics proposed by the Department of Physics.

As considered and recommended by the IAPC, the Senate Decided that 4-year B. Tech. programme in Engineering Physics, proposed by the Department of Physics as per suggestion of ECS held on January 05, 2015 will start from the session 2015-16 with intake of 30 seats. The structure of the programme proposed by the department and recommended by IAPC is approved. The approved structure of the programme is given in **Appendix 'E'**

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The Senate further decided that this programme being multi-disciplinary in nature will be taught by the faculty of the departments involved and it was also agreed by the departments involved. The list of programme electives may be increased to include other related subjects. Further, it was decided that the department be requested to prepare the syllabi of the subjects and send them at the earliest so that the same be considered by the IAPC and the Senate before the commencement of next session.

Item No. 59.12: To consider the concept note, structure and syllabus of M.Sc. in Economics programme received from Prof.& Head, Department of Humanities & Social Sciences.

As considered and recommended by the IAPC, the Senate decided that 2-year M.Sc. programme in Economics, proposed by the Department of Humanities and Social Sciences be accepted in principle, to start from the session 2016-17 with an intake of 30 seats. However, the Department was requested to provide more information about the job prospect of the students, minimum qualification for admission eligibility and mode of admitting students in the programme.

The Senate further decided that in the one year period, the Department will make efforts to increase the faculty in the area of Economics so that the existing faculty is not overloaded as they have to teach students of other B. Tech. programmes. Faculty from Department of Management Studies may also be taken in this regard.

Item No. 59.13: To consider structure for starting the 4-year B.Tech. (Engineering Chemistry) programme in the Department of Chemistry.

As considered and recommended by the IAPC, the Senate decided that the 4-year B. Tech. programme in Industrial Chemistry, proposed by the Department of Chemistry be deferred for the next meeting of Senate. In the mean time, the Department was requested to provide proper justification for starting such type of programme, job prospects of students and information from other premier institutions running this type of programme for re-consideration of the Senate.

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Item No. 59.14: To consider the modification related to Ph.D. Ordinances and Regulations.

The Senate considered the suggestions received from the members and decided that these suggestions be incorporated in Ph.D. Ordinance and Regulations. It was also decided that modified Ph.D. Ordinances and Regulations be sent to all faculty members with a request to send their suggestions within a week to the Dean Academics. These suggestions will be compiled and presented before the ECS for consideration. The finalized Ph.D. Ordinances and Regulations will be reported in the next meeting of the Senate.

Item No. 59.15: To report the enhancement of the remuneration to the examiners examining the Ph.D. Theses w.e.f. July 2015.

The Senate noted that the Director as Chairman, Senate has approved the enhancement of remuneration to the examiners of the Ph.D. thesis w.e.f. July 2015 as below:

Indian Examiner:	Evaluation of thesis	= ₹ 10,000.00
	Viva-Voce examination	= ₹ 3,000.00
Foreign examiner:	Evaluation of thesis	= US$ 500.00

Item No. 59.16: To report that a separate Mid Term Examination shall not be conducted in respect of such students who represent IIT Roorkee in technical competitions/sports meets etc. during the period of the MTE, with due permission of Institute and that they will be awarded marks for the MTE on the basis of their performance in the ETC.

The Senate re-considered the matter as the opinion of the faculty, in general, was not to award marks of MTE on the basis of ETE only. After discussion, it was decided that every student shall have to appear for MTE. However, if the student is permitted to represent IIT Roorkee in any competition during the period of MTE, he/she will be allowed to appear in the second MTE to be held within 15 days from the completion of the first MTE with full weight alongwith the student(s) allowed to appear for the second MTE on medical ground. The faculty members may conduct the MTE in respect of these students as notified by the academic section as per their convenience. No separate schedule for second

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examination will be announced. Here, the context of the second MTE is holding the MTE for the second time, in case they were not able to appear for the same on the first occasion on account of the circumstances stated above. The structure remains unchanged i.e., one MTE and one ETE.

Item No. 59.17: To report the starting of 4 year B. Tech. Programmes in Polymer Science & Engineering and Engineering Physics at Roorkee Campus.

The Senate noted that Director as Chairman Senate has approved the following:

1. The **B.Tech. Dual Degree (Process Engineering) with MBA** and **B.Tech. (Polymer Science & Technology)** programmes at Saharanpur campus will be phased out from the Academic Session starting from July 2015.
2. A new 4-year **B.Tech. Programme in Polymer Science & Engineering** with 40 seats will be started from the academic session 2015-16 at Roorkee campus.
3. A new 4-year **B.Tech. Programme in Engineering Physics** with 30 seats will be started from the academic session 2015-16 at Roorkee campus in place of **Integrated M.Sc.(Physics)**.

Item No. 59.18: To consider and approve the Academic Calendar for the Academic Session 2015-16.

The Senate decided that the Academic Calendar for the Academic Session 2015-16 as recommended by the committee with minor changes be approved as given at **Appendix 'F'.**

Item No. 59.19: To consider certain changes/ modifications in existing Tables-1, 2 & 6 for the PG Information Brochure 2015.

The Senate decided that the changes/modifications as given in the **Appendix 'G'** for the PG Information Brochure 2015 be approved.

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UNDER ANY OTHER ITEM:

Item No. 59.20: To report the letter F.No. 17-2/2014-TS.I dated 18th February 2015 and 2nd March 2015 of MHRD, New Delhi regarding revision of the rates of Ph.D. Scholarship in AICTE funded and Centrally Funded Technical Institutions under the Ministry of Human Resource Development.

The Senate noted the letter F.No. 17-2/2014-TS.I dated 18th February 2015 and 2nd March 2015 of MHRD, New Delhi regarding revision of the rates of Ph.D. Scholarship in AICTE funded and Centrally Funded Technical Institutions under the Ministry of Human Resource Development.**(Appendix 'H')**

Item No. 59.21: To consider the mode of examination (closed book to open book) as recommended by the IAPC.

The Senate considered and only noted the recommendation of the IAPC that the present mode of examination as approved by the Senate will continue. However, if any Department wants to change the mode of examination of any course from closed book to open book, the Department should send the proposal through the DFC for consideration of the IAPC and then the Senate.

The meeting ended with a vote of thanks to the Chair.

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Appendix-A

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Department of Chemical Engineering (Department Electives)

Category-1

Sl. No.	Autumn/Spring Semesters	
	Course No.	Name of Elective Course
1.	CHN-321	Biochemical Engineering
2.	CHN-322	Optimization of Chemical Engineering Processes
3.	CHN-323	Computer Application in Chemical Engineering
4.	CHN-324	Computational Fluid Dynamics
5.	CHN-325	Process Integration
6.	CHN-326	Fluidization Engineering
7.	CHN-327	Petroleum Refining
8.	CHN-328	Petrochemicals
9.	CHN-329	Fertilizer Technology

Category-2 Stream 1

Sl.No.	Autumn/Spring Semesters	
	Course No.	Name of Elective Course
1.	CHN-411	Polymer Physics and Rheology
2.	CHN-412	Modeling of Dynamic Systems*
3.	CHN-413	Novel Separation Techniques*
4.	CHN-414	Advanced Process Control
5.	CHN-415	Heterogonous Catalysis & Reactor Design
6.	CHN-416	Design of Piping System
7.	CHN-418	Advances in Fluid Mechanics*
8.	CHN-419	Probability and System's Reliability
9.	CHN-420	Advances in Heat Transfer*
10.	CHN-423	Microfluidics*
11.	CHN-425	Nanotechnology in Chemical Engineering*
12.	CHN-431	Fuel Cells Fundamentals*
13.	CHN-505	Chemical Reactor Analysis
14.	CHN-507	CAD of Heat Transfer Equipment*
15.	CHN-502	CAD of Mass Transfer Equipment*
16.	CHN-570	Natural Gas Engineering*

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Category- 2 Stream 2

Sl.No.	Autumn/Spring Semesters	
	Course No.	**Name of Elective Course**
1.	CHN-413	Novel Separation Techniques*
2.	CHN-417	Industrial Safety & Hazards Management*
3.	CHN-419	Probability and System's Reliability
4.	CHN-424	Industrial Pollution Abatement
5.	CHN-425	Nanotechnology in Chemical Engineering*
6.	CHN-427	Clean Technology in Process Industries*
7.	CHN-429	Waste-to-Energy*
8.	CHN-431	Fuel Cells Fundamentals*
9.	CHN-511	Air Pollution Control Engineering
10.	CHN-513	Water Pollution Control Engineering
11.	CHN-515	System Approach to Environmental Engineering*
12.	CHN-571	Data Acquisition and Monitoring Techniques
13.	CHN-582	Environmental Impact Assessment*
14.	CHN-586	Design of Pollution Control Systems*
15.	CHN-590	Environmental Chemistry

- Honours degree will be given to those student who study *mark courses.

Department of Computer Science & Engineering.

UG Category I:

S.No.	Course Code	Subject Name
1.	CSN-371	Artificial Intelligence
2.	CSN-372	Computer Graphics
3.	CSN-373	Probability Theory for Computer Engineering
4.	CSN-381	Information Retrieval
5.	CSN-382	Machine Learning
6.	CSN-521	Mobile and Pervasive Computing and
7.	CSN-510	Network Programming

UG Category II:

S.No.	Course Code	Subject Name
1.	CSN-471	Computer Vision
2.	CSN-475	Parallel and Distributed Algorithms
3.	CSN-476	Software Project Management
4.	CSN-481	Bioinformatics
5.	CSN-483	Intrusion Detection Systems
6.	CSN-484	Multimedia
7.	CSN-485	Quantum Computing, and
8.	CSN-513	Information Network Security
9.	CSN-515	Datamining and Warehousing,
10.	CSN-516	Modeling and Simulation
11.	CSN-519	Social Network Analysis

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12.	CSN-520	Cloud Computing

Department of Electronics and Communication Engineering

Category I: Electives / Honours Courses (for 3rd year)

S.No.	Course Code	Subject Name
1.	ECN - 314	Telecommunication Switching, Networks and Protocols
2.	ECN - 343	Fundamentals of Microelectronics
3.	ECN - 316	Digital Image Processing
4.	ECN - 344	Embedded Engineering Design
5.	CSN - 341	Computer Networks
6.	CSN - 371	Artificial Intelligence

Category II: Electives / Honours Courses (for 4th year)

S.No.	Course Code	Subject Name
1.	ECN - 512	Information and Communication Theory
2.	ECN - 523	Robotics & Computer Vision
3.	ECN - 532	Advanced Electro-Magnetic Field Theory
4.	ECN - 534	Antenna Theory & Design
5.	ECN - 539	Fibre Optics Systems
6.	ECN - 572	MOS Device Physics
7.	ECN - 573	Digital VLSI Circuits
8.	ECN - 581	Analog VLSI Circuits
9.	ECN - 515	Coding Theory and Applications
10.	ECN - 518	Speech and Audio Processing
11.	ECN - 550	Radar Signal Processing
12.	ECN - 554	Microwave and Millimeter - Wave Circuits
13.	ECN - 577	VLSI Technology
14.	ECN - 584	Mixed Signal Circuits
15.	ECN - 593	CAD and VLSI
16.	ECN - 612	Wireless Networks
17.	ECN - 614	Adaptive Signal Processing Techniques
18.	ECN - 631	RF Receiver Design

Following is the list of courses from which five courses to be taken by the students for obtaining degree with Minor Specialization in Electronics & Communication Engg. Students need to register for at least three 4-credit courses (out of the required five courses) to make total credits in the range 18 to 20.

Sl.No.	Course No.	Course Title
1.	ECN - 104	Digital Logic Design
2.	ECN - 142	Semiconductor Devices
3.	ECN - 203	Signals and Systems
4.	ECN - 205	Analog Circuits

5.	ECN - 212	Priciples of Digital Communication
6.	ECN - 232	Engineering Electromagnetics
7.	ECN - 291	Electronic Network Theory
8.	ECN - 311	Communication Systems and Techniques
9.	ECN - 312	Digital Signal Processing
10.	ECN - 331	Antenna Theory
11.	ECN - 333	Microwave Engineering

Department of Mechanical and Industrial Engineering

Mechanical Engineering: Minor Specialization Courses (MSC1 MSC2 MSC3 MSC4 MSC 5)

Design Courses (Two Courses from this part)

Sl. No.	Course No.	Course Title
1.	MIN-206	Mechanics of Materials
2.	MIN-211	Theory of Machines
3.	MIN-212	Machine Design

Thermal Courses (Two Courses from this part)

Sl. No.	Course No.	Course Title
1.	MIN-205	Fluid Mechanics
2.	MIN-304	Fluid Machinery
3.	MIN-305	Heat and Mass Transfer
4.	MIN-210	Energy Conversion
5.	MIN-106	Engineering Thermodynamics

Production and Industrial Courses (One Courses from this part)

Sl. No.	Course No.	Course Title
1.	MIN-208	Theory of Production Processes
2.	MIN-303	Principles of Industrial Engineering

Category-I (Mechanical) Department Elective Courses at 3rd yr level (MIN-ELE1/ELE2)

Sl. No.	Course No.	Course Title
1.	MIN-320	Automobile Engineering
2.	MIN-321	Vibration and Noise
3.	MIN-322	Principles of Lubrication Technology
4.	MIN-323	Design of Pressure Vessels & Piping
5.	MIN-324	FEM applications in Mechanical Engg.
6.	MIN-325	Numerical Methods in Manufacturing
7.	MIN-326	Value Engineering

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8.	MIN-327	Reverse Engineering
9.	MIN-328	Manufacturing System Analysis
10.	MIN-329	Computer Integrated Manufacturing
11.	MIN-330	Ergonomics
12.	MIN-331	Total Quality Management
13.	MIN-332	Industrial Hazards and Safety
14.	MIN-333	Industrial Management
15.	MIN-334	Facilities Design
16.	MIN-335	Concurrent Engineering
17.	MIN-336	Financial Management
18.	MIN-337	Processing of Non-Metals
19.	MIN-338	Measurement and Instrumentation
20.	MIN-339	Design of Heat Exchangers
21.	MIN-340	Refrigeration and Air-Conditioning
22.	MIN-341	Thermal Systems Design
23.	MIN-342	Environmental Pollution and Control
24.	MIN-343	Power Plants
25.	MIN-344	Industrial Combustion
26.	MIN-345	Compressible Flow
27.	MIN-346	Waste Heat recovery Systems
28.	MIN-349	Fire Dynamics
29.	MIN-350	Industrial Ventilation and Air Conditioning
30.	MIN-351	Gas Turbines
31.	MIN-352	Experimental Methods in Thermal Engineering
32.	MIN-354	Automatic Control

Category-II (Mechanical) Electives Floated at 4th Yr Level

(Machine Design Engineering)

Sl. No.	Course No.	Course Title
1.	MIN-410	Product and Process Optimization
2.	MIN-411	Maintenance Technology for Rotating Components
3.	MIN-412	Vehicle Dynamics
4.	MIN-413	Micro Electro Mechanical Systems
5.	MIN-415	Piping Technology
6.	MIN-416	Non Linear Dynamics
7.	MIN-417	Energy and Variational Principles in Engineering Mechanics
8.	MIN-500	Instrumentation and Experimental Methods
9.	MIN-502	Robotics and Control
10.	MIN-508	Advanced Automatic Control
11.	MIN-509	Extended Finite Element Methods
12.	MIN-553	Industrial Tribology
13.	MIN-554	Computer Aided Mechanism Design
14.	MIN-555	Experimental Stress Analysis
15.	MIN-556	Dynamics of Road Vehicles

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16.	MIN-558	Fracture Mechanics
17.	MIN-559	Computer Aided Design
18.	MIN-560	Mechanics of Composite Materials
19.	MIN-561	Advanced Mechanical Vibrations
20.	MIN-562	Noise Control in Mechanical Systems
21.	MIN-563	Mechatronics
22.	MIN-565	Smart Materials, Structures, and Devices
23.	MIN-516	Artificial Intelligence
24.	MIN-550	Advanced Machine Design
25.	MIN-551	Dynamics of Mechanical Systems
26.	MIN-566	Computer Aided Analysis of Mechanical Systems
27.	MIN-567	Computer Graphics
28.	MIN-568	Advanced Robotics

(Production and Industrial Engineering)

Sl. No.	Course No.	Course Title
1.	MIN-573	Design for Manufacturability
2.	MIN-574	Maintenance Management
3.	MIN-575	Product Design and Development
4.	MIN-576	Machine Tool Design and Numerical Control
5.	MIN-577	Industrial Automation
6.	MIN-578	Computer Aided Process Planning
7.	MIN-579	Information Systems and Data Management
8.	MIN-580	Welding Science
9.	MIN-581	Manufacturing Resources Management
10.	MIN-582	Flexible Manufacturing Systems
11.	MIN-583	Materials Management
12.	MIN-584	Operations Research
13.	MIN-585	Supply Chain Management
14.	MIN-586	Metal Forming
15.	MIN-587	Metal Casting
16.	MIN-588	Non-Traditional Machining Processes
17.	MIN-593	Non-Conventional Welding Processes
18.	MIN-594	Safety Aspects of Welded Structures
19.	MIN-595	Failure Analysis of Welding Joints
20.	MIN-596	Automation & Application of Robots in Welding
21.	MIN-597	Welding Procedures for Specific Applications
22.	MIN-598	Weldability of Metals
23.	MIN-599	Surface Engineering

(Thermal Engineering)

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Sl. No.	Course No.	Course Title
1.	MIN-523	Gas Turbines & Compressors
2.	MIN-524	Two Phase Flow & Heat Transfer
3.	MIN-525	Solar Energy
4.	MIN-526	Advanced Gas Dynamics
5.	MIN-527	Computational Fluid Dynamics & Heat Transfer
6.	MIN-528	Boundary Layer Theory
7.	MIN-529	Turbulent Flows
8.	MIN-530	Cold Preservation of Foods
9.	MIN-531	Hydro-dynamic Machines
10.	MIN-532	Renewable Energy Systems
11.	MIN-533	Refrigeration & Air-Conditioning System Design
12.	MIN-534	Air Conditioning and Ventilation
13.	MIN-535	Cryogenic Systems
14.	MIN-536	Convective Heat and Mass Transfer
15.	MIN-537	I. C. Engines
16.	MIN-538	I. C. Engine Combustion Processes Modelling
17.	MIN-539	Micro and Nano Scale Thermal Engineering
18.	MIN-540	Combustion
19.	MIN-541	Bio-Fluid Mechanics
20.	MIN-544	Design of Heat Exchangers
21.	MIN-545	Fuel Cells

Production and Industrial Engineering: Minor Specialization Courses (MSC1 MSC2 MSC3 MSC4 MSC 5)

Production and Industrial Courses (Three Courses from this part)

Sl. No.	Course No.	Course Title
1.	MIN-216	Theory of Production Processes -I
2.	MIN-309	Theory of Production Processes – II
3.	MIN-310	Machine Design
4.	MIN-312	Quality management
5.	MIN-313	Work System Design

Design Courses (One Courses from this part)

Sl. No.	Course No.	Course Title
1.	MIN-206	Mechanics of Materials
2.	MIN-211	Theory of Machines

Thermal Courses (One Courses from this part)

Sl. No.	Course No.	Course Title
1	MIN-106	Fluid Mechanics
2	MIN-210	Thermal Engineering

Category-I (Production and Industrial) Department Elective Courses at 3rd yr level (MIN-ELE1/ELE2)

S No.	Course No.	Course Title
1.	MIN-320	Automobile Engineering
2.	MIN-321	Vibration and Noise
3.	MIN-322	Principles of Lubrication Technology
4.	MIN-323	Design of Pressure Vessels & Piping
5.	MIN-324	FEM applications in Mechanical Engg.
6.	MIN-325	Numerical Methods in Manufacturing
7.	MIN-326	Value Engineering
8.	MIN-327	Reverse Engineering
9.	MIN-328	Manufacturing System Analysis
10.	MIN-329	Computer Integrated Manufacturing
11.	MIN-330	Ergonomics
12.	MIN-331	Total Quality Management
13.	MIN-332	Industrial Hazards and Safety
14.	MIN-333	Industrial Management
15.	MIN-334	Facilities Design
16.	MIN-335	Concurrent Engineering
17.	MIN-336	Financial Management
18.	MIN-337	Processing of Non-Metals
19.	MIN-338	Measurement and Instrumentation
20.	MIN-339	Design of Heat Exchangers
21.	MIN-340	Refrigeration and Air-Conditioning
22.	MIN-341	Thermal Systems Design
23.	MIN-342	Environmental Pollution and Control
24.	MIN-343	Power Plants
25.	MIN-344	Industrial Combustion
26.	MIN-345	Compressible Flow
27.	MIN-346	Waste Heat recovery Systems
28.	MIN-349	Fire Dynamics
29.	MIN-350	Industrial Ventilation and Air Conditioning
30.	MIN-351	Gas Turbines
31.	MIN-352	Experimental Methods in Thermal Engineering
32.	MIN-354	Automatic Control

