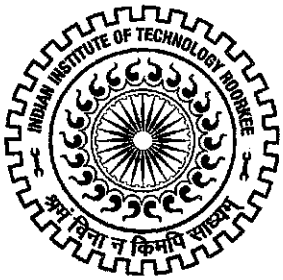
सीनेट की अट्ठावनवीं बैठक का कार्यवृत्त
MINUTES OF THE 58TH MEETING OF THE SENATE

9 दिसम्बर 2014
9TH DECEMBER 2014



भारतीय प्रौद्योगिकी संस्थान रूड़की
रूड़की – 247 667 (भारत)

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

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

Minutes the 58th meeting of the Senate held on 9th December 2014 in the Senate Hall of the Institute.

INDEX

MEETING SECTION
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Minutes of the 58th Meeting of the Senate held on 9th December 2014 in the Senate Hall of the Institute.

Following were present:

1.	Prof. Pradipta Banerji	Director & Chairman
2.	Prof. S.P. Gupta	Dy. Director
3.	Prof. V. Devdas	(Architecture & Planning)
4.	Prof. R.P. Singh	(Biotechnology)
5.	Prof. Ramasare Prasad	(Biotechnology)
6.	Prof. Partha Roy	(Biotechnology)
7.	Prof. Bikash Mohanty	(Chemical Engineering)
8.	Prof. Vijay Kumar Agarwal	(Chemical Engineering)
9.	Prof. C.B. Majumdar	(Chemical Engineering)
10.	Prof. Anil Kumar	(Chemistry)
11.	Prof. (Mrs.) Mala Nath	(Chemistry)
12.	Prof. A.K. Singh	(Chemistry)
13.	Prof. U.P. Singh	(Chemistry)
14.	Prof. M.R. Maurya	(Chemistry)
15.	Prof. Bina Gupta	(Chemistry)
16.	Prof. S.S. Jain	(Civil Engineering)
17.	Prof. Deepak Kashyap	(Civil Engineering)
18.	Prof. Pradeep Kumar	(Civil Engineering)
19.	Prof. P.K. Garg	(Civil Engineering)
20.	Prof. Pradeep Bhargava	(Civil Engineering)
21.	Prof. Satish Chandra	(Civil Engineering)
22.	Prof. Praveen Kumar	(Civil Engineering)
23.	Prof. K.S.Hari Prasad	(Civil Engineering)
24.	Prof. Akhil Upadhyay	(Civil Engineering)
25.	Prof. Manoj Mishra	(Computer Science)
26.	Prof. Ashok Kumar	(Earthquake Engineering)
27.	Prof. Bal Krishna Maheshwari	(Earthquake Engineering)
28.	Prof. Pankaj Agrawal	(Earthquake Engineering)
29.	Prof. Manish Shrikhande	(Earthquake Engineering)
30.	Prof. G.J. Chakrapai	(Earth Sciences)
31.	Prof. R. Krishnamurthi	(Earth Science)

32.	Prof. Vinod Kumar	(Electrical Engineering)
33.	Prof. Pramod Agarwal	(Electrical Engineering)
34.	Prof. Sajjan Pal Singh	(Electrical Engineering)
35.	Prof. M.V. Kartikeyan	(Electronics & Communication Engg.)
36.	Prof. Dharmendra Singh	(Electronics & Communication Engg.)
37.	Prof. N.K.Goel	(Hydrology)
38.	Prof. Pushupati Jha	(Humanities & Social Sciences)
39.	Prof. D.K. Nauriyal	(Humanities & Social Sciences)
40.	Prof. (Mrs.) Rashmi Gaur	(Humanities & Social Sciences)
41.	Prof. Nagendra Kumar	(Humanities & Social Sciences)
42.	Prof. Y.S. Negi	(Paper Technology)
43.	Prof. S.P. Sharma	(Mathematics)
44.	Prof. (Mrs.) Rama Bhargava	(Mathematics)
45.	Prof. Sunita Gakkhar	(Mathematics)
46.	Prof. Kusum Deep	(Mathematics)
47.	Prof. Tanuja Srivastava	(Mathematics)
48.	Prof. S.P. Yadav	(Mathematics)
49.	Prof. Dinesh Kumar	(Mechanical & Industrial Engg.)
50.	Prof. P.K. Jain	(Mechanical & Industrial Engg.)
51.	Prof. Akhilesh Gupta	(Mechanical & Industrial Engg.)
52.	Prof. B.K. Gandhi	(Mechanical & Industrial Engg.)
53.	Prof. Ravi Kumar	(Mechanical & Industrial Engg.)
54.	Prof. P.K. Ghosh	(Metallurgical & Materials Engg.)
55.	Prof. S.K. Nath	(Metallurgical & Materials Engg.)
56.	Prof. Anjan Sil	(Metallurgical & Materials Engg.)
57.	Prof. B.S.S. Daniel	(Metallurgical & Materials Engg.)
58.	Prof. Vir Singh	(Physics)
59.	Prof. Tashi Nautiyal	(Physics)
60.	Prof. Davinder Kaur Walia	(Physics)
61.	Prof. M.L. Kansal	(WRD&M)
62.	Prof. Ramesh Chandra	(Institute Instrumentation Centre)
63.	Dr. R.P. Saini,	Alternate Hydro Energy Centre
64.	Dr. S.N. Rangnekar	DOMS
65.	Dr. P. Jeevanandam	Associate Dean of Students' Welfare (Foreign Students)
66.	Dr. Apurbba Kumar Sharma	Associate Dean, Academic Studies
67.	Dr. R.K.Peddiniti	Associate Dean, Academic Research
68.	Dr. Yogendra Singh	Librarian