Category-II (Production and Industrial) Electives Floated at 4th Yr Level

(Machine Design Engineering)

Sl. No.	Course No.	Course Title
1.	MIN-410	Product and Process Optimization

2.	MIN-411	Maintenance Technology for Rotating Components
3.	MIN-412	Vehicle Dynamics
4.	MIN-413	Micro Electro Mechanical Systems
5.	MIN-415	Piping Technology
6.	MIN-416	Non Linear Dynamics
7.	MIN-417	Energy and Variational Principles in Engineering Mechanics
8.	MIN-500	Instrumentation and Experimental Methods
9.	MIN-502	Robotics and Control
10.	MIN-508	Advanced Automatic Control
11.	MIN-509	Extended Finite Element Methods
12.	MIN-553	Industrial Tribology
13.	MIN-554	Computer Aided Mechanism Design
14.	MIN-555	Experimental Stress Analysis
15.	MIN-556	Dynamics of Road Vehicles
16.	MIN-558	Fracture Mechanics
17.	MIN-559	Computer Aided Design
18.	MIN-560	Mechanics of Composite Materials
19.	MIN-561	Advanced Mechanical Vibrations
20.	MIN-562	Noise Control in Mechanical Systems
21.	MIN-563	Mechatronics
22.	MIN-565	Smart Materials, Structures, and Devices
23.	MIN-516	Artificial Intelligence
24.	MIN-550	Advanced Machine Design
25.	MIN-551	Dynamics of Mechanical Systems
26.	MIN-566	Computer Aided Analysis of Mechanical Systems
27.	MIN-567	Computer Graphics
28.	MIN-568	Advanced Robotics

(Production and Industrial Engineering)

Sl. No.	Course No.	Course Title
1.	MIN-573	Design for Manufacturability
2.	MIN-574	Maintenance Management
3.	MIN-575	Product Design and Development
4.	MIN-576	Machine Tool Design and Numerical Control
5.	MIN-577	Industrial Automation
6.	MIN-578	Computer Aided Process Planning
7.	MIN-579	Information Systems and Data Management
8.	MIN-580	Welding Science
9.	MIN-581	Manufacturing Resources Management
10.	MIN-582	Flexible Manufacturing Systems
11.	MIN-583	Materials Management
12.	MIN-584	Operations Research
13.	MIN-585	Supply Chain Management
14.	MIN-586	Metal Forming
15.	MIN-587	Metal Casting

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16.	MIN-588	Non-Tr...ional Machining Processes
17.	MIN-593	No...Conventional W...ding Processes
18.	MIN-594	...afety Aspect... Welded Structures
19.	MIN-595	Failure Analysis of Welding Joints
20.	MIN-596	Automation & Application of Robots in Welding
21.	MIN-597	Welding Procedures for Specific Ap...lications
22.	MIN-598	Weldability of Metals
23.	MIN-599	Surface Engineering

(Thermal Engineering)

Sl. No.	Course No.	Course Title
1.	MIN-523	Gas Turbines & Compressors
2.	MIN-524	Two Phase Flow & Heat Transfer
3.	MIN-525	Solar Energy
4.	MIN-526	Advanced Gas Dynamics
5.	MIN-527	Computational Fluid Dynamics & Heat Transfer
6.	MIN-528	Boundary Layer Theory
7.	MIN-529	Turbulent Flows
8.	MIN-530	Cold Preservation of Foods
9.	MIN-531	Hydro-dynamic Machines
10.	MIN-532	Renewable Energy Systems
11.	MIN-533	Refrigeration & Air-Conditioning System Design
12.	MIN-534	Air Conditioning and Ventilation
13.	MIN-535	Cryogenic Systems
14.	MIN-536	Convective Heat and Mass Transfer
15.	MIN-537	I. C. Engines
16.	MIN-538	I. C. Engine Combustion Processes Modelling
17.	MIN-539	Micro and Nano Scale Thermal Engineering
18.	MIN-540	Combustion
19.	MIN-541	Bio-Fluid Mechanics
20.	MIN-542	Energy Management
21.	MIN-543	Fluid Power Systems
22.	MIN-544	Design of Heat Exchangers
23.	MIN-545	Fuel Cells

Department of Metallurgical and Materials Engineering
Department Electives
Category I

1.	MTN-311	Foundry Technology
2.	MTN-312	Advances in Steel Making
3.	MTN-313	Fuel, furnaces and refractories
4.	MTN-314	Mineral Processing
5.	MTN-315	Metallurgy of joining

Category II

Autumn Semester

1.	MTN-511	Thin Film Technology
2.	MTN-513	Micro-fabrication Technology
3.	MTN-515	Microsensor, MEMS and Smart Devices
4.	MTN-517	High Temperature Materials
5.	MTN-519	Electro-Ceramics
6.	MTN-521	Materials for Renewable Energy
7.	MTN-505	Non Destructive Testing

Spring Semester

1.	MTN-514	Powder Metallurgy
2.	MTN-516	Principle of Materials Selection
3.	MTN-526	Failure Analysis
4.	MTN-532	Corrosion Protection Methods
5.	MTN-544	Physical Metallurgy of Light Metals and Alloys
6.	MTN-554	Crystallographic Texture
7.	MTN-558	Energy Storage Materials

Departmental Honours Courses

Autumn Semester

1.	MTN-531	X-Ray Diffraction Techniques
2.	MTN-533	Electron Microscopy

Spring Semester

1.	MTN-530	Nanomaterials and Applications
2.	MTN-542	Biomaterials
3.	MTN-528	Technology of Engineering Materials

Minor Specialization Course

Five course, designated as MSC-I to MSC-V

1.	MTN-104	Structural Metallurgy
2.	MTN-203	Phase Transformation and Heat Treatment
3.	MTN-204	Metal Casting and Joining
4.	MTN-205	Mechanical Behavior of Materials
5.	MTN-301	Mechanical Working of Metals
6.	MTN-302	Environmental Degradation of Materials
7.	MTN-303	Iron and Steel Making
8.	MTN-304	Ceramics and Metal Powered Processing
9.	MTN-305	Engineering Polymers and Composites

OEC (Offered by Department)

1.	MTN-505	Non Destructive Testing

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Appendix -B

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Paper Technology

1. Subject Code: PPN-502 Course Title: Washing and Bleaching

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

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

4. Relative Weightage: CWS 20 PRS 20 MTE 20 ETE 40 PRE 0

5. Credits: 4 6. Semester: Spring 7. Subject Area: PCC

8. Pre-requisite: Nil

9. Objective: To familiarize the students with washing, screening, cleaning, bleaching of pulp and secondary fibre processing.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Washing:** Importance of washing Mechanisms of washing, physico-chemical aspects of lignin removal in washing, operating targets for brown stock washing systems, displacement ratio, Norden efficiency, dilution factor, washing losses, factors affecting pulp washing; Washing equipments.	4
2.	**Screening:** Principles of screening, screening, Efficiency, variables affecting screening efficiency, Types of screens, and their applications, Screening Systems Design, combination of screens, common Screening Problems, causes and removal.	4
3.	**Cleaning:** Principals of cleaning, centrifugal cleaners, forward and reverse cleaners, , variables affecting centrifugal cleaner's performance, Process design calculations, process flow sheets for cleaning different types of pulps, combinations of centrifugal cleaners.	4
4.	**Bleaching Fundamentals:** Types of bleaching, conventional, ECF and TCF bleaching; Bleachability and its measurement; Bleached pulp characterization and measurement of different parameter like copper number, brightness, brightness reversion, P.C. number, viscosity; Factors affecting brightness reversion.	6
5.	**Bleaching Chemistry, Operations and Equipment:** Oxygen, chlorination, extraction, oxidative extraction, hypochlorite, chlorine dioxide, enzyme, ozone, peroxide and dithionite bleaching. Bleaching reactions, reaction kinetics, operating variables, pulp quality; Advantages and disadvantages of different bleaching agents, bleaching of mechanical and high yield pulps; bleach boosters. Bleaching equipments, towers, mixers, reactors	10 8
6.	**Secondary Fiber Processing:** Secondary fiber Contaminants. Effect of recycling of secondary fibers on machine operation and paper quality; Secondary fibers processing, Hydrapulper, screening and cleaning, systems, variables and process water reuse Deinking: Principles of deinking, washing and floatation deinking, deinking chemicals, deinking efficiency and quality of deinked pulp, variables affecting deinking efficiency; Flotation cell etc.	6
Total Contact Hours		42

List of Experiments:

1-4 Bleaching with conventional/ ECF/TCF bleaching sequence and bleached pulps characterization by determination of brightness, pulp viscosity, P.C. number.

5- Pulping in hydra pulper and determination of freeness of pulp as a function of time

6- Deinking of pulp and determination of residual ink in pulp (ERIC value) and dirt count

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Dence C.W., and Reeve D.W., "Pulp Bleaching: Principles and Practices", TAPPI Press.	1996
2.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 7: Recycled Fiber and Deinking (Ed. Göttsching L. and Pakarinen H.)", Finnish Paper Engineers' Association and TAPPI.	1999
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 6: Chemical Pulping (Ed. Gullichsen J and Fogelholm C-J.)", Finnish Paper Engineers' Association and TAPPI.	1999
4.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 3: Secondary Fibers and Non-wood Pulping (Ed. Hamilton F. and Leopold B.)", TAPPI Press.	1987
5.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 5: Alkaline Pulping (Ed. Grace T. M. and Melcolm E. W.)", TAPPI Press.	1989
6.	Kulas K. A., "Elemental Chlorine Free Bleaching: A Tappi Press Anthology of Published Papers (Pulp/Wood Products)", TAPPI Press.	2005

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NDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-504** Course Title: **Papermaking**

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

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

4. Relative Weightage: **CWS** [20] **PRS** [20] **MTE** [20] **ETE** [40] **PRE** [0]

5. Credits: [4] 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of the advances in the design and operation of papermaking processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Flow Distribution and Headboxes:** Flow distributers; Headboxes, rectifier roll type, hydraulic headboxes, head control, control of jet velocity and jet angle	4
2	**Stock and Whitewater Systems:** Design principles of short circulation and long circulation, closing the whitewater system, save-all; Broke system design, handling of brokes of different grades such as coated, colored, wet strength papers; Design of piping system	6
3	**Sheet Formers:** Fordrinier and gap formers, hybrid formers, formers for multi-layered paper and boards; Formation, quantitative measurement of formation; Factors affecting sheet formation	7
4	**Pressing and Drying:** Development in press parts, emended nip presses, development in paper drying, steam and condensate handling, hoods and hood exhaust, IR drying; Surface sizing	11
5	**Finishing and Calendering:** Developments in calendering, soft calendering, moisture and temperature calendering; Rewinder and sheet cutters	2
6	**CD Variability and its Control:** Benefits of improved CD uniformity, online measurement, CD control of grammage, moisture, caliper, and smoothness	2
7	**Paper Machine Clothing**: Design of forming, press and dryer fabrics; Material of construction; Manufacturing techniques; Cleaning and conditioning of forming, press, and dryer fabrics	2
8	**Auxiliary Systems of Paper Machine** Paper machine showers and doctors; Paper machine drives; Paper machine vacuum systems	6
9	**Paper Machine Safety:** Vibration measurement and control; Corrosion measurement and control; Safety from steam, moving parts and chemicals	2
Total Contact Hours		**42**

List of Experiment

i. Laboratory coating with different coating color compositions and super calendaring
ii. Evaluation of gloss, smoothness, porosity, and bending stiffness o the coated sheets
iii. Determination of surface strength and oil absorbency of paper
iv. Demonstration of printability testing with an IGT printability tester
v. Preparation of handsheets with different dosage of dye and determination of color
vi. Determination of formation factor
vii. Determination of compression strength of paper & board

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 8: Papermaking Part 1, Stock Preparation and Wet End (ed Paulapuro, H.)", Finnish Paper Engineers' Association and TAPPI	2000
2	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 9: Papermaking Part 2, Drying (ed. Karlsson, M.)", Finnish Paper Engineers' Association and TAPPI	2000
3	Gullichsen, J. and Paulapuro, H. "Papermaking Science and Technology, Book 10: Papermaking Part 3, Finishing (ed. Jokio, M.)", Finnish Paper Engineers' Association and TAPPI	1999
4	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 7: Paper Machine Operations (ed. Thorp, B.)", TAPPI Press	1991

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-512** Course Title: **Environmental Management**

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

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

4. Relative Weightage: **CWS** 25 **MTE** 25 **ETE** 50 **PRS** 0 **PRE** 0

5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite:
9. Objective: To make the students conversant about various environmental issues and management aspects related to Paper Industry.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Environmental issues for paper industry; Emissions and effluents; Environmental policy of India, environmental laws and standards, corporate responsibility for environmental protection.	4
2.	**Pollution Prevention:** Process modification; Recovery of by- products from industrial emissions and effluents; Energy and fresh water minimization, energy recovery; Housekeeping for limiting fugitive emission and leakages; Pollution dispersion and diffusion.	7
3.	**Pre and Primary Treatment:** Dilution, neutralization, sedimentation, coagulation and flocculation; Process design calculation	5
4.	**Biological Treatment:** Anaerobic and aerobic treatment of carbonaceous matter; Various treatment systems such as trickling filters, lagoons, UASB reactors and activated sludge processes; Sludge disposal and management; Process design calculation	9
5.	**Tertiary Treatment:** Color and toxicity removal systems, adsorption, membrane treatment systems, advance oxidation process; Process design calculation; Construct wetlands	7
6.	**Air Pollution Control:** Sources and quantities of pollutants; Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by adsorption and adsorption.	4
7.	**Solids Wastes:** Sources and quantities of solid waste in paper industry; Characterization and disposal methods; Compositing, landfill and briquetting; Pyrolysis, gasification and incineration; Reuse.	6
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication/ Reprint
1.	Eckenfelder W.W. and Ford D., "Water Pollution Control" 3rd Ed., Jonkins Publishing Company.	2000
2.	Pollution Control Acts, Rules and Notifications, Central Pollution Control Board, New Delhi.	2003
3.	Pichtel J, "Waste Management Practices: Municipal, Hazardous and Industrial", CRC Press.	2005
4.	Tchobanoglous G., Burton B.L., Metcalf L., and Stensel H.D., "Waste Water Engineering" 4th Ed., McGraw Hill.	2008
5.	Vallero D, "Fundamentals of Air Pollution", 4th Ed., Academic Press.	2007

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN- 514** Course Title: **System Closure**
2. Contact Hours: **L: 3** **T: 0** **P: 0**
3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0
4. Relative Weightage: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0
5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of methodology for conserving water, energy and fiber resources.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Concepts, issues and challenges of sustainability, section wise inputs and outputs in paper manufacturing, open, partially closed, and closed systems	4
2	**Legislative and Sustainable Approaches:** Discharge standards for liquid, solid and gaseous emissions, the Earth summit and other protocols, environmental impact assessment (EIA), eco-labeling, green rating, green house gas emissions, life cycle analysis (LCA), paper use and disposal; Energy usages, clean development mechanism	6
3	**Process Integration and Pinch Technology:** Concept of process integration and its applications to various process operations; Role of thermodynamics in process design; Targeting of energy, area, number of units and cost, super targeting; Concept of pinch technology, heat exchanger network analysis	9
4	**Energy Management in Pulp and Paper Mills:** Renewable and non-renewable energy sources, increasing use of bio-mass, cogeneration, development of energy efficient processes, process integration	7
5	**Water Needs of Pulp and Paper Industry:** Water sourcing; Closed system operations in fiber preparation, pulping, bleaching, papermaking and chemical recovery; Condensate recovery, management of non process elements; Process integration in closed water cycle; Rain water Harvesting	8
6	**Waste Management:** Liquid effluent discharges, tertiary treatment methods; Issues of TDS, Color, and AOX; Solid waste management, incineration and land fill; Air emission control for SO_x, NO_x, HCl, NCGs, TRS, and VOC	8
Total Contact Hours		**42**

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Brune, D., Chapman, D. V., Gwynne, M. D. and Pacyna, J. M., "The Global Environment: Science, Technology and Management", Marcel Dekker	1996
2	Environmental Issues and Technology in Pulp and Paper Industry – TAPPI Press Anthology of Published Papers, 1991-94	1995
3	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 19: Environmental Control (ed. Hynninen, P.)", Finnish Paper Engineers' Association and TAPPI	1998
4	Nebel, B. J., Adams, C. E. and Wright, N., "Environmental Science – The Way World Works", 4th Ed., Prentice Hall	1999
5	Boyce, M. P., "Handbook of Cogeneration and Combined Cycle Power", ASME Press	2002
6	El Halwagi M. M., "Process Integration", 7th Ed., Academic Press.	2006
7	Kemp I.C., "Pinch Analysis and Process Integration: A User Guide on Process Integration for the Efficient Use of Energy", 2nd Ed., Butterworth Heinemann.	2007

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-516** Course Title: **Chemical Recovery Process Calculations**

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

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

4. Relative Weightage: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite:

9. Objective: To impart knowledge of process design calculations in chemical recovery systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Multiple Effect Evaporators:** Material and energy balance calculations for different types of evaporators, calculation for area requirement and efficiency, process design calculations for condensers and steam-jet ejectors.	9
2.	**Recovery Boiler:** Material and energy balance calculations for recovery boilers, performance calculations, effect of various parameters on performance, calculations of effective cooling area for water walls.	10
3.	**Electrostatic Precipitator:** Process design calculations.	6
4.	**Causticizing Section:** Process design calculations for slakers, causticizers, clarifiers, mud washers and filters.	10
5.	**Lime Mud Reburning Systems:** Process design calculations, energy efficiency, performance calculations.	7
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Authors/Books/Publisher	Year of Publication
1.	Abrams T.L., "Process Engineering Design Criteria Hand Book: Pulp and Paper Normal Design Criteria," TAPPI Press.	1996
2.	Adams T.N., Frederick W.J., Grace T.M., Hupa M., Iisa K., Jones A.K., Tran H.N., "Kraft Recovery Boiler" TAPPI Press.	1997
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 6B: Chemical Pulping (Ed. Gullichsen J and Fogelholm C-J.)", Finnish Paper Engineers' Association and TAPPI.	1999
4.	Tappi Kraft Recovery Short Notes, TAPPI Press.	1996

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-524** Course Title: **Electrokinetics in Papermaking**

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

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

4. Relative Weightage: **CWS** [25] **PRS** [0] **MTE** [25] **ETE** [50] **PRE** [0]

5. Credits: [3] 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of electrokinetics in papermaking processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Colloidal State:** Classification of colloidal systems, the motion of particles in liquid media	2
2	**Surface and Total charge:** Charge on fibre, filler and other particles in papermaking furnish, charged groups and their ionization	4
3	**Factors Affecting Fibre Charge:** Effect of chemical environment - pH, electrolyte concentration, valency of counter ion; Anionic trash in papermaking	5
4	**Electrokinetic Phenomena:** Electric double layer, effects of stock additives and process operations such as pulping, bleaching, and refining on electrokinetic properties of papermaking furnish	6
5	**Charge Measurement:** Zeta potential, microelectrophoresis, streaming potential, AC streaming current, titration techniques such as potentiometric, conductometric and polyelectrolyte, colloid titration ratio, absolute charge and charge demand	6
6	**Sorption and Swelling:** Sorption and swelling of cellulosic materials in water and other media, physical- and chemi-adsorption, surface area of cellulose and cellulosic materials	5
7	**Coagulation and Flocculation in Papermaking:** Coagulation with electrolytes, flocculation and dispersion of colloidal materials, effects of additives on fiber flocculation	5
8	**Retention Mechanisms:** Charge neutralization, patch model, bridging, complex flocculation, dissolved and colloidal substances; Influence of shear	4
9	**Foam and Slime Control:** Nature of foam, foam formation and stabilization, effect of additives on foam stability, antifoam action; Micro-organisms and slime formation, chemical slime control	5
Total Contact Hours		**42**