69. Dr. (Mrs.) Smita Jha, Associate Professor, Department of Humanities & Social Sciences.
70. Dr. A. Swamianthan, Associate Professor, Mathematics
71. Lt. Col. (Retd.) A.K. Srivastava, Registrar & Secretary, Senate

The Chairman (Director) welcomed the members to the 58th 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. Padam Kumar, Department of Computer Science & Engineering
2. Prof. Ashwani Kumar Choudhary, Institute Instrumentation Centre
3. Prof. R.P. Gakkhar, Department of Mechanical & Industrial Engg.

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

1. Prof. Deepak Khare, W.R.D.& M
2. Prof. K.C. Gupta, Department of Chemistry
3. Prof. Rajesh Srivastava, Department of Physics
4. Dr. Apurbba K. Sharma, Associate Dean Academic
5. Prof. A.K. Jain, Department of Physics
6. Prof. Ravi Bhushan, Department of Chemistry
7. Dr. Rajat Rastogi, Department of Civil Engineering
8. Prof. A.K. Sen, Department of Earth Sciences
9. Prof. A.K. Saraf, Department of Earth Sciences
10. Prof. Shri Chand, Department of Chemical Engg.
11. Prof. S.K. Mishra, W.R.D. & M.
12. Prof. P.K. Jain, Department of Mechanical & Industrial Engg.
13. Prof. M. Parida, Department of Civil Engineering

The Agenda was then taken up:

Item No. 58.1: **To confirm the minutes of the 55th, 56th and 57th meetings of the Senate held on 16.04.2014, 10.07.2014 & 15.09.2014, respectively.**

The minutes of the 55th, 56th and 57th meetings of the Senate held on 16.04.2014, 10.07.2014 & 15.09.2014, respectively were confirmed.

Item No.58.2: **To receive a report on the actions taken to implement the decisions taken by the Senate in its 55th, 56th and 57th meeting held on 16.04.2014, 10.07.2014 and 15.09.2014, respectively.**

The Senate noted the actions taken on the resolutions of the 55th, 56th and 57th meeting held on 16.04.2014,

10.07.2014 and 15.09.2014, respectively with the observations on the under-mentioned items:

(a) Item No. 55.8 – The new weights for different course types as decided by the Senate, will be implemented from the Spring Semester 2014-15.

(b) Item No. 56.8 – If the CGPA of few students are same upto 3-digits as calculated, their earned credits be checked to decide the ranks. Higher earned credits case shall be given higher rank. If the earned credits are also same, then only the same rank shall be given.

Item No. 58.3: To consider the syllabus of Pre-Ph.D. course on Advanced Characterization Techniques for Saharanpur Campus.

As considered and recommended by the IAPC, the Senate decided that the syllabus of Pre-Ph.D. course on Advanced Characterization Techniques (5 credits), for the Saharanpur Campus as given at **Appendix 'A'** be approved.

Item No.58.4: To consider the syllabi of PG courses received from the Department of Physics.

As considered and recommended by the IAPC, the Senate decided that the syllabi of PG courses received from the Department of Physics as given at **Appendix 'B'** be approved.

Item No. 58.5: To consider the UG Electives under Category I & II.

As considered and recommended by the IAPC, the Senate decided that the open electives offered by the following departments be approved:

(a) Department of Earthquake Engineering
(b) Department of Physics
(c) Alternate Hydro Energy Centre

The Senate further approved the category I and category II electives of the following departments:

(a) Department of Biotechnology
(b) Department of Civil Engineering
(c) Department of Electrical Engineering

The list of the electives is given at **Appendix 'C'.** The Senate still further decided that the rest of the departments

who have not submitted the list of electives are required to send the list of category electives immediately to the Dean Academics.

Item No.58.6: To consider the Teaching Scheme of 5 year IDD Programmes

As considered and recommended by the IAPC, the Senate decided that the teaching scheme of the following IDD programmes as given at **Appendix 'D'** be approved:

(a) B.Tech. (Civil Engineering) and M.Tech. (Structural Engineering)
(b) B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)
(c) B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)

Item No. 58.7: To consider the seats distribution of PG Programmes for Main and Allied GATE disciplines.

As considered and recommended by the IAPC, the Senate decided that the seats distribution of PG Programmes for Main and Allied GATE disciplines as given at **Appendix 'E'** be approved.

Item No. 58.8: To consider the evaluation of M.Tech. Dissertation in the new structure.

As considered and recommended by the IAPC, the Senate decided that in M.Tech. II Year, the dissertation shall be evaluated for 100 marks in each semester, with the following distribution:

(a) Supervisor-35 marks- To be awarded by the Supervisor
(b) Report -20 marks
(c) Presentation-20marks } To be awarded by the Examination
(d) Viva-voce -25 marks } Board

The Senate further decided that the grades shall be awarded in each semester, on the basis of absolute marks obtained in the respective semesters.

Item No. 58.9: To consider the criteria for change of supervisor.

As considered and recommended by the Institute Research Committee, the Senate decided that the criteria for change of supervisor be approved as under:

(a) If the student has requested for change of supervisor or the supervisor has declined to supervise before the candidacy and both the outgoing and incoming supervisors have consented, then the supervisor will be changed.

(b) If the candidacy has already taken place and either the student has requested for change of supervisor or the supervisor has declined to supervise the student, the matter be sorted out in the DFC at the department level. If the DFC is unable to resolve the issue then the student will be asked to leave the Ph.D. programme and the supervisor will be debarred from getting any new candidate for the next five years.

The Senate further decided that to take care of faculty members not having Ph.D candidates and to encourage inter-disciplinary research, henceforth, joint supervision be permitted by the Director, provided the supervisors clearly specify the work to be supervised and indicate the approximate percentage of supervision when a request for joint supervision is made by any Ph.D. student. Accordingly, the Proforma '0' is modified as given in **Appendix 'F'.**

Item No. 58.10: To consider the revised Ordinances and Regulations for the Ph.D. programme.

As considered and recommended by the Institute Research Committee, the Senate decided that the revised Ordinances and Regulations for the Ph.D. programme as given at **Appendix 'G'** be recommended for approval by the Board of Governors.

The Senate further decided that only, for the Ph.D candidates admitted in 2014-15 session, the criteria of minimum CGPA of 7.00 will be applicable instead of minimum 'B' grade in every course. In case their CGPA is less than 7.00, they will be given a chance to improve their CGPA in subsequent semesters, but in any case, they will have to complete the course requirement in the stipulated period as

per the "Ordinances and Regulations". They may repeat the same course(s) in subsequent semesters for improvement in CGPA as is being done at present or the SRC may suggest more courses to improve the CGPA. The CGPA will be calculated taking all courses recommended by the SRC, including the seminar.

The Senate still further decided that the above criteria will be reviewed in the next meeting of the Senate to be held in February 2015, when the entire Ph.D. "Ordinances and Regulations" will be looked at again, for a comprehensive view.

Item No. 58.11: **Reported the admission of the candidates under project category.**

The Senate noted that the candidates seeking admission to the Ph.D. programme as project fellows either as full-time or part-time research scholars, shall be allowed to register for Ph.D. in the beginning of the next semester, if the candidate is selected in a project as a Project Fellow through proper selection, i.e. proper advertisement of Project Fellowship and selection by the committee constituted as per Institute rules. The candidate shall register with the PI or Co-PI as supervisor. It was also resolved that to ensure the same quality of the research scholars as in the regular selection, two more members from the Department, nominated by the Head of the Department, shall be included in the selection committee.