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Eklund, D. and Lindstrom, T. D., "Paper Chemistry: An Introduction", TAPPI Press	1991
2	Gess, J. M., "Retention of Fines and Fillers During Papermaking", TAPPI Press	1998
3	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 4: Papermaking Chemistry (ed. Neimo, L.)", Finnish Paper Engineers' Association and TAPPI	1999
4	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 6: Stock Preparation (ed. Hagemeyer, R. W. and Manson, D. W.)", TAPPI Press	1992
5	Swanson, J., "Colloid Chemistry of Papermaking Materials", TAPPI Press	2002

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code:**PPN-526** Course Title: **Bio-process and its Application**

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

3. Examination Duration (Hrs.): Theory [3] Practical [0]

4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]

5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Prerequisite: **Nil**

9. Objective: To impart knowledge regarding application of biotechnology in pulp and paper industry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** What is biotechnology? A typical plant and animal cell and cell organelles; Genetic engineering; Importance, interdisciplinary pursuit, product safety, public perception.	8
2.	**White-rot Fungi:** Taxonomy, production of fungal inoculum, enzymology and molecular genetics; Factors affecting enzyme production; Solid-state and submerged fermentation conditions wood degradation by white-rot fungi.	8
3.	**Raw Material Preparation:** Wood pretreatment to remove toxic extractives, bio-debarking, bio-retting of flax, bio-depithing.	3
4.	**Pulping and Bleaching:** Advantages and principles of bio-pulping and bio-bleaching; Fungal pretreatment of wood chips for chemical pulping, Principles of bio-mechanical pulping; Production of dissolving pulp; Removal of shives; Bleaching with xylanases and enzymes of white-rot fungi; Bio-deinking, principles and comparison with chemi-deinking process.	11
5.	**Fiber Modification:** Use of enzymes in beating, refining, drainage aids; Fuel generation, Sources of biomass, ethanol from biomass, biodiesel and biohydrogen and other applications.	8
6.	**Effluent Treatment:** Treatment of wastewaters with aerobic and/or anaerobic techniques; Decolorization and detoxification of bleached kraft effluents; Purification of process water in closed-cycle mills; Management of wastewater treatment sludges.	4
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication/ Reprint
1.	Bajpai P. and Bajpai P.K., "Biotechnology in the Pulp and Paper Industry", PIRA International.	1997
2.	Bajpai P., Bajpai P.K. and Kondo R. "Biotechnology for Environmental Protection in the Pulp and Paper Industry", Springer.	1999
3.	Raymond A.Y. and Akhtar M., "Environmentally Friendly Technologies for the Pulp and Paper Industry", John Wiley.	2003
4.	Smith J.E., "Biotechnology" 3rd Ed., Cambridge University Press.	1996

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-528** Course Title: **Pulp Mill Calculations**

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

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

4. Relative Weightage: **CWS** [25] **PRS** [0] **MTE** [25] **ETE** [50] **PRE** [0]

5. Credits: [3] 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of process calculations for pulping, screening, cleaning, washing and bleaching systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Raw Material Preparation Section:** Material and energy balance calculations for raw material preparation section; Physical properties of raw materials, bulk density; Energy calculations for conveyers, chippers, and chip screens	4
2	**Pulping Section:** Analysis of white, green and black liquors, process calculations for batch and continuous digesters, bath ratio; Calculations for Superbatch, RDH, MCC, and EMCC processes; Steam and power calculations; Modeling of soda and kraft pulping, calculation of H- and modified H-factors, use of empirical models for prediction of various parameters; Calculation for blow-heat recovery, digester and liquor heater	10
3	**Screening and Cleaning Systems:** Performance of screening and cleaning systems and their process design aspects, mass balance and efficiency for single and multiple stage systems, screening and cleaning equipment sizing, power consumption calculations	4
4	**Washing Systems:** Material and energy balance calculations for different types of washing systems, washing losses and washing efficiency, calculation of washing efficiency for varying dilution factor, displacement ratio and number of stages; Norden efficiency	5
5	**Bleaching Systems:** Calculations involving bleach liquor analysis; Material and energy balance for single and multiple stage bleaching sequences; Process design of tower, mixer and reactors; Calculations for bleaching efficiency, target brightness, shrinkage and environmental impact	5
6	**Recovery Section:** Material and energy balance calculations for multiple effect evaporators, area requirement and efficiency; Process design calculations for condensers and steam-jet ejectors; Process design calculations for slakers, causticizers, clarifiers, mud washers, filters, lime mud reburning system; Energy efficiency and performance calculations	10
7	**Stock Pumps and Piping:** Sizing of piping and pumps for stock flow in different sections of a pulp mill, power requirement for pumping	4
Total Contact Hours		**42**

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Dence, C. W. and Reeve, D. W., "Pulp Bleaching: Principles & Practice", TAPPI Press	1996
2	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 6: Chemical Pulping (ed. Gullichsen, J and Fogelholm, C-J.)", Finnish Paper Engineers' Association and TAPPI	1999
3	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 5: Alkaline Pulping (ed. Grace, T. M. and Melcolm, E. W.)", TAPPI Press	1989
4	Abrams, T. L., "Process Engineering Design Criteria Hand Book: Pulp and Paper Normal Design Criteria," TAPPI Press	1996
5	Adams, T. N., Frederick, W. J., Grace, T. M., Hupa, M., Iisa, K., Jones, A. K. and Tran, H. N., "Kraft Recovery Boiler" TAPPI Press	1997
6	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 6B: Chemical Pulping (ed. Gullichsen, J and Fogelholm, C-J.)", Finnish Paper Engineers' Association and TAPPI	1999

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-532** Course Title: **Printing and Converting Operation**

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

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

4. Relative Weightage: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of principal features of web converting operations and converted products.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Printing Processes:** Letterpress, flexography, gravure, lithography, and screen printing; Printing plates; Printing presses; Digital printing; Halftone printing; Plate making and printing operation	5
2.	**Color and Color Images:** Light and color, the visual system, measurement of color, reproduction of color	3
3.	**Paper in Printing:** Printing paper, runnability, printability, ink transfer	4
4.	**Printing Inks:** Composition of inks, pigments, binders, and additives; Optical properties; Rheological properties; Drying characteristics of printing inks.	3
5.	**Introduction to pigment coating:** Raw materials for paper coating, base stock, pigments, binders, additives; Coating mixture preparation, pigment coating formulations	5
6.	**Pigment Coating Processes:** Application systems; Metering systems; surface sizing and film coating; Drying, calendering and finishing of pigment coated papers; Properties of pigment coated papers	5
7.	**Adhesives in Converting:** Theories of adhesion, measurement of wetting and adhesion,; Types and properties of adhesives.	3
8.	**Corrugating:** Corrugated board types and properties; Production of corrugated board; Gluing; Quality control.	4
9.	**Dispersion Coatings:** Solution and emulsion properties of polymers, preparation of polymer solutions, formation and properties of coating films, functional properties of coated papers; Coating methods, polymers used in functional coatings.	4
10.	**Extrusion Coatings:** Coating processes and equipment; Coated product properties; Application of extrusion coated products. and emulsion properties of polymers, preparation of polymer solutions, formation and properties of coating films, functional properties of coated papers; Coating methods, polymers used in functional coatings.	3
11.	**Lamination and Other Converting Processes:** Substrates for lamination; Laminating methods, drying, radiation curing; Laminated product application; Metalizing; Wax coating; Hot melt coating; Lacquer coating.	3
Total Contact Hours		42

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication /Reprint
1	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 8: Coating, Converting, and Specialty Papers (ed. Kouris, M.)", TAPPI Press	1990
2	Casey, J. P., "Pulp and Paper: Chemistry and Chemical Technology", Vol. 4, 3rd Ed., John Wiley	1981
3	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 11: Pigment Coating and Surface Sizing of Paper (ed. Lehtinen, E.)", Finnish Paper Engineers' Association and TAPPI	2000
4	Gullichsen J. and Paulapuro, H., "Papermaking Science and Technology, Book 12: Paper And Paperboard Converting (ed. Savolainen, A.)", Finnish Paper Engineers' Association and TAPPI	1999

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code:**PPN-534** Course Title: **Coated and Specialty Papers**

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

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

4. Relative Weightage: CWS 25 PRS 0 MTE 25 ETE 50 PRE 0

5. Credit: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Prerequisite **Nil**

9. Objective: To provide knowledge on the characteristics of various constituents used in aqueous pigment coating processes, and characteristics and applications of various specialty paper grades.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Base Paper and Coating Ingredients:** Requirements of coating base paper; mechanical and wood free papers; Coating pigments such as kaolin, GCC, PCC, talc, titanium dioxide, gypsum, aluminum trihydrate, synthetic plastic pigments; Coating binders such as latex, synthetic co- binders and thickeners, starch, soya-protein, CMC, polyvinyl alcohol; Coating additives, characteristics and application of dispersants, viscosity modifiers, insolubilizers, lubricants; Principles of specialty chemicals such as sodium hexametaphosphate, fire retardants, softening agents and corrosion inhibitors etc.	8
2.	**Coating Processes:** Coating color preparation, coating techniques, multiple coating of paper, coating of board, drying of coated paper, process control and automation, rheology of pigment slurries.	5
3.	**Writing and Papers:** Characteristics of various grades such as newsprint, super calendared papers, coated mechanical papers, uncoated fine papers, coated fine papers, special fine papers, Different value-added grades such as MICR paper, photographic paper, azure laid paper, ARSR paper, TDL poster etc., Trouble shooting related to various grades; Requirements of writing and printing papers according to BIS:1848	8
4.	**Absorbent Grade Paper:** Requirement of absorbent grade paper; Different valued-added grades such as barrier paper, ivory base paper, overlay tissue, pictorial circuit board, seed germination paper, DBTU paper,	5
5.	**Wrapping and Packaging Paper:** Requirement of wrapping and packaging paper; Different value added quality papers such as abrasive base paper, anti-rust paper, food grade papers, paper cups, playing card paper etc., problems related to wrapping and packaging grades	4
6.	**Paperboard Grades:** Carton boards classification and quality requirements for various applications, containerboards and linerboard, corrugating medium, special boards, wallpaper base, core board and plaster board.	4
7.	**Tissue and Air-laid Papers:** Tissue converting, embossing, printing and perforation; Process of manufacture of air-laid papers, their characteristics and applications.	3
8.	**Industrial Specialty Papers:** Electrical insulation papers, automobile filter paper, special strong papers, release papers, copy and imaging papers, thermal papers, building papers, cigarette papers, and other functional papers.	5
Total Contact Hours		**42**

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 11: Pigment Coating and Surface Sizing of Paper (Ed. Lehtinen E.)", Finnish Paper Engineers' Association and TAPPI.	2000
2.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 18: Paper and Board Grades (Ed. Paulapuro H.)", Finnish Paper Engineers' Association and TAPPI.	2000
3.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 8: Coating, Converting, and Speciality Papers (Ed. Kouris M.)", TAPPI Press.	1990

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-538** Course Title: **Paper Mill Calculations**

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

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

4. Relative Weightage: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of process design calculation of papermaking processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Approach Flow System:** Basic Mass balance calculations in approach flow system, sizing of chests and piping, design parameters of screens, cleaners, and fan pumps, deaerator, flow distributors; Estimation of electrical power consumption	6
2	**Headbox:** Calculations for the required head, pressure and thrust in the headbox, selection of perforated rolls, no-wake distance for the nozzle, calculations for the pressurized and hydraulic headbox, characterization of turbulence; Calculations for jet angle, slice opening, volumetric flow rate from the head box	4
3	**Formers:** Drainage rate calculations, wire tension, selection of forming fabrics, dimensions of wire, sizing of different rolls, drainage elements and suction boxes on wire table; Calculation of vacuum, drag load, and other parameters for wire part; Design of cylinder mold machines; Calculation of drive load.	7
4	**Overall Water and Fiber Balance:** Mass balance for white water and fiber systems, broke handling, first pass retention, savealls, water requirement for showers and other cleaning devices, Concepts of system closure	4
5	**Vacuum Systems:** Vacuum producing devices; Sizing of vacuum pumps, piping, foils and separators; Calculation of energy requirements	3
6	**Press Part:** Water removal rate calculations; Dimensioning of press rolls and water drainage elements; Selection of press fabrics; Calculation of press parameters; Calculation of drive load	4
7	**Dryer Part:** Material and energy balance for multi-cylinder and Yankee dryers; Calculations of drying rate, surface area of dryers, air and steam requirement; Steam and condensate handling systems, sizing of steam piping; Calculation of drying rate for surface sized and pigment coated papers, calculations for IR and air impingement dryers, calculation for dryer hoods; Calculation of drive load	10
8	**Stock Pumps and Piping:** Sizing of piping and pumps for stock flow in different sections of a paper mill, power requirement for pumping	4
Total Contact Hours		**42**

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 8: Papermaking Part 1, Stock Preparation and Wet End (ed. Paulapuro, H.)", Finnish Paper Engineers' Association and TAPPI	2000
2	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 9: Papermaking Part 2, Drying (ed. Karlsson, M.)", Finnish Paper Engineers' Association and TAPPI	2000
3	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 10: Papermaking Part 3, Finishing (ed. Jokio, M.)", Finnish Paper Engineers' Association and TAPPI	1999
4	Kocurek, M. J., "Pulp and Paper Manufacture", Vol. 7, TAPPI Press	1994
5	TAPPI Technical Information Papers, TAPPI Press	2004

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code:**PPN-522** Course Title: **Paper Making Chemistry**

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

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

4. Relative Weightage: CWS [**25**] PRS [**0**] MTE [**25**] ETE [**50**] PRE [**0**]

5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Prerequisite **Nil**

9. Objective: To impart knowledge regarding advances in chemistry aspects in stock preparation and papermaking.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Importance of papermaking chemistry; Fiber-fiber water bonding; Rheology, surface energy, and surface tension of colloidal systems.	5
2.	**Fiber Bonding:** Importance of fiber bonding; Theories of fiber bonding; Effect of surface tension on fiber bonding; Types of bonds in dried paper; Measurement of fiber bonding and strength of bonds; Factor affecting fiber bonding; Effect of conformability, plasticity and swelling upon fiber bonding; Effect of fibrillation, fines, hemicelluloses, lignin, water, recycling, of alumina, sizing, fillers and other additives on fiber bonding; Effect of fibrillation and fiber cutting on paper properties; influence of coated broke on wet end chemistry, runability problems, deposits, white pitch, deposit control, dispersing and fixing agents.	14
3.	**Properties variation:** Effect of conditioning on paper properties; Permanence and barrier properties and paper defects, manufacturing variables that influence paper permanence, atmospheric properties affecting the permanence and durability of paper, reasons for change in various properties like brightness, strength properties and structural properties.	4
4.	**Retention Mechanism:** Charge neutralization, patch model, bridging, complex flocculation, dissolved and colloidal substances; Influence of shear.	4
5.	**Chemistry of sizing agents:** Chemistry of aluminium in papermaking, Aqueous coordinate chemistry, aqueous hydrolysis, olation and polymerization, distribution of aluminium species as a function of pH, aluminium adsorption; Basics of wetting and penetration, Licas's Washburn equation, factors affecting penetration,	3
6.	Chemistry of dry strength additives and wet strength additives.	2
7.	**Paper Machine Water Chemistry:** Com[position of white water, origin of dissolved materials, mechanical, chemical deinked pulps, fillers chemicals; Influence of salts and dissolved substances in white water; Key parameters in controlling the chemistry in papermaking, solid contents and retention, ph, conductivity, charge, calcium ion concentration, aluminium ion, COD and TOC concentrations, silicate contents, temperature and gas contents, close loop systems.	5
8.	**Paper machine Microbiology:** Microbes, microbes in the taxonomic systems, bacteria, fungi, algae and protozoa, cell composition, metabolic properties and growth conditions of microbes such as nutrients, temperature and pH, retention time and toxic compounds; Problems caused by microbes such as slime, runability, corrosion, additive and product problems; Problems that cause the occurrence of microbes in papermaking system, factors affecting the growth of microbes; identification of microbes.	5
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	Eklund D. and LindstromT.D., "Paper Chemistry: An Introduction", TAPPI Press.	1991

2.	Gess J.M "Retention of Fines and Fillers During Papermaking", TAPPI Press.	1998
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 4: Papermaking Chemistry (Ed. Neimo L.)", Finnish Paper Engineers' Association and TAPPI.	1999
4.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 6: Stock Preparation (Ed. Hagemeyer R. W. and Manson D. W.)", TAPPI Press.	1992
5.	Roberts J.C. "Paper Chemistry", Blackie Academic & Professional.	1996
6.	Swanson J., "Colloid Chemistry of Papermaking Materials", TAPPI Press.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-536** Course Title: **Packaging Papers and Boards**

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

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

4. Relative Weightage: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: 3 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize the students with various types of packaging paper and boards

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Paper and board for packaging:** Use of paper and paperboard in flexible and rigid packaging, comparison with other packaging materials, kraft paper, flexible packaging paper, extensible kraft; Grades of paperboard, multilayer boards, solid bleached board, unbleached kraft paperboard, uncoated recycled paperboard, coated recycled paperboard, application of various board in packaging	9
2.	**Paper Board Manufacture:** Forming section, wet pressing, drying, and calandering, paperboard properties and their control during manufacture	6
3.	**Pigment Coating:** Pigments, binders, additives, coating formulations and preparation of coating mixture, coating techniques, properties of coated paper and board	4
4.	**Corrugating:** Corrugated board types and properties; Production of corrugated board; Gluing; Quality control.	4
5.	**Manufacturing of Packages:** Pouches, sacks, boxes, cartons, composite cans and fiber drums, aseptic drink boxes, package printing, sealing and gluing, liquid packaging	5
6.	**Polymer dispersions as Barrier coatings:** Properties of the polymers used, application techniques, rheology of polymer dispersions, properties of polymer dispersion films.,	6
7.	**Extrusion coating:** Extrusion coating plastics, substrates, extrusion coating process, properties and applications of extrusion coated products.	4
8.	**Lamination:** laminating methods, laminating substrates, adhesives, properties of laminated paper and board products	4
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 12: Paper And Paperboard Converting (Ed. Savolainen A.)", Finnish Paper Engineers' Association and TAPPI.	2012
2.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 13: Printing (Ed. Oittinen P. and Saarelma H.)", Finnish Paper Engineers' Association and TAPPI.	2012
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 17: Pulp and Paper Testing (Ed. Levlin J.-E. and Söderhjelm L.)", Finnish Paper Engineers' Association and TAPPI.	2012
4.	Mark R. E., "Handbook of Physical and Mechanical Testing of Paper and Paperboard", Vol. 1&2, Marcel Dekker.	2002
5.	Campbell I.M., "Introduction to synthetic polymers", Oxford University Press	2000

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-544** Course Title: **Package Performance**
2. Contact Hours: L:**3** T: 0 P:2/2
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [20] PRS [20] MTE [20] ETE [40] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of package performance
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Role of packaging in protection and preservation, containment, communication; Structural requirements of packaging.	5
2	**Hazards in Packaging:** Thermal, mechanical, climate condition, pressure, temperature, humidity, permeability, diffusion, leaching.	5
3	**Standard Organization for Packaging Test Performance:** International Organization for Standardization, ASTM International, European Committee for Standardization, TAPPI, Military Standards, International Safe Transport Association. Bureau of Indian standards and committees for packaging, other regulatory mechanism like FSSAI, Indian Pharmacopoeia etc.	2
4	**General Performance Evolution:** Mechanical hazard, shock, vibration, compression and stack, notch during handling, storage, shelving, transportation, permeability, compatibility, migration, diffusion; Measurement of comparative legibility by means of polarizing filter instrumentation; Determining effect of packaging on food and beverage products during storage; Foreign odours in paper packaging, methods for odour and taste transfer from polymeric packaging film, methods for odour and flavour transfer from rigid polymeric packaging; Methodology– sequential analysis, methods for assessing modifications to the flavour of foodstuffs due to packaging; Standard practice for conditioning containers, packages, or packaging components for testing, standard atmospheres for conditioning and testing flexible barrier materials.	10
5	**Evaluation of Performance of Packaging during Transport:** Performance testing of shipping containers and systems, performance testing of packages for single parcel delivery systems, complete filled transport packages – general rules for the compilation of performance test schedules, packaged-products for Less-Than-Truckload (LTL) Shipment, packaged products for distribution centre to retail outlet shipment, thermal controlled transport packaging for parcel delivery system shipment, thermal transport packaging used in parcel delivery system, shipping containers and their environment related safety issues-heavy metal contents restrictions.	10
6	**Specific Performance Criteria for Major Packaging Industry:** Electronic industry test and performance criteria of mechanical damage, cooling, radio frequency noise, electromagnetic interference, electrostatic charge,	10

	environmental stress test, thermal shock; Food and pharmaceutical industry, safety of drug and pharmaceutical, barrier property, self life, compatibility, sterilizability, temperature and child resistance; Medical packaging, grading of medical packaging, barrier property, compatibility with product, sterilizability of product, visibility, low temperature properties, degradation conditioning resistance, child and temperature resistance,	
Total Contact Hours		42

List of practicals

1. Experiment on mechanical properties of packaging materials
2. Experiment on freshness of food and vegetables maintains by packaging materials and tested by calorimetric and other spectroscopy methods
3. Experiment on packaging in maintaining anti microbial activity
4. Experiment on coating properties of packaging materials
5. Experiment on seal properties of packaging materials
6. Experiment on barrier properties of gases through packaging materials

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Brandenburg, Richard K., Lee, Julian June-Ling, "Fundamentals of Packaging Dynamics", 4th ed., Publisher: L.A.B. Equipment.	2001
2.	Salvatore Parisi, "Food Industry and Packaging Materials - Performance-oriented Guidelines for Users", Publisher: Smithers Rapra	2013
3.	Richard Coles, Mark J. Kirwan, "Food and Beverage Packaging Technology" 2nd Edition, Publisher: Wiley-Blackwell	2011
4.	Joseph F. Hanlon, Robert J. Kelsey, Hallie Forcinio, "Handbook of Packaging Engineering", 3rd edition, Publisher: CRC Press.	1998
5.	Sek M. and Kirkpatrick J., "Corrugated Cushion Design Handbook", Publisher: VUT.	2001
6.	Herling R.J., "ASTM STP 1294 Durability Testing of Nonmetallic Materials"", Publisher: ASTM International.	1996
7.	Lockhart, H., and Paine, F.A., "Packaging of Pharmaceuticals and Healthcare Products", Publisher: Blackie.	2006

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-546** Course Title: **Packaging Design**
2. Contact Hours: L:**2** T: 0 P: 2
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [15] PRS [25] MTE [20] ETE [40] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PCC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of packaging design
10. Details of Course:

S. No.	Contents	Contact Hours
1	**General Aspects of Package Design:** Functions of product and packaging design, graphic design, structural design, software for design, economics of design, transport storage aspect of design, hazard aspects of design.	2
2	**Functions of Product and Package Design:** Brand representation, brand protection anti-counterfeiting features through packaging, product differentiation, product positioning, shifting behavioural pattern, cutting edge innovation.	2
3	**Graphic Design:** Role of graphic design, demographics and psychographics; Environment (Retail, OEM), package aesthetic, decoration, feature layout.	3
4	**Functional Requirement of Package:** Protection and preservation, containment, communication.	2
5	**Structural Design Aspects:** Relationship between the structure and the properties of packaging materials, product-package compatibility, predicting, role of structure, drawing of structure, prototype, testing criteria of performance.	2
6	**Software of Design:** Software for packaging drafting, mould design, simulation of performance & manufacturing, introduction to software packages such as 'CAPE PACK', 'Artios CAD', 'AutoCAD' etc.	3
7	**Economics of Design:** Cost of development, material, processing, storage, handling, waste, transportation, insurance, and inventory.	2
8	**Roadmap of Package Design:** Identification of design opportunity, explore value and market place, correlate with strategy, identify customer requirement and translate to voice and prioritize concept.	4
9	**Concept Development:** Boundaries of design, flow of design, potential of design, criticality of design, understanding of variability, capability & impact of variability, minimize complexity, cost, maximize performance and adaptability, compare response and reduce noise in response; Optimization of details, control details to robustness, certify and document requirement, identification of implementation.	6
10	**Validation:** Importance of validation, package validation, validation of	2

	packaging line, statistics in packaging operations.	
Total Contact Hours		28

List of practical

1. Experiment on design of food packaging
2. Experiment on design of pharmaceutical packaging
3. Experiment on design of health care products packaging
4. Experiment on design of cosmetic products packaging
5. Experiment on design of detergents and soaps
6. Design of packaging using computer aided programme.
7.

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Julius Wiedemann, "Packaging Design Book", Publisher: TASCHEN	2010
2.	Walter Herdeg, "An International Survey of Package Design", Publisher: Graphic Press.	1984
3.	Pepin Press , "Structural Package Design", The Pepin Press.	2007
4.	Kai Yang and Basem El Haik, "Design for Six Sigma: A Roadmap for Product Development" , Publisher: McGraw – Hill.	2008
5.	Scott Boylston, "Designing Sustainable Packing Design", Publisher: Laurence King Publishing Ltd.	2009

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-552** Course Title: **Smart Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of logistic and supply chain management in business atmosphere.
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Packaging smartly, smart packaging, intelligent packaging, active packaging, smart packaging of food and pharmaceutical products.	6
2	**Smart Packaging Benefits:** Improved communication of product information, communication of product history and condition after packaging, increased integrity and activity of products, response to change in product atmosphere, product authenticity and act to counter to theft, appropriate communication of disposal, seal integrity.	8
3	**Driver for Smart Packaging:** Customer convenience, improved shelf life, communication on state of product, disposal of packaging, economics of smart packaging.	4
4	**Smart Packaging and its Active Ingredients Chemistry:** Freshness indicator, time-temperature indicator, thermo chromic material, temperature indicator and controller, moisture absorber, moisture regulator, oxygen scavenger and carbon dioxide emitter, ethanol emitter, oxygen producer, amine, aldehyde scavenger, ethylene oxide absorber, microbial inhibitors.	10
5	**Smart Packaging Structure and Chemistry of Products:** Fruits and vegetables packaging, meat, fish and poultry products, beverages, spray household and cosmetic packaging, pharmaceutical and health care packaging.	10
6	**Issues Related to Smart Packaging:** Safety and regulations issues related to unreliable indicators, migration of packaging materials to products.	4
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Yam, K. L., "Encyclopaedia of Packaging Technology", Publisher: John Wiley & Sons.	2009
2.	Brody, A. L., "Active Packaging for Food Applications", Publisher: CRC Press.	2001
3.	Kerry, J., and Butler, P., "Smart Packaging Technologies for Fast Moving Consumer Goods", Publisher: John Wiley & Sons.	2008
4.	Dainelli D, Nathalie Gontard, Dimitrios Spyropoulos, Esther Zondervan-van den Beuken, Paul Tobback (2008). "Active and intelligent food packaging: legal aspects and safety concerns". Trends in Food Science & Technology 19 (1): 167–177. Retrieved 12 Nov 2014.	2014

5.	Soroka, W., "Illustrated Glossary of Packaging Terms", Institute of Packaging Professionals.	2008
6.	Katsumoto, Kiyoshi, "Oxygen Scavenging Layer Consisting Of Oxidizable Compound, Second, Separate Layer Consisting of Oxidation Catalyst", Katsumoto, Kiyoshi.	1997
7.	Cichello, Simon, "A Guide to Oxygen Absorbers", Retrieved March 2010.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-554** Course Title: **Optoelectronics in Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of optoelectronics in packaging
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Present Status and Challenges in Optoelectronics:** Detection of defects in packaging, applications in food packaging, applications in F-tablets and other pharmaceuticals packaging, applications in health care products packaging.	8
2	**Methodology:** Thermal, imaging, spectroscopy, optical sorting, biosensor, bio-luminance, polymerase chain reaction, enzyme-linked immune-sorbent assay (ELISA) test.	9
3	**Probes:** Temperature, pH, spectro-chip, fibre fluorescence, lens selection, evanescence, hostile environment, opto-chemical sensors.	9
4	**Designing and Development of Optoelectronic Devices:** Silicon sensors designing, nanosensors designing , spectroscopic sensors , luminance.	9
5	**Regulation & Packaging Technology:** FDA, food and drug cosmetic acts, national regulations.	7
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Zirong Tang, Tielin Shi, Frank G. Shi, "Wiley Encyclopedia of Electrical and Electronics Devices", Publisher: John Wiley & Sons.	2010
2.	Alan R. Mickelson, Nagesgh R. Basayanthally, Yung Cheng Lee, "Optoelectronic Packaging" , Publisher: Wiley Intersecience Series.	2006
3.	Oksana Ostroverkhovai, "Handbook of Organic Material for Optical and Opto-Electronic Devices" , Publisher: Woodhead Publishing Limited .	2006
4.	Leonid Kazoysky, "Optical Fiber Communication System". Publisher: Publisher: Artech House Publishers	1996
5.	Kit L. Yam, "The Wiley Encyclopedia of Packaging Technology", Publisher: Wiley and Sons.	2009

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-556** Course Title: **Robotics and Automated Packaging**
2. Contact Hours: L:**3** T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of robotics and automated packaging
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Robotics and Process Control Systems in Packaging:** Robotics v/s human intervention for different production processes like heat treatment, fumigation, irradiation etc., basic principles & technologies of robotics and process control in food, pharmaceuticals and other industries, recent innovation, future scope.	8
2	**Probes in Robotics and Process Control:** Various probes like thermal imaging, optical, spectroscopic, lesser, diodes, semi-conductor.	8
3	**Machine Vision, Control and Integration:** Machine vision, various sensors and integration, wireless control, data acquisition, integration and supervisory control.	10
4	**Design & Development of Automated and Robotics Packaging System:** Fundamental of design and development, fundamental of robotics, fundamental of automations, rode map of design and development of automated system and robotics in packaging industry.	10
5	**Application of Automation and Robotics in Packaging:** Care and maintenance in food irradiation, industry, sorting, processing industry like fresh food product, poultry and meat, sea food, confectionery, thermal processing, low temperature and chilling applications.	6
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	D. Caldwell, "Robotics and Automation in Food Industry: Current and Future Technology", Publisher: Wood head.	2013
2.	Low Kin Huat, "Industrial Robotics; Programming, Simulation and Applications", Publisher: Literature Verlag.	2011
3.	Robert James Didocha, "Robotics Zation Feasibility Study and Packaging/ Containerization Feasibility Study", Publisher: Engineering Experiment Station Georgia Institute of Technology.	2006
4.	Khodabandehloo, "Robotics Meat, Fish and Poultry Processing", Publisher: Springer.	1983

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-558** Course Title: **Food and Pharmaceutical Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0] [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of food and pharmaceutical packaging.
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Packaging for fresh fruits and vegetables, processed food packaging, pharmaceutical packaging, criticality and need.	2
2	**Function of Packaging:** Physical protection, barrier properties, compatibility, sterilizability, security, convenience.	5
3	**Factor Effecting Food and Pharmaceutical Packaging:** Mechanical damage, external factor such as climate/environment, temperature, pressure, humidity, microbial contamination/ sterility and air/ gases etc., internal factors such as product chemistry and compatibility to packaging.	5
4	**Packaging Property and Testing:** Dimension, weight, coat weight, thickness, density, integrity, accelerated aging test and degradation, internal pressure, compatibility with product (sorption and migration), permeation / barrier property, water permeation and absorption, oxygen and other gas transmission property, porosity, puncture and seal test, vacuum leak, resistance to chemicals, printing and coating performance, tensile strength in dry and wet conditions and mechanical weak point, seal strength, tear strength, wet burst test, cleanliness, chloride contents, sulphate contents, conditioning and flexural durability.	7
5	Processing of packaging materials for food and pharmaceutical; Processing of sterile and non sterile packaging materials, GMP, HACCP.	4
6	**Sterilization & Testing:** Process of sterilization using gamma rays, electron beam, ethylene oxide, low temperature oxidative sterilization and high temperature sterilization; Standard testing of sterilized packaging materials.	4
7	**Typical Food Packaging Structure & Testing:** Green vegetables, fruits, dried and powdered spices, snack food, pickles, milk, oil, fats and butter, beverages and confectionary, raw meat and uncooked food, semi-cooked, cooked foods, ready to eat food.	7
8	**Typical Pharmaceutical Packaging Structure & Testing:** Tablets and capsules, liquids, gels, pastes, inhalers, protein, enzymes, vaccines & other biological fluids, advanced controlled release pharmaceuticals.	4
9	**Health Care Packaging:** Disposable, medical textile, artificial packaging.	4
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Gordon L. Robertson, "Food Packaging: Principles and Practice", 2nd edition, Publisher: CRC Press.	2006
2.	Jung H. Han, "Innovations in Food Packaging, Food Science and Technology", Publisher: Academic press.	2005
3.	Richard Coles, Derek McDowell and Mark J. Kirwan, "Food Packaging Technology", Publisher: CRC Press.	2003
4.	Edward Bauer, "Pharmaceutical Packaging Handbook", Publisher: CRC Press.	2009
5.	A. Kaushik, "Text book of Pharmaceutical Packaging", Publisher: CRC Press.	2011
6.	D. A. Dean, "Pharmaceutical Packaging Technology", Publisher: CRC Press.	2000
7.	Kit Yam, "The Wiley Encyclopedia of Packaging Technology", Publisher: Wiley	2009
8.	Joseph Hanlon, "Handbook of Package Engineering", Publisher: CRC Press.	1998

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-560** Course Title: **Hazardous Material Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of hazardous material packaging
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Hazardous Materials:** Explosive, dangerous gases, dangerous liquids, dangerous solids, oxidisers, peroxides, toxic and infectious materials, radioactive materials, corrosive materials, miscellaneous hazardous materials.	8
2	**Classification of Hazardous Materials:** MSDS of hazardous materials, compatibility classification dot grouping of hazardous materials, selection of packaging materials, specification of packaging materials according to class.	8
3	**Global Regulations:** UN recommendations on the transport of dangerous goods by rail, road, sea and air. IATA dangerous goods regulation, international maritime goods code, globally harmonised system of classification and labelling of chemicals.	5
4	**Regulations on Packaging of Dangerous Materials:** Information and marking on packaging materials as per regulations on packaging transport and storage of hazardous materials.	3
5	**Customer Service and Logistics:** Importance of customer service, component of customer service, measuring customer service.	2
6	**Regulations on Size and Weight of Dangerous Material Packaging:** Bulk container, non-bulk container and intermediate bulk container.	4
7	**Packaging Recommendations for Dangerous Goods and Testing:** Packaging recommendations for classes 4, 5, 6, and 8 and testing of packaging materials for dangerous goods.	4
8	**Safety in Packaging and Moving of Dangerous Materials:** Personal safety and during handling of dangerous materials, precaution during moving and handling of dangerous materials, emergency assistance and spill assistance, symbols and labels-identification of associated hazards and warnings.	4
9	**Roadmap of Packaging Hazardous Materials:** Identification of hazard, segregation as per hazard, section of packaging materials and size as per hazard, marking of packaging materials as per regulation, packing and moving, responding to emergency, example of packaging hazardous materials.	4
Total Contact Hours		42

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11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Institute of Packaging Professionals Chemical Packaging Committee, "Shippers Guide to Loading and Securement of Packaged Materials/Dangerous Goods in Intermodal Equipment: Highway, Rail, Water", Publisher: Institute of Packaging Professionals	1999
2.	ASTM D 4919-03 Standard Specification for Testing of Hazardous Materials Packaging.	2006
3.	Gazette of India: Extraordinary Part-II (3(i)) Ministry of Environment and Forest, Notification 8th July 2011.	2009
4.	Dangerous good regulations (DGR), Publisher: IATA	2009
5.	Transport of Dangerous Goods Regulations, Canada , 28th Oct ,2009	2009
6.	Eugene Meyer, "Chemistry of Hazardous Materials" (6th Edition), Publisher: Brady Fire Series	2013

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-562** Course Title: **Industrial Packaging**
2. Contact Hours: L:**3** T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of industrial packaging
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Aim of Industrial Packaging:** History of industrial packaging, classification of industry and packaging; Industrial packaging and its relation in heavy industry, consumer product, food industry; Pharmaceutical and health industry packaging.	8
2	**Materials, Operations and Present Trends in Industrial Packaging:** Materials used in industrial packaging, operation in industrial packaging, development of operation based on industry in industrial packaging, industrial packaging trends and innovation.	9
3	**Industrial Packaging:** Handling, transportation, regulations, handling norms of industrially packed products, transportation and logistics methods of industrially packed goods, regulations in industrial packaging.	7
4	**Recent Trends**: Networking and computer in industrial packaging, industrial packaging and automation in palletizing, industrial packaging container loading and robotics.	9
5	**Design, Developments and Application of Industrial Packaging:** Introduction to designing methods of industrial packaging, introduction to new process development of developing packaging materials for industrial packaging, some applications of industrial packaging products, future prospect of industrial packaging products; Disposal and reuse of industrial packaging containers.	9
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Walter Soroka , "Fundamental of Packaging Technology"' 4th edition , Publisher: DEStech Publications, Inc.	2009
2.	Walter F. Friedman & Jerome , J. Kipness , "Industrial Packaging", Publisher: John Wiley & Sons.	1960
3.	Aaron L. Brody and Kenneth S. Marsh, "The Wiley Encyclopaedia of Packaging	1997

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	Technology", 2nd Edition, Publisher: Wiley –Inter Science.	
4.	Kit L. Yam, "The Wiley Encyclopaedia of Packaging Technology", 3rd Edition, Publisher: John wiley & Sons	2009
5.	James Z.R. Brights, Walter Fred Friedmen, Jerome J. Kipnees, "Industrial Packaging : Material Handling and Packaging", Publisher: Literary Licensing .	2013

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-563** Course Title: **Logistics and Supply Chain Management**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of logistic and supply chain management in business atmosphere
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Concept of Logistics:** Distribution packaging-a system approach, scope and definition, historical prospective, importance of logistics and distribution, logistics and supply chain structure.	4
2	**Overview of Supply Chain Management:** Introduction, nature and concept of supply chain management, contribution of supply chain management, supply chain management system, supply chains specific to product groups and major differences.	4
3	**Integrated Logistics and Supply Chain:** The total logistic concept planning, the financial impact of logistics, globalization and integration, competitive advantage through logistics, logistics and supply chain management; Multi modal systems and their impact on packaging requirements.	4
4	**Strategic Supply Chain Management :** Introduction to strategic supply chain management, supply chain in value chain perspective, strategic role of supply chain management –architecture.	4
5	**Customer Service and Logistics:** Importance of customer service, component of customer service, measuring customer service.	4
6	**Customer Value, Service and Channel Strategies in Supply Chain :** Consumer value, customer service element & cost, gap analysis & service measurement.	4
7	**Key Issues, Challenges, Planning and Process :** Key issues and challenges related to logistics, external environment, manufacturing and supply, planning for logistics with parameter to pressure for changing, design, product characteristics, product life cycles, packing, logistics process tools and technique.	4
8	**Value of Information and Order Management in Logistics and Supply Chain:** Introduction, nature, concept and components of order management, market intelligence, demand forecast.	4
9	**Transportation Warehousing, Sourcing, Procurement, and Performance Measurement:** Location of transport supply, elements of transport, selection of transport and mode of transport, containerization, principle of ware housing, strategy, operation, storage and handling, pallet movement and ware housing design, cross docking, tracking distribution losses and evaluation distribution	10

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	packaging, introduction, strategy of supply chain management, supply chain in value chain, customer value and supply chain.	
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	D. K. Aggarwal, "Supply Chain Management", Publisher: Macmillan	2010
2.	Alen Rushton, Phil Croucher, Peter Baker, "Hand Book of Logistics and Distribution", Publisher: Kogan Page	2006
3.	James B. Ayers, Handbook of Logistics and Distribution" , Publisher: Auerbach.	2006
4.	F. Robert Jacobs, Richard Chase, "Operation and Supply Chain Management", Publisher: McGraw Hill	2014
5.	C. John Langley, Robert A. Novack, Brian J. Gibson, John J. Coyle, "Logistic Approach to Supply Chain Management", Publisher: CENEAGE Learning India Pvt Ltd.	2009

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-564** Course Title: **Sustainable Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of sustainable packaging
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Definition of sustainable packaging, criteria of sustainable packaging, cost, analysis of cost, analysis of life cycle of packaging, examples of sustainable packaging used in industry, introduction to compass.	10
2	**Life Cycle Analysis:** Life cycle analysis, sustainable packaging, waste management, producer responsibility, design for environment, streamlined life cycle analysis, recycling, carbon foot print.	10
3	**Compass:** Design process, consumption matrix, emission brief, packaging waste and its use, life cycle of packaging, how compass is helpful?	5
4	**Costing and Sustainable Packaging:** Opportunity analysis, present cost, specification analysis, automation probability , purchase of raw materials.	5
5	**Price and Sustainable Packaging:** Analysis of consciousness of customer towards green, readiness of customer to go green at higher cost, product positioning and greenness, market placement, pricing matrix.	10
6	**Sustainable Packaging and Software:** Scenario based analysis, comparative analysis, cube utilization, integrated reporting engine.	2
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Scott Boylston, "Designing Sustainable Packaging", Publisher: Laurence King Publishing.	2009
2.	Wendy Jedlicka, "Packaging Sustainability: Tools, Systems and Strategies for Innovative Package Design, Publisher: Wiley.	2012
3.	Verghese Karli, Lewis, Helen, Fitzpartrick, Leanne, "Packaging for Sustainability", Publisher: Springer.	2008
4.	Philips M. Parker, "The 2011-2016 Outlook for Sustainable Packaging Services in India", Publisher: Icon Group International.	2011
5.	Kem – Laurin Kramer, "User Experience in the Age of Sustainability", Publisher: Morgan Kaufmann.	2012