If the candidate is not selected in a project through proper advertisement or the candidate wants to switch over to MHRD assistance, he/she has to appear for Ph.D. selection along with other candidates provided he/she has a 'No-Objection Certificate' from the PI.

Further, it was resolved that the Project Fellows shall be allowed to register for Ph.D. only if the remaining period of the project is more than one and a half years instead of two years, as per the present rules. These candidates are also eligible of MHRD assistantship for a maximum period of TWO years once their project is completed provided the essential qualifications for MHRD assistantships are met.

Item No. 58.12: To consider a new grade for the students detained due to short attendance.

As considered and recommended by the IAPC, the Senate decided that a new grade **"FS"** be awarded to the students who are detained due to short attendance and are not allowed to appear for re-examination.

Item No.58.13: To consider the proposal of Library, MGCL for making all Electronic Theses and Dissertations available in open domain and also further submission of Theses and Dissertations only in digital format.

The Senate decided that the proposal be sent to the Departments for consideration in DFCs.

Item No. 58.14: To consider the recommendation of the Committee formed vide O.M. No. DR(ACD.)/1234/CGPA dated September 23, 2014 to recommend a formula for the conversion of CGPA into percentage.

As considered and recommended by the IAPC, the Senate decided that the Institute should indicate that CGPA 6.00 be considered as equivalent to 65%. After the meeting, it was pointed out that the students need the percentage to fill the on-line applications.

The Senate further decided that CGPA 9.00 and above be considered as equivalent to 95%. Accordingly the equivalent percentage of different CGPAs will be as given below:

S.No.	CGPA	Equivalent percentage of marks
1.	5.00	55%
2.	5.50	60%
3.	6.00	65%
4.	6.50	70%
5.	7.00	75%
6.	7.50	80%
7.	8.00	85%
8.	8.50	90%
9.	9.00 or above	95%

Item No. 58.15: **To consider the new elective courses as proposed by the Department of Management Studies for the students of DOMS:**

As considered and recommended by the IAPC, the Senate decided that the under-mentioned electives proposed by the Department of Management Studies be approved:

(a) BMN - 681 : Six Sigma and Application
(b) BM N- 682 : Data Analytics
(c) BMN - 683 : Strategic Human Resource Management
(d) BMN - 684 : Marketing Metrics

The Senate further decided that the syllabi of the above courses as given at **Appendix 'H'** be approved.

Item No. 58.16: **To consider the structure of IDD programme (B.Tech. + M.Tech.) received from the various departments:**

As considered and recommended by the IAPC, the Senate decided that the structure of the under-mentioned IDD programmes (B.Tech + M.Tech.) of the various departments as given at **Appendix 'I'** be approved:-

(a) B.Tech. (Computer Science and Engineering) and M.Tech. (Computer Science and Engineering)
(b) B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)
(c) B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)
(d) B.Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
(e) B.Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
(f) B.Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)
(g) B.Tech. (Mechanical Engineering) and M.Tech. (Thermal Engineering)
(h) B.Tech. (Production and Industrial Engineering) and M.Tech. (Thermal Engineering)
(i) B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)
(j) B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)
(k) B.Tech. (Metallurgical and Materials Engineering) and M.Tech. (Industrial Engineering)

(l) B.Tech. (Metallurgical and Materials Engineering) and M.Tech. (Materials Engineering)

Item No. 58.17: To consider the corrections in the structure of B.Tech. (Polymer Science and Technology), 2nd year in the subject PE-205: Polymer Blends and Composites.

As considered and recommended by the IAPC, the Senate decided that the title of the subject of **Polymer Blends and Composites** be revised as **PE-205 Polymer Blends** for the students of B.Tech. (Polymer Science and Technology) II Year.

Item No. 58.18: To consider the slight modification in DCC course No. MI-216 : Theory of Production Processes-I.

As considered and recommended by the IAPC, the Senate decided that the syllabi of DCC course **No. MI-216 : Theory of Production Processes-I** as given at **Appendix 'J'** be approved.

Item No. 58.19: To report the structure of M.Sc. (Mathematics) with new syllabi of the courses to be implemented from the session 2015-2016 by the Department of Mathematics.

The Senate noted the structure of M.Sc. (Mathematics) with new syllabi of courses to be implemented from the session 2015-16 by the Department of Mathematics **(Appendix 'K').**

Item No. 58.20: To report the changes in the structure of the old IDD programme due to revision of the PG structure with effect from the session 2014-15.

The Senate noted the following changes in the old IID programme due to revision of the PG Structure with effect from the session 2014-2015:-

(a) The IDD students under the old structure are required to do the PG level courses as **per Table-1**.

(b) In all the IDD programmes the electives floated for PG students under the new structure will be made available to the IDD students irrespective of minor change in credits, if any. The students of IDD will have

to take the required number of electives as already approved for them.

(c) Seminar of IDD students will be held during the IV year Spring Semester alongwith the students of the M. Tech I year.

(d) During the V year, the students of IDD will only do dissertation, which will be evaluated in the same manner, as per the procedure approved for the students of M.Tech. in the new structure.

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

Appendix 'A'
Item No. Senate/58.3

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Applied Science and Engineering**

1. Subject Code: **AS-901** Course Title: **Advanced Characterization Techniques**

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

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

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

5. Credits: 5 6. Semester: **Autumn/Spring** 7. Subject Area: **Science/Engineering**

8. Pre-requisite: **None**

9. Objective: To impart knowledge of characterization techniques by various analytical methods

10. Details of the Course:

S. No.	Contents	Contact Hours
1	**Elemental analysis:** CHNSO, Inductively coupled plasma optical emission spectroscopy	4
2	**Spectroscopic characterization:** Vibrational spectroscopy (IR and Raman spectroscopy), UV-visible and photoluminescence, ESCA, atomic and molecular absorption spectra, NMR, mass spectroscopy	12
3	**Thermal analysis :** Principles and applications of differential scanning calorimetry (DSC), differential thermal analysis (DTA), thermogravimetric analysis (TGA)	5
4	**X-ray diffraction :** Introduction to X-rays, crystal structures, structural factor, principle of X-ray diffractions, wide angle X-ray diffraction, small angle X-ray scattering, single phase analysis, multi-phase analysis, estimation of particle size and strain, studying nano/meso-structures by XRD	10
5	**Microstructural characterization:** 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; Principle and usage of atomic force microscopy (AFM)	11
	Total	42

List of Experiments

1. Determination of Fe and C in an unkown sample by ICPT.
2. Analysis of C, H, N and S in a given sample by CHNS analyser
3. UV-visible spectrometer for analyzing organic sample
4. Demonstration of atomic absorption spectroscopy for estimating metal contents in a sample.
5. Identification of compounds using DSC
6. Structure and particle size analysis by XRD
7. Identification of compounds in an unknown sample by XRD.

8. Sample preparation for optical microscopy and examination of microstructure.
9. Use of SEM to examine structure and particle size
10. Demonstration of AFM for analyzing nanomaterials

11. Suggested Books

S. No.	Name of Authors /Books/Publishers	Year of Publication
1	Goodhew, P.J., Humphreys J. and Beanland, R., "Electron Microscopy and Analysis", 3rd Ed., Taylor and Francis	2001
2	Cullity, B.D. and Stock S.R., "Elements of X-Ray Diffraction", 3rd Ed., Prentice Hall	2001
3	Williams, D. B. and Carter, C. B., "Transmission Electron Microscopy: A Textbook for Materials Science", 2nd Ed., Springer	2009
4	Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L. and Michael, J.R., "Scanning Electron Microscopy and X-ray Microanalysis", 3rd Ed., Springer	2003
5	Speyer, R., "Thermal Analysis of Materials", CRC Press	1993
6	Dehoff, R.T. and Rhines, F.N., "Quantitaive Microscopy", McGraw Hill	1968
7	Silverstein, Webster & Kiemle, "Spectrometric identification of organic compounds" 7th Ed. John Wiley and Sons	2005
8	K. Nakamoto, "IR and Raman spectra of inorganic and coordination compounds" 4th Ed., John Wiley and Sons	1986
9	Editor: J. D. Winefordner, "Raman spectroscopy in chemical analysis" Vol. 157, John Wiley and Sons	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE

List of Syllabi of PG Programmes received from Departments/Centres as per Approved Structure by the Senate