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-565** Course Title: **Industrial Design**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of industrial design
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Definition of industrial design, history of industrial design, difference between industrial design and other aspects of product design, overlapping of product design and industrial design.	10
2	**Component of Industrial Design:** Aesthetic, ergonomics, functionality and /or usability.	4
3	**Utility of Industrial Design:** Marketability, brand development, improved production process.	3
4	**Approach to Industrial Design:** Opportunity analysis, concept development using CAD, prototype developments, optimization of details, industrial CT scanning and CAD model.	5
5	**Industrial Design & Product Improvement:** Value addition, value creation, value estimation in marketing, brand building, reduction in cost of production.	5
6	**Industrial Design and IPR:** What is innovative design? Newness in design, steps to approach for IPR.	5
7	**Example of Iconic Industrial Design, its Value and Point of Sale:** I-pod of apple, Lurelle Guild, vacuum cleaner, chair by Charles Eames and Russel Wright, coffee urn, 35 mm photography, first truck with a cab-over-engine configuration, Pacer, Gremlin, Matador coup, Jeep cherokee of automotive industry, electric razors, electrolux refrigerators, Le Creuset French ovens, model 1300 Volkswagen Beetle, electric guitars, calculator Olivetti Divisumma by Marcello Nizzoli, Western Electric Model 302 telephone etc.	10

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Pulos, Arthur J., "The American Design Adventure 1940-1975", Publisher: Cambridge, Mass: MIT Press	1988
2.	de Noblet, J., "Industrial Design', Publisher: A.F.A.A.	1993
3.	Adrian Forty, "Objects of Desire: Design and Society Since 1750", Publisher: Thames Hudson.	1992
4.	Maurice Barnwell, "Design, Creativity and Culture", Black Dog.	2011
5.	Denis A. Coelho, "Industrial Design – New Frontier", Publisher: In Tech. Open Access Publisher.	2011
6.	Jeffrey Meikle, "Industrial Design engineering in America", Publisher: Temple University Press.	1979
7.	Maurice Barnwell, "Design Evolution: Big Bang to Big Data", Publisher: Barnwell.	2014

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-566** Course Title: **Lamination and Functional Packaging**
2. Contact Hours: L:**3** T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of lamination and functional packing
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Tailor making of properties through lamination, lamination in packaging, typical laminated structures in use, advantage of lamination in packaging, advantages/disadvantages of lamination process, applications of laminated structures in packaging.	5
2	**Laminated Structures in Packaging:** laminated packaging of fruits, vegetables and food, beverage and confectionery, oils and fats, pharmaceuticals, biological fluids and heath care; laminated packaging of products, pharmaceutical and healthcare products, detergents, cosmetics, electronics.	8
3	**Functions of Laminated Structures in Packaging:** Seal security and improved mechanical property of packaging materials, barrier, controlled permeability of oxygen, water vapour etc., insulation and temperature control, surface compatibility of packaging materials and products.	6
4	**Introduction to Functional Coating:** Chemistry of functional coating, fundamental, classification, mechanisms of application like polyurethane dispersion, wax dispersion, acrylic dispersion, silicon nitride, tri peptide etc.	6
5	**Testing of Laminated Structure and Functional Coating:** Tensile strength, seal strength, burst strength, vapour permeability, gas permeability, conditioned testing, tape test, thickness test and density test etc.	5
6	**Application of Functional Coating:** Mechanism of performance of functional coating in the field of application of oil barrier, aroma preservation, cold seal, adhesion promoter, slip agent, blood compatibility and improved biomechanics, improved bio-fouling etc.	5
7	**Lamination and Coating Machining:** Water based, solvent based, solvent free coating and laminate manufacturing machine, extrusion coating, co-extrusion.	7
Total Contact Hours		42

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11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Kit L. Yam, "The Wiley Encyclopaedia of Packaging Technology", 3rd edition John Wily & Sons Publication.	2010
2.	Sina Ebnesajjad, "Plastic Film in Food Packaging: Materials, Technology and Application",Publisher: Elsevier Science.	2006
3.	Edward Bauer, "Pharmaceutical Packaging Handbook", Publisher: CRC Press.	2009
4.	J. M. Lagaron, "Multifunctional and Nanoreinforced Polymer for Food Packaging", Publisher: Woodhead Publication.	2011
5.	Elizabeth A. Balwin, Robert Hagenmeir, Jinhe Ba, "Edible Coatings and Film to Improve Food Quality", Publisher: CRC Press.	2011
6.	Aristippos Gennadios, "Protein – Based Film and Coating", Publisher: CRC Press.	2002

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-567** Course Title: **Economics of Packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of economics of packaging.
10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** General need of packaging and concept of value addition through packaging, benefits of packaging, cost of packaging, strategy of business and alignment of it to packaging, marketing & packaging of product, brand representation and packaging, packaging performance and functional requirements.	5
2	**Introduction to Economics of Packaging:** Packaging in a market economy, push and pull factors, economy and commercial role of packaging communication.	5
3	**Purchase Decision, Sale Price and Cost:** Packaging and purchase decision, pricing methods in retail, distributor and direct consumer sale, effect of packaging cost on sale price and contribution margin.	2
4	**Price Point Based on Packaging:** Material price, value addition perceived by customer due to packaging, competitor pricing strategy due to packaging materials, packaging material production cost, production losses, other losses, packaging material quality control and assurance cost, transportation cost, alternate methods of price quotation, production runs and their impact on costing of various packaging materials.	4
6	**Packaging Materials Cost Evaluation:** Vendor development, quantity and quality based cost, logistic and lead time and other commercial terms.	3
7	**Design and Development Cost of Packaging Materials:** Design cost, tooling, samples, sample evaluation, testing, test marketing, specifications, preparation, quality control, verification, certification and validation cost, start up cost.	4
8	**Capital Investment and One Time Cost:** Production machine, quality control instrument and accessory, tooling, dies, special moulds, and gravure cylinders etc.	4
9	**Material costs:** Basic unit price, special packaging, freight, packaging materials storage and handling, sampling and inspection costs.	4
10	**Packaging Processing Cost:** Labour cost, distribution cost, utility, right off inventory cost, practical examples dependent on small and large batch sizes.	7
11	**Circular Economics of Packaging Materials:** Introduction, structuring of circular economy of circular economy, retail and circular economy.	2
12	**Economic Impact of the Packaging and Packaging Waste Classes:** Packaging waste and waste management cost, green dot scheme, economic aspect of recycling packaging materials; Concept on return logistics of	2

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	packaging.	
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Gerald Stone, "Core Economics & Business Case for Packaging", Publisher: Worth Pap.	2011
2.	William E. Brown, "Plastics in Food Packaging, Properties, Fabrication, Design", Marcel Dekkar.	1992
3.	Paul Krugman, Robin Wells, Margaret Ray, David Anderson, "Microeconomics in Modules and Business Case in Packaging", Publisher: Worth.	2011
4.	Brijesh K. Tewari, Tomas Norton, Nicholas M. Holden, "Sustainable Food Processing", John Wiley & Sons.	2014
5.	Scott A. Morris, "Food and Package Industry", John Wiley & Sons.	2011

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-568** Course Title: **Nanotechnology Application In packaging**
2. Contact Hours: L:3 T: 0 P: 0
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [25] PRS [0] MTE [25] ETE [50] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PP**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of Nanotechnology application in packaging.

Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Nanotechnology, nanomaterials, nanostructure, nano- and micro- scale materials and its properties and variation, application of nano materials in packaging, synthesis of nanomaterials: top down, bottom up approach; nanofabrication: thin film, nanowire, carbon nanotubes.	10
2	**Function of Nanomaterial in Packaging:** Physical protection, barrier properties, compatibility, sterilizability.	5
3	**Applications of Nanotechnology:** Nanotechnology in printing, nanotechnology in coating, nanotechnology in electronics, optoelectronics, and photonics packaging, low and high- materials for micro- and nano-electronics packaging, nanotechnology in supply chain/security, nanotechnology in paper-based packaging, social and environmental impacts of nanotechnology in packaging, life cycle analysis and economical feasibility of nanocomposites in barrier packaging market.	10
4	**Nanomaterials in Packaging:** Clay, silver, silicate etc.	3
5	**Polymers, Nanocomposites and Ink in Packaging and its Processing:** PP, PE, nylon and polyamide, EVOH, PLA and copolymers, starch, nano-ink composition, testing and evaluation of performance.	5
6	**Some Example of Nanopackaging materials:** Nanotechnology and food packaging, electronic packaging, health care packaging.	2
7	**Nanotechnology, Testing, Regulations & Safety:** Toxicity and food packaging, instrumental methods of testing, premarket approval, and safety regulations and safety aspects covered in existing regulations, regulations that need modifications, nanotechnology and future packaging.	7
Total Contact Hours		42

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Leslie Pray, Ann Yaktine, Rapporteurs, "Nanotechnology in Food Products", Publisher: National Academics Press.	2009
2.	Ian Barnett, "The Nanotechnology Opportunity in Food and Drinks	2011

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	Packaging", Publisher: Datamonitor Consumer.	
3.	Amar K. Mohanty, Manjusri Misra and Hari Singh Nalwa, Manjusri Misra, "Packaging Nanotechnology Hardcover", Publisher: American Scientific Publishers.	2006
4.	Bhusan, "Spinger Handbook of Nanotechnology", 2nd Revision, Publisher: Springer.	2011
5.	M Lagarón, "Multifunctional and Nanoreinforced Polymers for Food Packaging", Publisher: Woodhead Publishing.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PPN-570** Course Title: **Advance analytical Techniques**
2. Contact Hours: L:**3** T: 0 P: 2/2
3. Examination Duration (Hrs.): Theory [3] Practical [0]
4. Relative Weightage: CWS [20] PRS [20] MTE [20] ETE [40] PRE [0]
5. Credit: **3** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Prerequisite **Nil**
9. Objective: To impart knowledge of advance Analytical techniques

Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to advanced characterization techniques: brief discussion on importance, history, current and prospective applications.	2
2	**Spectroscopic Characterization**: Vibrational spectroscopy (IR and Raman spectroscopy), UV-visible and photoluminescence, ESCA, atomic absorption spectra, NMR, mass spectroscopy. **Elemental analysis:** CHNSO, inductively coupled plasma optical emission spectroscopy.	10
3	**Phase, Structural and Microstructure Characterization :** Introduction to X-rays, crystal structures, structural factor, principle of X-ray diffractions, single phase analysis, multi-phase analysis, estimation of particle size and strain, studying nano/meso-structures by XRD. Introduction to optical, fluorescence and confocal microscopy; Electron microscopy, construction details of electron microscopes e.g. SEM, TEM and STM and their detailed working principle to study different nano/micro/meso structures; Principles and usages of atomic force microscopy (AFM).	12
4	**Electrical and Thermal Properties**: Conductivity measurement via two and four probe method of ceramic, polymer and metals, dielectric properties, dielectric constant, dielectric loss, advanced techniques for thermal characterization; TGA, DSC,DMA,TMA etc., shielding effect.	10
5	**Polymer and Packaging characterization**: Mechanical performance of polymeric materials in packaging, permeability, structure reaction between structure and permeability, polymeric and cellulosic materials.	5
6	**Application in Packaging**: Performance and analysis of packaging materials, application of characterization in packaging, food packaging, cosmetic and nutraceutical packaging, pharmaceutical & health care packaging, electronic packaging etc.	3
Total Contact Hours		42

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List of Practical:

1. Spectroscopic characterization of given material (inorganic/organic/packaging material) like FTIR, NMR
2. Structural and morphological analysis of amorphous/crystalline material by XRD/FESEM
3. Thermal properties of polymer/ceramic by TGA, DTA etc.
4. Electrical properties of polymeric and packaging material by two probe /four probe method
5. Evaluation of dielectric properties of material(Dielectric constant, Dielectric loss)
6. Surface properties by Atomic Force Microscopy of polymeric thin/thick films

11. Suggested Books:

S.No.	Name of Books/Authors	Year of publication
1	Richard K. Ulrich , William D. Brown, "Advanced Electronic Packaging, 2nd Edition", Publisher: Wiley-IEEE Press	2006
2	Jack Cares, "Analytical Instrumentation Handbook", 3rd Edition, Publisher: CRC Press	2004
3	Richard Coles, Mark J. Kirwan, "Food and Beverage Packaging Technology" 2nd Edition, Publisher: Wiley-Blackwell	2011
4	Hobart H. Willard, Lynne L. Merritt Jr, John Dean, "Instrumental Methods of Analysis (Chemistry) Hardcover", Publisher: Wadsworth Publishing Co. Inc.	1988
5	Yam K L, "Encyclopedia of Packaging Technology", Publisher: John Wiley & Sons	2009
6	Lockhart, H., and Paine, F.A., "Packaging of Pharmaceuticals and Healthcare Products", Publisher: Blackie	2006
7	Dehoff, R.T. and Rhines, F.N., "Quantitaive Microscopy", Publisher: McGraw Hill	2000
8	Silverstein, Webster & Kiemle, "Spectrometric identification of organic compounds" 7th Ed., Publisher: John Wiley and Sons	1986
9	Speyer, R., "Thermal Analysis of Materials", Publisher: CRC Press	2005
10	K. Nakamoto, "IR and Raman spectra of inorganic and coordination compounds" 4th Ed., Publisher: John Wiley and Sons	1968
11	J. D. Winefordner, "Raman spectroscopy in chemical analysis" Vol. 157, Publisher: John Wiley and Sons	1993

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Polymer & Process Engineering**

1. Subject Code: **PE-901** Course Title: **Engineering Polymeric Composites**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**
4. Relative Weightage: **CWS : 25** **PRS : 0** **MTE : 25** **ETE : 50** **PRE : 0**
5. Credits: **4** 6. Semester: **Autumn / Spring** 7. Subject Area: **Pre-PhD**
8. Pre-requisite: **NIL**
9. Objective: The course will impart knowledge of advanced composites for high-tech applications.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Need to reinforce polymers, particulate, short and continuous fiber and nano fibers reinforced composites based on thermoplastic and thermoset matrices.	1
2.	**Particulate Polymeric Composites:** Principles of reinforcing filler and particle selection, incorporation and packing of reinforcement particles, melt flow and rheology of particulate polymeric composites and their processing. Extrusion, Compounding, and Injection molding, Properties, statistical mechanics and semi-empirical equations for mechanical properties; Applications.	8
3.	**Short Fiber Reinforced Polymeric Composites:** Short Synthetic and Natural Fibers as Reinforcement Materials and their selection, orientation and its effects on reinforcement efficiency, melt flow and rheology of particulate polymeric composites and their processing. Extrusion, Compounding, and Injection molding, Properties, interface, compatibilizer, matrix modification, fiber treatment, statistical mechanics and semi-empirical equations for mechanical properties; Applications.	9
4.	**Continuous Fiber Reinforced Thermoset Polymeric Composites:** Thermosetting matrix resins, Reinforcing Fibers : Carbon, glass, kevlar, silica, boron fibers, fiber forms, orientation, aspect ratio, mats, fiber-matrix interphase, adhesion, interface improvement, interfacial agents, fiber surface treatment, matrix modification compatibilizer, Fabrication techniques processes and equipment, compression moulding, pultrusion and advanced processing properties and statistical mechanics, semi empirical equations for mechanical properties; Applications.	9

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5.	**Continuous Fiber Reinforced Thermoplastic Polymeric Composites:** Thermoplastic resins, interphase, adhesion, interface improvement, interfacial agents, fiber surface treatment and matrix modification compatibilizer, Fabrication techniques processes and equipment, Applications.	8
6.	**Nano Composites:** Fillers: Plate, equi-axed, inorganic fillers, carbon and other nano tubes. Matrices: Engineering, high tech and liquid crystal polymer matrices. Processing; Direct and solution mixing, in-situ polymerization.	5
7.	**Applications:** Fire resistant, high temperature, automobile, and aerospace applications.	2
	Total	**42**

11. Suggested Books

S. No.	Name of Books / Authors / Publisher	Year of Publication
1.	Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science & Technology", Wiley-VCH.	2003
2.	De S and White J, "Short Fiber Composites", Technomic.	2006
3.	Palsule S., "Polymer Composites", New Age International	2008
4	Summerscales J and Short D, "Fiber Reinforced Polymers", Technomic.	2006

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE : **Department of Polymer and Process Engineering**

1. Subject Code: **PP-918** Course Title: **Data Mining Applications in Ecommerce**
2. Contact Hours: **L :3** **T:0** **P: 0**
3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**
4. Relative Weightage: **CWS: 25** **PRS: 0** **MTE : 25** **ETE : 50** **PRE : 0**
5. Credits: 3 6. Semester: **Both** 7. Subject Area : **DEC**
8. Pre-requisite: **Nil**
9. Objective: To understand the role of data mining in Ecommerce environment.
10. Details of Course:

S. No.	Contents	Contact hours
1.	**Introduction:**Overview of data mining,functionalities, data pre-processing, cleaning, integration,transformation,reduction anddiscretization.	5
2.	**Association Analysis:** Market basket analysis, frequent pattern mining, mining association rules, correlationanalysis, constraint based association mining.	4
3.	**Classification and Prediction:**Introduction to classification and prediction,classification by decision tree,bayesian classification, rule-based classification, lazy learners, regression analysis for prediction, evaluating accuracy of classifier/predictor.	4
4.	**Cluster Analysis:** Data types for cluster analysis, hierarchical clustering, centroid-based clustering, distribution-based clustering, density-based clustering, constraint based clustering, outlier analysis.	4
5.	**Web Mining:** Introduction to web mining, mining data streams, link analysis,social network analysis.	6
5.	**Introduction to Ecommerce:** Origin and growth, infrastructure, business models, security and payment systems.	4
6.	**Ecommerce Marketing and Advertising:** Consumer behaviour and purchase decisions, marketing and advertisingstrategies and tools.	5
7.	**Applications:** Introduction to data mining softwares, advertising on web, recommendation systems, behaviouranalysis, personalization system, stock market analysis, security analysis and portfolio management, financial Performance Analysis.	10
	Total	**42**

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11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Jiawei H., and MichelineK., "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers.	2011
2.	Russell M., "Mining The Social Web", O'reilly Publishers.	2013
3.	Ian H.W., Eibe F., and Hall M., " Data Mining: Practical Machine Learning Tools and Techniques", 3rdEd., The Morgan Kaufmann Series in Data Management Systems.	2011
3	Laudon K., Traver C., "E-commerce: Business. Technology. Society", Pearson.	2013
4.	Hanson W., and Kalyanam K., " Internet Marketing &Ecommerce", 2nd Ed., Cengage Learning.	2012
5.	Linoff G., and Berry M., "Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management", 3rd Ed., Wiley.	2011

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DEPARTMENT OF PAPER TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: 41 **M.Tech. (Pulp and Paper)**
Department: PP **Department of Paper Technology**
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
Semester- I (Autumn)														
1.	PPN-501	Pulping	PCC	4	3	1	2/2	3	-	20	20	20	40	-
2.	PPN-503	Chemical Recovery Process	PCC	4	3	1	2/2	3	-	20	20	20	40	-
3.	PPN-505	Paper Proprieties and Stock Preparation	PCC	4	3	1	2/2	3	-	20	20	20	40	-
4.		Program Elective-I	PEC	4	3	1	0	3	-	25	-	25	50	-
5.		Program Elective-II	PEC	3	3	0	2/2	3	-	20	20	20	40	-
		Total		19	15	4	4							
Semester-II (Spring)														
1.	PPN-502	Washing and Bleaching	PCC	4	3	1	2/2	3	-	20	20	20	40	-
2.	PPN-504	Paper Making	PCC	4	3	1	2/2	3	-	20	20	20	40	-
3.	PPN-700	Seminar	SEM	2	0	0	2	-	-	-	-	-	100	-
4.		Programe Elective III	PEC	3	3	0	0	3	-	25	-	25	50	-
5.		Programe Elective IV	PEC	3	3	0	0	3	-	25	-	25	50	-
6.		Programe Elective-V	PEC	3	3	0	0	3	-	25	-	25	50	-
		Total		19	15	2	2							

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DEPARTMENT OF PAPER TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **41** **M.Tech. (Pulp and Paper)**
Department: **PP** **Department of Paper Technology**
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
Semester- I (Autumn)														
1.	PPN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	50	-	-	50
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	PPN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	50	-	-	50
		Total		18										

Summary				
Semester	1	2	3	4
Semester-wise Total Credits	**19**	**19**	**12**	**18**
Total Credits	**68**			

Program Elective Courses M.Tech. (Pulp and Paper)

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
Program Elective-I Autumn Semester														
1.	PPN-511	Modeling and Simulation	PEC	4	3	1	0	3	-	25	-	25	50	-
2.	PPN-513	Process Optimization	PEC	4	3	1	0	3	-	25	-	25	50	-
3.	PPN-515	Advance Numerical Methods and Statistics	PEC	4	3	1	0	3	-	25	-	25	50	-
Program Elective-II Autumn Semester														
4.	PPN-521	Process Automation	PEC	3	3	0	2/2	3	-	20	20	20	40	-
5.	PPN-523	Process Instrumentation and Control	PEC	3	3	0	2/2	3	-	20	20	20	40	-
6.	PPN-525	Computer Based Control Systems	PEC	3	3	0	2/2	3	-	20	20	20	40	-
Program Elective-III Spring Semester														
7.	PPN-512	Environmental Management	PEC	3	3	0	0	3	-	25	-	25	50	-
8.	PPN-514	System Closure	PEC	3	3	0	0	3	-	25	-	25	50	-
9.	PPN-516	Chemical Recovery Process Calculations	PEC	3	3	0	0	3	-	25	-	25	50	-
Program Elective-IV Spring Semester														
10.	PPN-522	Paper Making Chemistry	PEC	3	3	0	0	3	-	25	-	25	50	-
11.	PPN-524	Electro kinetics in Paper Making	PEC	3	3	0	0	3	-	25	-	25	50	-
12.	PPN-526	Bio Process and its application	PEC	3	3	0	0	3	-	25	-	25	50	-
13.	PPN-528	Pulp Mill Calculations	PEC	3	3	0	0	3	-	25	-	25	50	-
Program Elective-V Spring Semester														
14.	PPN-532	Printing and Converting Operations	PEC	3	3	0	0	3	-	25	-	25	50	-
15.	PPN-534	Coated and Specialty Papers	PEC	3	3	0	0	3	-	25	-	25	50	-
16.	PPN-536	Packaging Papers and Boards	PEC	3	3	0	0	3	-	25	-	25	50	-
17.	PPN-538	Paper Mill Calculations	PEC	3	3	0	0	3	-	25	-	25	50	-

Appendix-

DEPARTMENT OF PAPER TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **42** **M.Tech. (Packaging Technology)**
Department: **PP** **Department of Paper Technology**
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
Semester- I (Autumn)														
1.	PPN-541	Packaging Principles, Processes and Sustainability	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	PPN-543	Packaging Materials	PCC	5	4	0	2	3	0	15	25	20	40	-
3.	PPN-545	Printing Technology	PCC	3	3	0	0	3	0	25	-	25	50	-
4.	PPN-547	Converting Processes for Packaging	PCC	3	3	0	0	3	0	25	-	25	50	-
5.		Program Elective-I	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	13	-	2							
Semester-II (Spring)														
1.	PPN-544	Package Performance	PCC	3	3	0	2/2	3	0	20	20	20	40	-
2.	PPN-546	Package Design	PCC	3	2	0	2	2	0	15	25	20	40	-
3.	PPN-700	Seminar	SEM	2	0	0	4	0	0	-	-	-	100	-
4.		Program Elective-II	PEC	3	3	0	0	-	0	-	-	-	-	-
5.		Program Elective-III	PEC	3	3	0	0	-	0	-	-	-	-	-
6.		Program Elective-IV	PEC	3	3	0	0	-	0	-	-	-	-	-
7.		Program Elective-V	PEC	3	3	0	0	-	0	-	-	-	-	-
		Total		20	5	0	3							

DEPARTMENT OF PAPER TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **42** **M.Tech. (Packaging Technology)**
Department: **PP** **Department of Paper Technology**
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
Semester- I (Autumn)														
1.	PPN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	50	-	-	50
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	PPN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	50	-	-	50
		Total		18										

Summary				
Semester	1	2	3	4
Semester-wise Total Credits	**18**	**20**	**12**	**18**
Total Credits	**68**			

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Program Elective Courses M.Tech. (Packaging Technology)

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
Program Elective-I														
1.	PPN-551	Application of Modeling and Simulation in Packaging	PEC	4	3	0	2	3	-	15	25	20	40	-
2.	PPN-553	Statistical Analysis and Design of Experiments	PEC	4	3	1	0	3	-	25	-	25	50	-
3.	PPN-515	Advanced Numerical Methods and Statistics	PEC	4	3	1	0	3	-	25	-	25	50	-
Program Elective-II														
4.	PPN-561	Business Law	PEC	3	3	0	0	3	0	25	-	25	50	-
5.	PPN-563	Logistics and Supply Chain Management	PEC	3	3	0	0	2	0	25	-	25	50	-
6.	PPN-565	Industrial Design	PEC	3	2	0	2	-	0	15	25	20	40	-
7.	PPN-567	Economics of Packaging	PEC	3	3	0	0	-	0	25	-	25	50	-
Program Elective-III, IV, V														
8.	PPN-552	Smart Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
9.	PPN-554	Optoelectronics in Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
10.	PPN-556	Robotics and Automated Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
11.	PPN-558	Food and Pharmaceutical Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
12.	PPN-560	Hazardous Material Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
13.	PPN-562	Industrial Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
14.	PPN-564	Sustainable Packaging and Life Cycle Analysis	PEC	3	3	0	0	3	-	25	-	25	50	-
15.	PPN-566	Lamination and Functional Coatings	PEC	3	3	0	0	3	-	25	-	25	50	-
16.	PPN-568	Nanotechnology Applications in Packaging	PEC	3	3	0	0	3	-	25	-	25	50	-
17.	PPN-570	Advanced Analytical Techniques	PEC	3	3	0	2/2	3	-	20	20	20	40	-

Appendix-C

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-580** Course Title: **Advanced Linear Control Systems**

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

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

4. Relative Weight: **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Knowledge of Linear Control System**

9. Objective: To introduce advanced control methods, including linear and nonlinear systems. Also to introduce advanced state space methods.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Modeling of dynamical system in continuous time state space and discrete time state space model, Solution of continuous time state equation using: Similarity Transformation, Cayley Hamilton approach and Inverse Laplace approach, Solution of discrete time state equation.	6
2.	**Controllability and Observability:** General concept of Controllability and Observability, Controllability test for continuous time and discrete time system, Observability test for continuous time and discrete time system, Stabilizabilty and Detectability definition and tests, loss of Controllability and Observability due to sampling, Controllable and Observable canonical forms	8
3.	**Multivariable Control System:** Examples of multivariable control systems, State space, polynomial and stable fraction models. Realization theory of multivariable systems and algorithms. Spectral factorizations of systems.	8
4.	**Stability Analysis:** Stability concept, stability definition in the sense of Lyapunov, stability of continuous time Linear systems, stability of discrete time Linear systems, stability of nonlinear systems, Lyapunov stability theorem, Lyapunov instability theorem, direct method of Lyapunov for continuous time and discrete time systems.	8
5.	**Controller/Observer Design:** Pole placement technique, Ackerman's approach and Linear quadratic regulator for continuous time and discrete time systems, full order and reduced order observer design. Introduction to Optimal Control Problem.	12
	Total	42

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11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Hostetter G. H., Savant, and Stefani, *Design of Feedback Control Systems*, Oxford University Press	2001
2.	Kailath Thomas, *Linear Systems*, Prentice Hall	1996
3.	C.T.Chen: Linear system theory and design, 3rd edition Oxford	1999
4.	John bay: Fundamentals of linear state space systems, McGraw Hill	1998

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-582** Course Title: **Advanced System Engineering**

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

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

4. Relative Weight: **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Basic knowledge of Control Systems**

9. Objective: **To impart the knowledge advanced system engineering techniques**

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Models and their classifications, statement of model reduction problem, reduced order models, Models of discrete systems, Transfer function (frequency domain), model simplification methods, state space (Time domain) order reduction methods.	8
2.	Hierarchical structures, decentralized control, modeling of large scale systems, aggregation and Eigen value assignment	4
3.	Continued fraction expansion methods, time moment matching, PADE approximation, differentiation and truncation method of model order reduction, factor division method	8
4.	Stability based reduction methods-Routh approximation method, Routh Hurwitz array method, Stability equation method, Mihailove stability criterion method, Dominant pole retention method	10
5.	Error minimization methods, Order reduction of discrete time Systems	4
6.	Minimal realization time scale analysis, Decoupling methods, fast-slow subsystem, state feedback design, singular perturbations, controllers with accessible and inaccessible states, design of optimal controllers, controller reduction	8

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11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Gordon G., "System Simulation", Prentice Hall of India	1978
2.	Jamshidi M., "Large Scale Systems Modeling and Control ", Series Volume- 9, North Holland NY	1983
3.	Mahmud M. S., Singh M. G., " Large Scale Systems Modelling", Volume -3, Pergamum Press	1981
4.	Peebles Z. P. Jr., "Probability, Random Variables and Random Signal Principles", 4th Edition, Tata McGraw Hill	2002
5.	Papoulis A., " Probability and Statistics", PHI	1990

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PROGRAM CODE : 121 – B.Tech. (Polymer Science and Engineering)

DEPARTMENT : Department of Polymer Science and Engineering

YEAR : I

Appendix-D

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weights (%)				
S.No	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Semester-I (Autumn)														
1.	MAN-001	Mathematics-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PEN-101	Introduction to Polymer Science and Engineering	DCC	2	2	0	0	0	0	-	-	100	-	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	15	-	35	50	-
4.	HSN-001A HSN-001B	Communication skills (Basic) Communication skills (Advanced)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self-Awareness	HSSC	2	1	1	0	2	0	15	-	35	50	-
6.	CYN-009	Polymer Chemistry	BSC	4	3	1	0	2	0	25	-	25	50	-
7.	PEN-103	Computer Programming and Numerical Methods	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**03**	**4**							
Semester-II (Spring)														
1.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	CHN-102	Material and Energy Balance	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-106	Thermodynamics and Chemical Kinetics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	PEN-202	Properties of Polymer	DCC	3	2	1	2/2	2	0	20	20	20	40	0
5.	CYN-011	Characterization Techniques of Polymers	BSC	4	2	0	4	0	3	-	25	25	0	50
6.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	0
		Total		**23**	**16**	**5**	**6**							

PROGRAM CODE : 121 – B.Tech. (Polymer Science and Engineering)

DEPARTMENT : Department of Polymer Science and Engineering

YEAR : II

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weights (%)				
S.No	SUBJECT CODE	COURSE TITLE	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Semester-III (Autumn)														
1.	CHN-201	Heat Transfer	DCC	4	3	1	2/2	3	0	20	20	20	40	0
2.	CHN-211	Fluid and Fluid Particle Mechanics	DCC	4	3	1	2/2	0	0	20	20	20	40	0
3.	PEN-201	Polymer Engineering Thermodynamics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	PEN-203	Polymer Blends	DCC	3	2	1	0	2	0	25	-	25	50	-
5.	MEN-003	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	-	25	25	-	50
6.	HSN-ELE	Any one course from 'Humanities and Social Science Elective Course'	HSSMEC	3	3	0	0	3	0	15	-	35	50	-
		Total		**22**	**16**	**4**	**6**							
Semester-IV (Spring)														
1.	CHN-212	Mass Transfer	DCC	4	3	1	2/2	3	0	20	20	20	40	0
2.	PEN-202	Polymer Reaction Engineering	DCC	4	3	1	2/2	3	0	20	20	20	40	0
3.	PEN-204	Polymer Rheology and Processing	DCC	3	2	0	3/2	2	0	20	20	20	40	0
4.	PEN-206	Polymer Production Engineeing	DCC	3	3	0	0	3	0	15	0	35	50	-
5.	PEN-208	Elastomers Processing and Engineering	DCC	3	2	0	2	2	0	15	25	20	40	0
6.	MTN-106	Materials Science	ESC	4	3	1	0	3	0	25	-	25	50	-
		Total		**21**	**16**	**3**	**5**							

PROGRAM CODE : 121 – B.Tech. (Polymer Science and Engineering)

DEPARTMENT : Department of Polymer Science and Engineering

YEAR : III

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weights (%)				
S.No	SUBJECT CODE	COURSE TITLE	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Semester-V (Autumn)														
1.	CHN-303	Process Dynamics and Control	DCC	4	3	1	2/2	3	0	20	20	20	40	0
2.	PEN-301	Polymer Product Processing and Engineering	DCC	4	3	1	2/2	3	0	20	20	20	40	0
3.	PEN-303	Process Design of Equipment*	DCC	4	3	0	2	4	0	15	25	20	40	0
4.	PEN-391	Technical Communication	DCC	2	0	2	0	0	0	-	100	-	-	-
5.	PEN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	15	-	35	50	-
		Total		**21**	**15**	**5**	**4**							
Semester-VI (Spring)														
1.	PEN-302	Modeling and Simulation of Polymers	DCC	4	3	1	0	3	0	25	-	25	50	-
2.	PEN-304	Polymer Composites	DCC	3	2	0	2	2	0	15	25	20	40	-
3.	CHN-310	Process Utilities, Economics and Plant Design	DCC	3	3	0	0	3	0	15	0	35	40	0
4.	PEN-ELE2	Departmental Elective Course-II	DEC	4	-	-	-	-	-	-	-	-	-	-
5.	MSC1/DHC1	Minor Specialization Course-I Departmental Honours Course-I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
6.	PEN-300	Industry Oriented Problem	DCC	3	-	-	-	-	-	-	-	-	-	100
7.	BM-ELE	Any one course from 'Management Studies'	HSSMEC	4	-	-	-	-	-	-	-	-	-	-
8.	PEN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**20/24**	**11**	**2**	**2**							

***Open book examinations of four hours duration**

PROGRAM CODE : 121 – B.Tech. (Polymer Science and Engineering)

DEPARTMENT : Department of Polymer Science and Engineering

YEAR : IV

Teaching Scheme					Contact Hours/Week			Exam Duration (Hrs.)		Relative Weights (%)				
S.No	SUBJECT CODE	COURSE TITLE	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Semester-VII (Autumn)														
1.	PEN-DEC3	Department Elective Course-III	DEC	4	-	-	-	-	-	-	-	-	-	-
2.	PEN-DEC4	Department Elective Course-IV	DEC	4	-	-	-	-	-	-	-	-	-	-
3.	MSC2/DHC2	Minor Specialization Course-II/ Departmental Honours Course-II	MSC/DHC	4	-	-	-	-	-	-	-	-	-	-
4.	MSC3/DHC3	Minor Specialization Course-III/ Departmental Honours Course-III	MSC/DHC	4	-	-	-	-	-	-	-	-	-	-
5.	PEN-499	Training Seminar	DCC	2	-	-	-	-	-	-	-	-	100	-
6.	PEN-400A	Project	DCC	4	-	-	-	-	-	-	-	-	-	100
		Total		**14/22**										
Semester-VIII (Spring)														
1.	PEN-ELE5	Department Elective Course-V	DEC	4	-	-	-	-	-	-	-	-	-	-
2.	PEN-ELE6	Department Elective Course-VI	DEC	4	-	-	-	-	-	-	-	-	-	-
3.	MSC4/DHC4	Minor Specialization Course-IV/ Departmental Honours Course-IV	MSC/DHC	4	-	-	-	-	-	-	-	-	-	-
4.	MSC5/DHC5	Minor Specialization Course-V Departmental Honours Course-V	MSC/DHC	4	-	-	-	-	-	-	-	-	-	-
5.	PEN-402	Project	DCC	8	-	-	-	-	-	-	-	-	-	100
		Total		**16/24**										

List of Electives

Category I

Autumn/Spring Semesters	
Course No.	**Name of Electives Course**
PEN-321	Optimization of Polymer Engineering Processes
PEN-322	Advanced Numerical Methods
PEN-323	Computational Fluid Dynamics
PEN-324	Process Integration
PEN-325	Probability and System's Reliability

Category 2

Autumn/Spring Semesters	
Course No.	**Name of Elective Course**
PEN-401	Bio-Polymer Engineeing
PEN-402	High Preferential and Special Polymers
PEN-403	Electronic and Conducting Polymers
PEN-404	Green Polymer Engineering
PEN-405	Transport Phenomena in Polymeric Solutions
PEN-406	Advanced Polymers Composites
PEN-407	Advanced Extrusion and Compounding
PEN-408	Paints and Coating Engineering
PEN-409	Fiber and Film Technology
PEN-410	Adhesive and Sealants Technology
PEN-411	Rubber Product Technology
PEN-412	Polymer Colloids
PEN-413	Polymer Nanocomposites
PEN-414	Modeling of Nanoscale Materials

PROGRAM CODE : 122 - B.Tech. Engineering Physics
DEPARTMENT : Department of Physics
YEAR : I

Teaching Scheme				Contact Hours/Week				Exam Duration (Hrs.)		Relative Weights (%)				
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	25	0	25	50	0
2.	PHN-101	Introduction to Engineering Physics	DCC	2	2	0	0	0	0	0	0	0	100	0
3.	PHN-103	Computer Programming	ESC	4	3	0	2	3	0	15	25	20	40	0
4.	CYN-001	Physical Chemistry	BSC	4	3	0	2	3	0	15	25	20	40	0
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	0	25	50	0
6.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	0	25	50	0
7.	HSN-001A/B	Communication Skills (Basic / Advanced)	HSSC	2	1	0	2	2	0	25	0	25	50	0
		TOTAL		**21**										
(Spring)														
1.	MAN-010	Optimization Techniques	BSC	4	3	1	0	3	0	25	0	25	50	0
2.	PHN-008	Electromagnetic Theory	DCC	4	3	1	0	3	0	25	0	25	50	0
3.	PHN-102	Analog and Digital Electronics	DCC	4	3	0	2	3	2	15	25	20	40	0
4.	PHN-104	Thermal and Statistical Physics	DCC	4	3	0	2	3	2	15	25	20	40	0
5.	EEN-112	Electrical Science	ESC	4	3	1	0	3	0	25	0	25	50	0
6.	CYN-002	Organic and Inorganic Chemistry	BSC	4	3	1	0	3	0	25	0	25	50	0
		TOTAL		**24**										

PROGRAM CODE : 122 - B.Tech. Engineering Physics
DEPARTMENT : Department of Physics
YEAR : II

Teaching Scheme				Contact Hours/Week				Exam Duration (Hrs.)		Relative Weights (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
(Autumn)														
1.	MIN-003	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	0	50	0	0	50
2.	PHN-205	Engineering Analysis and Design	DCC	4	3	1	0	3	0	25	0	25	50	0
3.	PHN-207	Mechanics and Relativity	DCC	4	3	0	2	3	0	15	25	20	40	0
4.	PHN-209	Mathematical Physics	DCC	3	3	1	0	3	0	25	0	25	50	0
5.	PHN-211	Quantum Physics	DCC	3	3	1	0	3	0	25	0	25	50	0
6.	HSN-ELE	HSS Elective Course[1]	HSSMC	3	3	0	0	3	0	25	0	25	50	0
		TOTAL		**21**										
(Spring)														
1.	MTN-105	Electrical and Electronics Materials	ESC	4	3	1	0	3	0	25	0	25	50	0
2.	PHN-204	Atomic Molecular and Laser Physics	DCC	3	3	0	0	3	0	25	0	25	50	0
3.	PHN-206	Elements of Condensed Matter Physics	DCC	3	3	0	0	3	0	25	0	25	50	0
4.	PHN-208	Nuclear Physics and Applications	DCC	3	3	0	0	3	0	25	0	25	50	0
5.	PHN-210	Microprocessors and Peripheral Devices	DCC	5	3	1	2	3	0	15	25	20	40	0
6.	PHN-214	Applied Optics	DCC	4	3	0	2	3	2	15	25	20	40	0
		TOTAL		**22**										

PROGRAM CODE : 122 - B.Tech. Engineering Physics
DEPARTMENT : Department of Physics
YEAR : III