Subcode	Course Title	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE	Credits
	Physics Department											
PHN-502	Laboratory Work	0	0	6	0	6	-	50	-	-	50	3
PHN-503	Quantum Mechanics – I	3	1	0	3	0	25	-	25	50	-	4
PHN-504	Condensed Matter Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-505	Mathematical Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-506	Statistical Mechanics	3	0	0	3	0	25	-	25	50	-	3
PHN-507	Classical Electrodynamics	3	1	0	3	0	25	-	25	50	-	4
PHN-508	Quantum Mechanics - II	3	0	0	3	0	25	-	25	50	-	3
PHN-509	Classical Mechanics	3	0	0	3	0	25	-	25	50	-	3
PHN-513	Semiconductor Devices and Applications	3	0	3	3	3	15	25	20	40	-	4
PHN-512	Physics of Earth's Atmosphere	2	0	0	2	0	25	-	25	50	-	2
PHN-518	Elements of Nuclear and Particle Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-516	Atomic, Molecular and Laser Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-601	Advanced Condensed Matter Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-602	Nuclear Astrophysics	3	0	0	3	0	25	-	25	50	-	3
PHN-603	Advanced Atmospheric Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-604	Physics of Nanosystems	3	0	0	3	0	25	-	25	50	-	3
PHN-605	Advanced Laser Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-606	Superfluidity and Superconductivity	3	0	0	3	0	25	-	25	50	-	3
PHN-607	Advanced Nuclear Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-608	Fiber and Nonlinear Optics	3	0	0	3	0	25	-	25	50	-	3
PHN-609	Experiments in Condensed Matter Physics	0	0	6	0	6	-	50	-	-	50	3

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE

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SubCode	Course Title	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE	Credits
PHN-610	QuantumOptics	3	0	0	3	0	25	-	25	50	-	3
PHN-611	Experiments in Atmospheric Physics	0	0	6	0	6	-	50	-	-	50	3
PHN-612	Advanced topics in Mathematical Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-613	Experiments in Laser Physics	0	0	6	0	6	-	50	-	-	50	3
PHN-614	Introduction to Superstring theory	3	0	0	3	0	25	-	25	50	-	3
PHN-615	Experiments in Nuclear Physics	0	0	6	0	6	-	50	-	-	50	3
PHN-616	Advanced Electroceramics Technology	3	0	0	3	0	25	-	25	50	-	3
PHN-617	Advanced Characterization Techniques	3	0	0	3	0	25	-	25	50	-	3
PHN-618	Atomic and Molecular Collision Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-619	A Primer in Quantum Field Theory	3	0	0	3	0	25	-	25	50	-	3
PHN-620	Advanced Quantum Field Theory	3	0	0	3	0	25	-	25	50	-	3
PHN-621	Astrophysics	3	0	0	3	0	25	-	25	50	-	3
PHN-622	Solar Terrestrial Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-623	General Relativity	3	0	0	3	0	25	-	25	50	-	3
PHN-624	Computational Nuclear Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-625	Particle Physics	3	0	0	3	0	25	-	25	50	-	3
PHN-627	Quantum Theory of Solids	3	0	0	3	0	25	-	25	50	-	3
PHN-629	Weather Forecasting	3	0	0	3	0	25	-	25	50	-	3
PHN-631	Nuclear Instrumentation	3	0	0	3	0	25	-	25	50	-	3
PHN-633	Physics and Technology of Thin Films	3	0	0	3	0	25	-	25	50	-	3
PHN-635	Advanced Nuclear reactions	3	0	0	3	0	25	-	25	50	-	3
PHN-637	Semiconductor Photonics	3	0	0	3	0	25	-	25	50	-	3

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ROORKEE

List of Syllabi of PG Programmes received from Departments/Centres as per Approved Structure by the Senate