Teaching Scheme				Contact Hours/Week				Exam Duration (Hrs.)		Relative Weights (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
(Autumn)														
1.	PHN-311	Numerical Analysis and Computational Physics	DCC	3	2	0	2	3	2	15	25	20	40	0
2.	PHN-313	Signals and Systems	DCC	4	3	1	0	3	0	25	0	25	50	0
3.	PHN-315	Laser & Photonics	DCC	3	3	0	0	3	0	25	0	25	50	0
4.	PHN-317	Plasma Physics and Applications	DCC	3	3	0	0	3	0	25	0	25	50	0
5.	PHN-319	Technical Communication	DCC	2	2	0	0	3	0					
6.	PHN-ELE-1	Depratmental Elective *I	DEC	4	3	1	0	3	0					
7.	OEC/ BM-ELE	Open Elective Course/Management Studies Elective Course[2]	OEC/HSSMEC	3	2	1	0	2	0	25	0	25	50	0
		TOTAL		**19/22**										
(Apring)														
1.	PHN-310	Applied Instrumentation	DCC	4	2	0	4	3	2					
2.	PHN-312	Semiconductor Devices	DCC	4	3	1	2/2	3	2	20	20	20	40	0
3.	PHN-ELE2	Depratmental Elective II	DEC	4	3	1	0	3	0	25	0	25	50	
4.	PHN-300	Industry-oriented Problem / Lab-based Project / Software Engineering-based Project	DCC	4	0	0	6	-	100					
5.	OEC/BM-ELE	Open Elective Course/Management Studies Elective Course[2]	OEC/HSSMEC	3	3	2	1	0	2	0	25	0	25	50
6.	PHN-399	Educational Tour	DCC	0	0	0	0	0	0	0	0	0	0	0
7.	MSC1/ DHC1	MSC** - 1/ DHC*** - 1 (optional)	MSC/ DHC	4	3	1	0	3	0	25	0	25	50	0
		TOTAL		**16/23**										

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PROGRAM CODE : 122 - B.Tech. Engineering Physics
DEPARTMENT : Department of Physics
YEAR : IV

Teaching Scheme				Contact Hours/Week				Exam Duration (Hrs.)	Relative Weights (%)					
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
(Autumn)														
1.	PHN-ELE3	Depratmental Elective III	DEC	4	3	1	0	3	0	25	0	25	50	0
2.	PHN-ELE4	Depratmental Elective IV	DEC	4	2	1	0	3	0	25	0	25	50	0
3.	PHN-499	Training Seminar	DCC	2	0	2	0	-	0	100	0	0	0	0
4.	PHN-400A	B.Tech. Project	DCC	4	0	0	0	3	0	0	0	0	0	100
5.	MSC2/DHC2	MSC - 2 / DHC - 2 (optional)	MSC/DHC	4	3	0	0	3	0	25	0	25	50	0
6.	MSC3/DHC3	MSC - 3 / DHC - 3 (optional)	MSC/DHC	4	3	0	0	3	0	25	0	25	50	0
		TOTAL		**14/22**										
(Spring)														
1.	PHN-ELE5	Depratmental Elective V	DEC	4	3	0	0	3	0	25	0	25	50	0
2.	PHN-ELE6	Depratmental Elective VI	DEC	4	3	0	0	3	0	25	0	25	50	0
3.	PHN-400B	B.Tech Project (Contd. from Autumn Semester)	DCC	8	0	0	12	0	0	0	0	0	0	100
4.	MSC4/DHC4	MSC - 4 / DHC - 4 (optional)	MSC/DHC	4	3	1	0	3	0	25	0	25	50	0
5.	MSC5/DHC5	MSC - 5 / DHC - 5 (optional)	MSC/DHC	4	3	1	0	3	0	25	0	25	50	0
		TOTAL		**16/24**										

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[1] – Any one course in this category is to be opted either in the Autumn or in the Spring semester in the II year. The course should be selected from the list (basket) of Humanities and Social Sciences Elective Courses.

[2] – 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 III year. The HSSMEC course should be selected from the list (basket) of Management Studies Elective Courses.

*DEC - Departmental Elective Course

**MSC - Minor Specialization Course

***DHC - Departmental Honours Course

List of Minor Specialization courses of Physics for other Departments

					Teaching Scheme (Hrs./Week)			
	Subject Code	Course Title	Semester in which the course is running	Subject area	Credits	L	T	P
1	PHN-207	Mechanics and Relativity	Autumn	DCC/MSC	4	3	1	0
2	PHN-211	Quantum Physics	Autumn	DCC/MSC	4	3	1	0
3	PHN-204	Atomic Molecular and Laser Physics	Spring	DCC/MSC	3	3	0	0
4	PHN-206	Elements of Condensed Matter Physics	Spring	DCC/MSC	3	3	0	0
5	PHN-208	Nuclear Physics and Applications	Spring	DCC/MSC	3	3	0	0
				Total	17	15	2	0

Department Elective Courses DHC (B. Tech - Engineering Physics)

					Teaching Scheme (Hrs./Week)			
	Subject Code	Course Title	Semester in which the course is running	Subject area	Credits	L	T	P
1.	EEN-352	Digital Image Processing	III Year Autumn (Any One)	DEC	4	3	1	0
2.	PHN-321	Fabrication and Measurement Techniques	III Year Autumn (Any One)	DEC	4	2	0	4
3.	PHN-323	Radiation Detection and Measurements	III Year Autumn (Any One)	DEC	4	3	1	0
4.	PHN-325	Atmospheric Physics and Climate Dynamics	III Year Autumn (Any One)	DEC	4	3	1	0
5.	ECN-312	Principles of Digital Communication	III Year Spring (Any One)	DEC	4	3	1	0
6.	PHN-314	Nanotechnology	III Year Spring (Any One)	DEC	4	3	1	0
7.	PHN-316	Properties of Matter and Acoustics	III Year Spring (Any One)	DEC	4	3	0	2
8.	MAN-106	Data Structures	III Year Spring (Any One)	DEC	4	3	0	0
9.	ESN-401	Principles of Remote Sensing	IV Year Autumn (Any Two)	DEC	4	2	1	0
10.	PHN-425	Superconducting Materials	IV Year Autumn (Any Two)	DEC	4	3	1	0
11.	EEN-355	Digital Signal Processing	IV Year Autumn (Any Two)	DEC	4	3	1	2/2
12.	PHN-427	Optoelectronics	IV Year Autumn (Any Two)	DEC	4	3	1	0
13.	PHN-429	Nuclear Science & Engineering	IV Year Autumn (Any Two)	DEC	4	3	1	0
14.	PHN-431	Weather Forecasting	IV Year Autumn (Any Two)	DEC	4	3	1	0

15.	BT-XXX	Biophysics & Applications	IV Year Spring (Any Two)	DEC	4	3	1	0
16.	PHN-418	Modern Particle Physics	IV Year Spring (Any Two)	DEC	4	3	1	0
17.	PHN-422	Emerging Phenomenon in Materials	IV Year Spring (Any Two)	DEC	4	3	1	0
18.	PHN-424	Quantum Information & Computing	IV Year Spring (Any Two)	DEC	4	3	1	0
19.	PHN-426	Space Technology	IV Year Spring (Any Two)	DEC	4	3	1	0
20.	PHN-428	Advanced Electroceramics Techno	IV Year Spring (Any Two)	DEC	4	3	1	0

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Department Honor Courses DHC (B. Tech - Engineering Physics)

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
Elective-Group-I (VI Semester: One paper to be chosen)														
1.	PHN-601	Advanced Condensed Matter Physics	DHC	4	3	1	0	3	0	25	0	25	50	0
2.	PHN-603	Advanced Atmospheric Physics	DHC	4	3	1	0	3	0	25	0	25	50	0
3.	PHN-605	Advanced Laser Physics	DHC	4	3	1	0	3	0	25	0	25	50	0
4.	PHN-607	Advanced Nuclear Physics	DHC	4	3	1	0	3	0	25	0	25	50	0
5.	PHN-639	Advanced Atomic and Molecular Physics	DHC	4	3	1	0	3	0	25	0	25	50	0
Elective- Group-II(VII Semester: One paper to be chosen)														
6.	PHN-609	Experiments in Condensed Matter Physics	DHC	3	0	0	6	3	0	0	50	0	0	50
7.	PHN-611	Experiments in Atmospheric Physics	DHC	3	0	0	6	3	0	0	50	0	0	50
8.	PHN-613	Experiments in Laser Physics	DHC	3	0	0	6	3	0	0	50	0	0	50
9.	PHN-615	Experiments in Nuclear Physics	DHC	3	0	0	6	3	0	0	50	0	0	50
Elective- Group-III (VII Semester: One paper to be chosen)														
10.	PHN-617	Advanced Characterization Techniques	DHC	3	3	0	0	3	0	25	0	25	50	0
11.	PHN-619	A Primer in Quantum Field Theory	DHC	3	3	0	0	3	0	25	0	25	50	0
12.	PHN-621	Astrophysics	DHC	3	3	0	0	3	0	25	0	25	50	0
13.	PHN-623	General Relativity	DHC	3	3	0	0	3	0	25	0	25	50	0
14.	PHN-625	Particle Physics	DHC	3	3	0	0	3	0	25	0	25	50	0
15.	PHN-627	Quantum Theory of Solids	DHC	3	3	0	0	3	0	25	0	25	50	0
16.	PHN-629	Weather Forecasting	DHC	3	3	0	0	3	0	25	0	25	50	0
17.	PHN-631	Nuclear Instrumentation	DHC	3	3	0	0	3	0	25	0	25	50	0
18.	PHN-633	Physics and Technology of Thin Films	DHC	3	3	0	0	3	0	25	0	25	50	0
19.	PHN-635	Advanced Nuclear reactions	DHC	3	3	0	0	3	0	25	0	25	50	0
20.	PHN-637	Semiconductor Photonics	DHC	3	3	0	0	3	0	25	0	25	50	0

Elective- Group-IV (VIII Semester: Two papers to be chosen)															
21.	PHN-602	Nuclear Astrophysics	DHC	3	3	0	0	3	0	25	0	25	50	0
22.	PHN-604	Physics of Nanosystems	DHC	3	3	0	0	3	0	25	0	25	50	0
23.	PHN-606	Superfluidity and Superconductivity	DHC	3	3	0	0	3	0	25	0	25	50	0
24.	PHN-608	Fiber and Nonlinear Optics	DHC	3	3	0	0	3	0	25	0	25	50	0
25.	PHN-610	Quantum Optics	DHC	3	3	0	0	3	0	25	0	25	50	0
26.	PHN-612	Advanced topics in Mathematical Physics	DHC	3	3	0	0	3	0	25	0	25	50	0
27.	PHN-614	Introduction to Superstring theory	DHC	3	3	0	0	3	0	25	0	25	50	0
28.	PHN-616	Advanced Electroceramics Technology	DHC	3	3	0	0	3	0	25	0	25	50	0
29.	PHN-618	Atomic and Molecular Collision Physics	DHC	3	3	0	0	3	0	25	0	25	50	0
30.	PHN-620	Advanced Quantum Field Theory	DHC	3	3	0	0	3	0	25	0	25	50	0
31.	PHN-622	Solar Terrestrial Physics	DHC	3	3	0	0	3	0	25	0	25	50	0
32.	PHN-624	Computational Nuclear Physics	DHC	3	3	0	0	3	0	25	0	25	50	0

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Appendix-F

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ACADEMIC CALENDAR FOR THE YEAR 2015-16
(Autumn Semester)

S.No.	Details	Autumn Semester	
		Date	Day
1.	Reporting and Registration of New Ph.D. students.	08.07.2015	Wednesday
2.	Institute reopens	14.07.2015	Tuesday
3.	Registration of all new PG students	14.07.2015	Tuesday
4.	Reporting and Registrations of all new UG/IMT/IMS students	15.07.2015	Wednesday
5.	Re-examination and Second examination on medical grounds (for Spring Semester 2014-15)	15.07.2015 - 17.07.2015	Wednesday-Friday
6.	Academic registration of all existing students in Departments/Centers	16.07.2015	Thursday
	Id-ul-Fiter*	**17.07.2015**	**Friday**
7.	Orientation programme for all new students. Selections of all newly admitted UG/IMT/IMS students for N.C.C./N.S.S./N.S.O. and Language Proficiency test	16.07.2015-19.07.2015	Thursday - Sunday
8.	Commencement of Classes for all students	20.07.2015	Monday
9.	Registration/Counseling for vacant seats of all PG programmes	24.07.2015	Friday
10.	Closing of admissions	24.07.2015	Friday
11.	Last date for sending the grades of Re-examination	24.07.2015	Friday
12.	Last date of Addition/deletion of courses	31.07.2015	Friday
13.	Uploading of roll lists of registered students	01.08.2015	Saturday
14.	Online subject registration of all new students	01.08.2015-05.08.2015	Saturday - Wednesday
15.	Last date of Academic Registration	03.08.2015	Monday
16.	Uploading of final course-wise roll lists of registered students	07.08.2015	Friday
17.	Assignment of Major/Minor projects to all B.Tech. students	07.08.2015	Friday
	Independence Day	**15.08.2015**	**Saturday**
18.	Request to Departments to send list of Institute Elective/ Open Electives to be offered in Spring Semester 2015-16	04.09.2015	Friday
	Janmashtami	**05.09.2015**	**Saturday**
19.	Last date to receive Institute Electives/Open Electives to be offered in Spring Semester from the departments	10.09.2015	Thursday
20.	Notification to UG/IDD/IMT/IMS students about Institute Elective/ Open Elective Courses to be offered in Spring semester 2015-16	14.09.2015	Monday

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S.No.	Details	Autumn Semester	
		Date	Day
21.	Annual Convocation 2015	19.09.2015	Saturday
22.	Notification to students regarding shortage of attendance by the Departments upto 18.09.2015	21.09.2015	Monday
23.	Mid Term Examination (MTE) for all students	21.09.2015-24.09.2015	Monday-Thursday
	Id-ul-Zuha (Bakrid)*	**25.09.2015**	**Friday**
24.	Online subject registration for Institute Elective/ Open Elective Courses by UG students for next semester	25.09.2015-29.09.2015	Friday - Tuesday
25.	Intimation to parents/guardians in respect of students having short attendance & upload on Website	30.09.2015	Wednesday
26.	Submission of remaining document(s) by all new students	30.09.2015	Wednesday
27.	Last date for withdrawal of courses	01.10.2015	Thursday
28.	Last date for requesting Second Examination on medical ground	01.10.2015	Thursday
	Mahatma Gandhi's Birthday	**02.10.2015**	**Friday**
29.	Last date to display allotted list of Institute Electives/ Open Electives to students for Spring Semester 2015-16	09.10.2015	Friday
30.	THOMSO 2015	09.10.2015-11.10.2015	Friday-Sunday
31.	Last date of sending list of **Departmental Electives** to Academic Section along with **list of students in each elective**	19.10.2015	Monday
	Dussehra (Vijaya Dashmi)	**22.10.2015**	**Thursday**
	Muharram*	**24.10.2015**	**Saturday**
32.	Notification of End Term Examination schedule including seating plan (Institute Core and Elective Courses)	26.10.2015	Monday
33.	Ph.D. Interview	27.10.2015-28.10.2015	Tuesday-Wednesday
34.	Last date for Finalization and Display of Time Tables by all Departments and sending to Academic Section	28.10.2015	Wednesday
35.	Communication from Chairman, DAPC to Course Coordinators requesting to submit the final list of students having short attendance	02.11.2015	Monday
36.	Online filling of Response Forms and Subject Registration for next semester by all students	06.11.2015-09.11.2015	Friday - Monday
37.	Display of list of students having short attendance upto 06.11.2015 by the Departments/Centres and to send the Final list to Academic Section	09.11.2015	Monday
38.	Last date of Teaching	10.11.2015	Tuesday
	National Education Day (To be clubbed with Science Day)		
	Diwali (Deepawali)	**11.11.2015**	**Wednesday**
	Govardhan Puja	**12.11.2015**	**Thursday**
	Bhai Duj	**13.11.2015**	**Friday**

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S.No.	Details	Autumn Semester	
		Date	Day
39.	Notification of detained students due to shortage of attendance in End Term Exam by the Academic Section	12.11.2015	Thursday
40.	Online Application for Change of Branch during 2015-16 session by 1st year B. Tech./IMT/IMS students	14.11.2015-21.11.2015	Saturday - Saturday
41.	End Term Examination (excluding Sunday) Practical examinations, if any, *may be held during last few laboratory days).*	14.11.2015-23.11.2015	Saturday-Monday
42.	Evaluation of Final Year M.Tech./M.Arch./M.U.R.P. / M.Tech.(ES) /IDD/IMT Dissertation	02.11.2015-20.11.2015	Monday-Friday
	Guru Nanak Birthday	**25.11.2015**	**Wednesday**
43.	Last date of showing End Term Examination Answer Scripts to students	27.11.2015	Friday
44.	Finalization of grades by the Grade Moderation Committees	30.11.2015	Monday
45.	Display of grades for all courses	30.11.2015	Monday
46.	Last date of sending grades to Academic Section	30.11.2015	Monday
47.	Last date to contact departments/centres for grade modification, if any, by students	02.12.2015	Wednesday
48.	Last date for sending modified grades to academic section	04.12.2015	Friday
49.	Winter vacation for students (except for M.Tech/ IDD final year and Ph.D. students)	04.12.2015-03.01.2016	Friday - Sunday
50.	Winter vacation for Teaching Faculty (Faculty members can avail total 65 days of vacation during the winter & summer breaks)	04.12.2015-03.01.2016	Friday - Sunday
51.	Last date for applying for Re-Examination	08.12.2015	Tuesday
52.	Last date of preparation of Grade sheets	10.12.2015	Thursday
53.	Submission of progress reports of the Ph.D. students by the Departments/Centers	14.01.2016	Monday
54.	Finalization of Change of Branch of 1st year B.Tech./ IMT/ IMS students for the session 2015-16	21.12.2015	Monday
	Id-e-Milad*	**24.12.2015**	**Thursday**
	Christmas Day	**25.12.2015**	**Friday**
55.	Reporting and Registration of new Ph.D. students	28.12.2015	Monday
56.	Institute Reopens for Spring Semester	04.01.2016	Monday
57.	Registration of all existing students in the Departments/ Centres	04.01.2016	Monday
58.	Re-examination and Second examination on medical ground (for Autumn Semester 2015-16)	04.01.2016-06.01.2016	Monday-Wednesday
59.	Commencement of Classes for all students for Spring Semester 2015-16	05.01.2016	Tuesday

- *Subject to change on visibility of Moon.

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Teaching days for Autumn Semester 2015-16 (w.e.f. 16.7.2015 to 10.11.2015)

Day	Months						
	July	August	September	October	November	Less for MTE/Thomso	Total days
Monday	20,27	3,10,17,24,31	7,14,21,28	5,12,19,26	2	1	15
Tuesday	21,28	4,11,18,25	1,8,15,22,29	6,13,20,27	3	1	15
Wednesday	22,29	5,12,19,26	2,9,16,23,30	7,14,21,28	4	1	15
Thursday	23,30	6,13,20,27	3,10,17,24	1,8,15,29	5, 9	1	15
Friday	24,31	7,14,21,28	4,11,18	9,16,23,30	6,10	1	14
Total days	10	21	21	20	7	5	79-5 =74

Details of Saturday and Sunday used in MTE/THOMSO

MTE (September 21-24, 2015) - 21.09.2015 – Monday
22.09.2015 – Tuesday
23.09.2015 – Wednesday
24.09.2015 – Thursday

THOMSO (October 9-11, 2015) - 09.10.2015 – Friday
10.10.2015 – Saturday
11.10.2015 – Sunday

October 09, 2015 (Friday) – This will be a **Non-Teaching Working Day.**

November 9, 2015 (Monday)- This day will be observed as **Thursday** for the purpose of time-table

November 10, 2015 (Tuesday) - This day will be observed as **Friday** for the purpose of time-table

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ACADEMIC CALENDAR FOR THE YEAR 2015-16
(Spring Semester)

S.No.	Details	Spring Semester	
		Date	Day
1.	Reporting and Registration of New Ph.D. Students	28.12.2015	Monday
2.	Institute reopens	04.01.2016	Monday
3.	Registration of all existing students in the Departments/ Centres	04.01.2016	Monday
4.	Re-examination and Second examination on medical ground (for Autumn Semester 2015-16)	04.01.2016-06.01.2016	Monday-Wednesday
5.	Commencement of Classes for all students	05.01.2016	Tuesday
6.	Online Subject Registration of New Ph.D. Students	11.01.2016-12.01.2016	Monday - Tuesday
7.	Last date for sending the grades of Re-examination	13.01.2016	Wednesday
8.	Last date of Addition/deletion of Courses	18.01.2016	Monday
9.	Last date of Academic Registration	18.01.2016	Monday
10.	Uploading of Roll Lists of Registered Students on Website	19.01.2016	Tuesday
11.	Uploading of Final Course-wise Roll Lists of Registered Students on Website	22.01.2016	Friday
12.	Finalization of Seminar and Dissertation topics of 1st year M.Tech./M.U.R.P./M. Arch. and IDD/IMT IVth year students	22.01.2016	Friday
	Republic Day	**26.01.2016**	**Tuesday**
13.	Notification of MTE Schedule	29.01.2016	Friday
14.	Request to Departments to send list of Institute Electives/ Open Electives to be offered in Autumn Semester 2016-17	12.02.2016	Friday
15.	Last date to receive Institute Electives/Open Electives to be offered in Autumn Semester (2016-17) from the Departments / Centers	19.02.2016	Friday
16.	Mid Term Examination (MTE) for all students	22.02.2016-25.02.2016	Monday - Thursday
17.	Notification to UG/IDD/IMT/IMS students about Institute Elective Open Elective Courses to be offered in Autumn Semester 2016-17	24.02.2016	Wednesday
18.	**SCIENCE DAY**	28.02.2016	Sunday
19.	Submission of remaining document(s) by new Ph.D. students	29.02.2016	Monday
20.	Notification to students regarding shortage of attendance by the departments upto 26.02.2016	29.02.2016	Monday
21.	Intimation to parents/guardians in respect of students having short attendance and upload on Institute Website	04.03.2016	Friday
22.	Last date for withdrawal of courses	04.03.2016	Friday
23.	Last date for requesting Second Examination on medical ground	04.03.2016	Friday
	Maha Shivratri	**07.03.2016**	**Monday**
24.	Online subject registration for Institute Elective Courses by UG students for next semester	08.03.2016-11.03.2016	Tuesday – Friday

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S.No.	Details	Spring Semester	
		Date	Day
25.	Hobbies Club – Annual Exhibition	12.03.2016-13.03.2016	Saturday – Sunday
26.	Last date to display allotted list of Institute Electives/ Open Electives to students for Autumn Semester 2016-17	15.03.2016	Tuesday
27.	COGNIZANCE – 2016	18.03.2016-20.03.2016	Friday - Sunday
	Holi	**24.03.2016**	**Thursday**
	Good Friday	**25.03.2016**	**Friday**
28.	Last date of sending list of **Departmental Electives** to Academic Section along with **list of students in each elective**	28.03.2016	Monday
29.	Ph.D. Interview	30.03.2016-31.03.2016	Wednesday – Thursday
30.	Notification of End Term Examination Schedule including Seating Plan (Institute Core and Elective Courses)	01.04.2016	Friday
31.	Communication from Chairman, DAPC to Course Coordinators to submit the final list of students having short attendance	01.04.2016	Friday
32.	Last date for Finalization of Time Tables by all Departments	06.04.2016	Monday
33.	**Online** filling of Response Forms and Subject Registration for next semester by all students	11.04.2016 - 14.04.2016	Monday - Thursday
34.	Seminar presentation of M.Tech. I Year	11.04.2016-14.04.2016	Monday – Thursday
	Ram Navami	**15.04.2016**	**Friday**
	Mahavir Jayanti	**19.04.2016**	**Tuesday**
35.	Display of list of students having short attendance upto 18.04.2016 by Departments/Centres and to send the Final list to Academic Section	19.04.2016	Friday
36.	Notification of detained students for shortage of attendance in End Term Examination by the Academic Section	20.04.2016	Tuesday
37.	Viva-Voce Examination for Major Project (Only for B. Tech. 4th year students)	21.04.2016-22.04.2016	Thursday - Friday
38.	Submission of proficiency grades by all concerned Officers-in-Charges to UG Section	22.04.2016	Friday
39.	Last date of Teaching	22.04.2016	Friday
40.	End Term Examination (excluding Sunday) Practical examinations, if any, *may be held during last few laboratory days*	23.04.2016-02.05.2016	Saturday - Monday
41.	Submission of Final Year M.Tech./ M. Arch./ M.U.R.P./ M.Tech. (ES)/ IDD/IMT Dissertation	02.05.2016 - 06.05.2016	Monday - Friday
42.	Last date of showing of End Term Examination Answer Scripts to students	06.05.2016	Friday
43.	Finalization of grades by the Grade Moderation Committees	09.05.2016	Monday

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S.No.	Details	Spring Semester	
		Date	Day
44.	Display of Grades for all courses	09.05.2016	Monday
45.	Last date for sending Grades to Academic Section	09.05.2016	Thursday
46.	Summer Vacation for Students (except for M.Tech./ IDD final year and Ph.D. students)	09.05.2016-15.07.2016	Monday - Friday
47.	Evaluation of Final Year M.Tech./ M. Arch./ M.U.R.P./ M.Tech.(ES)/ IDD/IMT Dissertation and sending grades	09.05.2016 - 20.05.2016	Monday - Friday
48.	Last date to contact Departments/Centres by students for grade modification, if any	11.05.2016	Wednesday
49.	Last date for sending modified grades to academic section	13.05.2016	Friday
50.	Last date for applying for the re-examination of Spring Semester 2015-16	16.05.2016	Monday
51.	Last date for preparation of Grade sheets (except for M.Tech./ M. Arch./ IDD final year students)	20.05.2016	Friday
	Budh Purnima	**21.05.2016**	**Saturday**
52.	Last date of preparation of Grade sheets of Final Year M.Tech./ M. Arch/ IDD/IMT	06.06.2016	Monday
53.	Summer Vacation for Teaching Faculty	21.05.2016-14.07.2016	Saturday - Thursday
	Id-ul-Fiter*	**07.07.2016**	**Thursday**
54.	Reporting and Registration of new Ph.D. students	08.07.2016	Friday
55.	Institute reopens and Registration of all new PG students	14.07.2016	Thursday
56.	Reporting and Registrations of all new UG/IMT/IMS students	14.07.2016	Thursday
57.	Registration of all existing students in the Departments/ Centres	15.07.2016	Friday
58.	Re-examination and Second examination on medical grounds (for Spring Semester 2015-16)	14.07.2016-16.07.2016	Thursday - Saturday
59.	Commencement of Classes for Autumn Semester (2016-17)	19.07.2016	Tuesday

*Subject to change on visibility of moon.

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Teaching days for Spring Semester 2015-16 (w.e.f. 04.1.2016 to 22.4.2016)

Day	Months					
	January	February	March	April	Less for MTE/Cogn.	Total days
Monday	11,18,25	1,8,15,**22**,29	14,21,28	4,11,18	1	13
Tuesday	5,12,19	2,9,16,**23**	1,8,15,22,29	5,12, 20	1	14
Wednesday	6,13,20,27	3,10,17,**24**	2,9,16,23,30	6,13	1	14
Thursday	7,14,21,28	4,11,18,**25**	3,10,17,31	7 ,21	1	13
Friday	8,15,22,29	5,12,19,26	4,11,**18**	1,8,22	1	13
Total days	18	21	20	13	5	72-5 = 67

Details of days used in MTE and COGNIZANCE

MTE (February 29- March 03, 2016) - 29.02.2016 – Monday
01.03.2016 – Tuesday
02.03.2016 – Wednesday
03.03.2016 – Thursday

COGNIZANCE (March 18-20, 2016) - 18.03.2015 – Friday
19.03.2015 – Saturday
20.03.2015 – Sunday

COGNIZANCE (March 18, Friday) - This will be a **Non-Teaching working day**

April 20, 2016 (Wednesday) - This day will be observed as **Tuesday** for the purpose of time-table

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ANNEXURE-G1

1. Change in essential qualification / eligibility in Table -1

Programme Name	Code No.	Existing	Proposed
Civil Engg Department			
Hydraulics Engg	19	Bachelor's degree in Civil Engg./ **Agricultural Engg.** or equivalent	Bachelor's degree in Civil Engg.or equivalent

2. Change desired in gate discipline due to a new gate discipline i.e. ecology & evolution in Table-2

Deptt	Code No.	Existing GATE Discipline										Proposed GATE Discipline									
		Main GATE Dis.					Other GATE Dis.					Main GATE Dis.					Other GATE Dis.				
			Ge	OB	SC	ST		Ge	OB	SC	ST		Ge	OB	SC	ST		Ge	OB	SC	ST
AHC	13	CE(5)	3	1	1	0	AG/CH/EE/ME/PI/XE/AR/CY/BT/PH/MA/XL (10)	5	3	1	1	CE(5)	3	1	1	0	AG/CH/EE/ME/PI/XE/AR/CY/BT/PH/MA/XL/**EY** (10)	5	3	1	1
HYD	33	CE/AG (12)	6	3	2	1	ME/GG/XE/PH (3)	3	1	1	0	CE/AG (12)	6	3	2	1	ME/GG/XE/PH/**EY** (3)	3	1	1	0
PPD	41	CH (10)	5	3	1	1	ME/BT/TF	5	3	1	1	CH (10)	5	3	1	1	ME/BT/TF/**EY**	5	3	1	1
DMC	48	CE/ME/PI/CS/CH/AR/GG/PH/MA/XL/XE (15)	8	4	2	1	-	-	-	-	-	CE/ME/PI/CS/CH/AR/GG/PH/MA/XL/XE/**EY** (15)	8	4	2	1	-	-	-	-	-

3. Changes desired in Admission Criteria in Table – 6

Department	Admission Criteria	
	Existing	**Proposed**
Electrical Engg Engg	**70% Normalized GATE marks and 30% Written Test**	Only Normalized GATE marks

4. Change desired in GATE due to change in essential qualification in Table-2

Deptt	Code No.	Existing GATE Discipline										Proposed GATE Discipline									
		Main GATE Dis.					Other GATE Dis.					Main GATE Dis.					Other GATE Dis.				
			Ge	OB	SC	ST		Ge	OB	SC	ST		Ge	OB	SC	ST		Ge	OB	SC	ST
CED	19	CE (15)	8	4	2	1	AG(3)	1	1	1		CE (18)	9	5	3	1	-	-	-	-	-

16 MAR 2015

F.NO.17-2/2014-TS.I
Government of India
Ministry of Human Resource Development
Department of Higher Education
Technical Section-I

Shastri Bhavan, New Delhi
Dated the 2nd March, 2015

To,

The Chairman, AICTE
The Directors, IITs (As per standard list)
The Directors, IIITs (as per standard list)
The Director, IISc, Bangalore
The Directors, IISERs (as per standard list)
The Directors, NITs (as per standard list)
The Director, NITIE, Mumbai
The Director, ISM, Dhanbad
The Director, NERIST, Nirjuli, Arunachal Pradesh
The Director, SLIET, Longowal
The Director, NIFFT, Ranchi
The Directors, NITTRs (as per standard list)
The Directors, SPAs (as per standard list)
The Director, IIEST, Shibpur

Subject: Revision of rates of Ph.D. Scholarship in AICTE funded and Centrally Funded Technical Institutions under the Ministry of Human Resource Development

Sir/Madam,

In partial modification of the Order of even number dated 18.02.2015 and in pursuance of the DST's Order No.SR/S9/Z-09/2012 dated 21.10.2014 on the subject mentioned above, paragraph 2, 7 & 8 of the order dated 18.02.2015 are modified to the extent indicated below:

S.No.	Qualifying Degree	Revised Emoluments (Per Month)
01.	**JUNIOR RESEARCH FELLOW (JRF):** Post Graduate Degree in Basic Science with NET/GATE Qualification or Graduate Degree in Professional Course with NET/GATE Qualification or Post Graduate Degree in Professional Courses.	**Rs.25,000/-**
02.	**SENIOR RESEARCH FELLOW (SRF)** JRF Qualification with two years of research experience.	**Rs.28,000/-**

Contd...2/-

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2. The revised rates of fellowship/assistantship will be effective from 01.10.2014 in respect of Ph.D. students, as per order issued by DST and 01.12.2014 in respect of ME/M.Tech/MS/M.Des. students as per order issued by the UGC.

3. The additional cost on account of this revision may be met by the individual Institutes from out of their existing budgetary grant without any additionality in the current financial year, 2014-15. During the next financial year, 2015-16, the expenditure will be met, as first charge, out of the sanctioned allocations to the Institutions by the Department of Higher Education.

4. Other terms & conditions of the order dated 18.02.2015 will remain same.

5. This issues with the concurrence of the Ministry of Finance, Department of Expenditure vide their ID Note No.14-2/2015-EIII A dated 02.03.2015, and in consultation with IF Division of the Department.

Yours faithfully,

(Alok Mishra)
Director
Tel:23381058

Copy to:

1. Department of Expenditure [(Shri Ashok Kumar, Under Secretary (E.III(A)] w.r.t. their ID Note No.14-2/2015/E.III dated 02.03.2015
2. Department of Science & Technology (Dr. R. Brakaspathy, Scientist-G) in pursuance of the OM No.SR/S9/Z-09/2012 dated 21.10.2014.
3. PS to Hon'ble HRM/PS to Hon'ble MoS(RSK)/PS to Hon'ble MoS(UK)
4. PPS to Secretary (HE)/PPS to AS(TE)/PPS to JS&FA
5. Dir(TC)/Dir(Management)/Dir(TE)/Dir(NITs)
6. IF Division, MHRD
7. Webmaster, CMIS, MHRD for uploading the order on Ministry's website.

19 MAR 2015

F.NO.17-2/2014-TS.I
Government of India
Ministry of Human Resource Development
Department of Higher Education
Technical Section-I

Shastri Bhavan, New Delhi
Dated the 18th February, 2015

To,

The Chairman, AICTE
The Directors, IITs (As per standard list)
The Directors, IIITs (as per standard list)
The Director, IISc, Bangalore
The Directors, IISERs (as per standard list)
The Directors, NITs (as per standard list)
The Director, NITIE, Mumbai
The Director, ISM, Dhanbad
The Director, NERIST, Nirjuli, Arunachal Pradesh
The Director, SLIET, Longowal
The Director, NIFFT, Ranchi
The Directors, NITTRs (as per standard list)
The Directors, SPAs (as per standard list)

Subject: Revision of rates of Ph.D. Scholarship in AICTE funded and Centrally Funded Technical Institutions under the Ministry of Human Resource Development

Sir/Madam,

With reference to the letter No.25-2/2010-TS.II dated 30.09.2010 on the subject cited above, it has been decided to revise the Scholarship/Fellowship/Assistantship in AICTE approved and Centrally Funded Technical Institutions under the Ministry of Human Resource Development, as given below:-

2. For Ph.D. Programmes (Junior Research Fellow (JRF)/Senior Research Fellow (SRF)

S.No.	Qualifying Degree	Existing Emoluments (per month)	Revised Emoluments (Per Month)
01.	Graduate Degree in Professional Courses (BE/B.Tech/M.Sc equivalent) with valid GATE Score above the prescribed cut off level/NET Qualification	16,000/- (For 1st & 2nd Year) 18,000/- (Upto 5th Year)	25,000/-
02.	Post Graduate Degree in Professional Courses (ME/ M.Tech. or equivalent) with two years of research experience	18,000/- (For 1st and 2nd Year) 20,000/- (For 3rd & 4th Year)	28,000/-

Contd...2/-

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2.1 For M.E./M.Tech/MS/M.Des

S.No.	Qualifying Degree	Existing Emoluments (per month)	Revised Emoluments (Per Month)
01.	B.E./B.Tech/BS/B.Des and GATE/ GPAT qualified	8,000/- (Both 1st & 2nd Year) and 5th Year of Dual Degree Programmes)	12,400/- (Both 1st & 2nd Year) and 5th Year of Dual Degree Programmes)

2.3 The concerned Institution should review the performance of the Fellow after two years through an appropriate Review Committee constituted by the Head of the Institution. The fellowship in the slab after 2 years of research experience may be provided after successful assessment by the Review Committee.

2.3 Such revision in rates would also be applicable to other Government and Government Aided Institutions funded by AICTE and UGC. However, no salary grant or any other salary grant would be given to any of the Institutes for implementing the Scheme.

2.4 Sponsored and Self-Financed Category of students including those in receipt of any other similar assistantship/scholarship/fellowship would not be eligible for assistantship/scholarship/fellowship under the revised scheme. Further, the assistantship/scholarship/fellowship would be provided to the scholars on the basis of GATE scores above the prescribed cut-off level. B.Tech. Graduates from the IITs getting a CGPA score of 8 or above (on scale of 10) would also be entitled to the assistantship without having to appear in GATE.

2.5 The stipend of research fellow/associate is exempted from the payment of income tax under Section 10(16) of the Income Tax Act, 1961.

3. **Service Conditions:**

3.1 **DA and CCA:** JRFs, SRFs and M.E./M.Tech/MS/M.Des will not be entitled to these allowances.

3.2 **House Rent Allowance (HRA):** All research fellows and M.E./M.Tech/MS/M.Des may be provided hostel accommodation wherever available and those residing in accommodation provided by the Institute will not be eligible for drawing HRA. Wherever provision of hostel accommodation is not possible, HRA may be allowed to JRF, SRF as per Central Government norms applicable in the city/location where they are working. The fellowship amount may be taken as basic for calculating the HRA.

3.3 **Leave and other entitlement benefits:** The JRFs, SRFs and M.E./M.Tech/MS/M.Des are eligible only for casual leave. Participation of any of these categories in any scientific event/workshop in India or abroad will be treated as 'Duty'. The travel entitlement for JRF/SRF/ M.E./M.Tech/MS/M.Des for participation in scientific events/workshops in India will continue to be same as earlier, i.e. 2nd AC by rail. Maternity Leave as per Government of India instructions issued from time to time would be available to female candidates in all categories.

Contd...3/-

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3.4 **Bonus and Leave Travel Concessions:** JRFs and SRFs and M.E./M.Tech/MS/M.Des will not be entitled to these allowances.

3.5 **Retirement Benefits**: JRFs, SRFs and M.E./M.Tech/MS/M.Des will not be entitled to these benefits.

4. **Publication/Patent:** The results of JRF/SRF/M.E./M.Tech/ MS/M.Des research work may be published in standard referred journals at the discretion of the Fellow or his Guide. It should be ensured by the Fellow that the assistance provided by the funding agency of Government of India is acknowledged in all such publications.

5. **Encouragement for pursuing higher degrees**: Students selected as JRF/SRF may be encouraged to register for higher degrees and the tuition fees to undertake these studies may be reimbursed to the students from the contingency grant sanctioned under the project grant, if required.

6. **Obligations of JRF/SRF**:

(i) He/She shall be governed by the disciplinary regulations of the host Institute where he/she is working.

(ii) The JRF/SRF/M.E./M.Tech/ MS/M.Des must send a detailed consolidated report of the research work done during the entire period of Fellowship on completion of the tenure/resignation of the Fellowship at the earliest.

7. **Date of Effect:** The revision in emoluments comes into effect from 01.02.2015 for all categories of JRF/SRF/M.E./M.Tech/ MS/M.Des.

8. The additional cost on account of this revision may be met by the individual Institutes from out of their existing budgetary grant without any additionality in the current financial year, 2014-15. During the next financial year, 2015-16, the expenditure on this account may be capped at the current year's level and also within the given allocation, without any additionality.

8. This issues with the concurrence of the Department of Expenditure, Ministry of Finance vide their ID Note No.33197/2015/E.III(A) dated 18.02.2015.

Yours faithfully,

(Alok Mishra)
Director
Tel:23381058

Copy to:

1. Department of Expenditure [(Shri Ashok Kumar, Under Secretary(E.III(A)] with reference to the ID Note No.33197/2015/E.III(A) dated 18.02.2015.
2. Department of Science & Technology (Dr. R. Brakaspathy, Scientist-G) in pursuance of the OM No.SR/S9/Z-09/2012 dated 21.10.2014.
3. PS to Hon'ble HRM/
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15.	BT-XXX	Biophysics & Applications	IV Year Spring (Any Two)	DEC	4	3	1	0
16.	PHN-418	Modern Particle Physics	IV Year Spring (Any Two)	DEC	4	3	1	0
17.	PHN-422	Emerging Phenomenon in Materials	IV Year Spring (Any Two)	DEC	4	3	1	0
18.	PHN-424	Quantum Information & Computing	IV Year Spring (Any Two)	DEC	4	3	1	0
19.	PHN-426	Space Technology	IV Year Spring (Any Two)	DEC	4	3	1	0
20.	PHN-428	Advanced Electroceramics Techno	IV Year Spring (Any Two)	DEC	4	3	1	0