SubCode	Course Title	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE	Credits
PHN-639	Advanced Atomic and Molecular Physics	3	1	0	3	0	25	-	25	50	-	4
PHN-701	Laboratory Work	0	-	6	-	6	-	50	-	-	50	3
PHN-702	Nanomaterials and Technology	3	1	-	3	-	25	-	25	50	-	4
PHN-703	Semiconductor Materials and Devices	3	1	-	3	-	25	-	25	50	-	4
PHN-704	Quantum Hetrostructures	3	1	-	3	-	25	-	25	50	-	4
PHN-705	Characterization of Materials	3	1	-	3	-	25	-	25	50	-	4
PHN-706	Functional Materials and Devices	3	1	-	3	-	25	-	25	50	-	4
PHN-707	Computational Techniques and Programming	2	-	2	2	2	15	25	20	40	-	3
PHN-708	Solar Photovoltaics	3	1	-	3	-	25	-	25	50	-	4
PHN-710	Advanced Ceramics & Composites	3	1	-	3	-	25	-	25	50	-	4
PHN-712	Optoelectronics	3	1	-	3	-	25	-	25	50	-	4
PHN-714	Semiconductor Micro Electronic Technology	3	1	-	3	-	25	-	25	50	-	4

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-502** Course Title: **Laboratory Work**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

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

8. Pre-requisite: **Nil**

9. Objective: To familiarize with the basic experiments in Solid State Physics, Nuclear Physics, Laser Physics and Atmospheric Physics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Study of Hall effect and to determine the Hall coefficient	14 x 6
2	To measure resistivity of semiconductor by Four Probe method and determination of band gap.	
3	To determine reverse saturation current, material constant and band gap of PN Junction	
4	To ascertain of the Random nature of nuclear radiation	
5	To study G.M. tube characteristics and to calculate the dead time,	
6	To determine the relative beta counting of two strong β-sources of nuclear radiation and to determine the absorption coefficients,	
7	To determine the distribution of the size of Aerosol.	
8	To measure the attenuation of laser radiation in varying atmospheric condition.	
9	The measurement of precipitation rate of water using rain gauge.	
10	To determine the numerical aperture of a given multimode fiber using the far field measurements.	
11	To measure the spot size and the angle of divergence of a laser beam, to produce the elliptically and circularly polarized light from an unpolarized laser beam and study their angular intensity profiles.	
12	Design of counter using JK flip flop and a relaxation oscillator with given frequency and duty cycle	
13.	Design a Schmitt trigger with given UTP LTP and hysteresis	

14.	To design a binary/BCD up-down counter using IC 74190/74191	
	Total	**84**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Nakra B.C. &. Chaudhery K.K , " Instrumentation Measurements & Analysis", Tata McGraw Hill	**2002**
2.	Sayer M. & Mansingh A., "Measurement, Instrumentation & Experiment Design in Physics and Engineering", Prentice Hall India	**2000**
3.	Melissinos A.C. and Napolitano J, "Experiments in Modern Physics", Academic Press	**2000**
4.	W.R. Runyan , "Semiconductor Measurements and Instrumentation", McGraw Hill	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-503** Course Title: **Quantum Mechanics-I**

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** 7. Subject Area: **PCC**

8. Pre-requisite: **PH-303 or equivalent**

9. Objective: To apply quantum mechanics to the dynamics of single particle in one-, two- and three- dimensional potential fields.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Postulates of Quantum Mechanics and meaning of measurement, Operators and their expectation values, Schrodinger equation, Particle in a box, Orthogonality of eigen functions, Dirac rotations, Hilbert space.	6
2.	**Matrix Formulation:** Matrix formulation of 1-dimensional harmonic oscillator problem; creation and annihilation operators; Equation of motion and classical correspondence, Heisenberg equation of motion, Schrodinger, Heisenberg and Interaction picture, Motion in a one-dimensional periodic potential, Kroning-penny model.	8
3.	**Motion in a Central Potential:** Angular momentum operator, expressions of L^2 and L_z, eigen values and eigen functions of L^2 and L_z, hydrogen atom, solution of radial equation, energy eigen values, eigen functions of H atom, orthogonality of eigen functions, rigid rotator, matrix representation L^2, L_x, L_y, L_z, generalized angular momentum, generator of rotation and their commutation relations, spin – ½ matrices, coupling of angular momenta, Clebsch-Gordon Coefficients.	10
4.	**Scattering Theory:** Scattering amplitude, differential and total cross-section, scattering by a central potential, method of partial waves, phase-shift analysis, optical theorem, scattering by a square-well potential, integral equation, the Born approximation.	10
5.	**Approximate Methods:** WKB approximation, WKB expansion, connecting formulas, variational principle and its application to Helium atom and hydrogen molecule	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Schiff L.I., "Quantum Mechanics", 3rd Ed, McGraw Hill Book Co.	1990
2.	Merzbacher E, "Quantum Mechanics", 2nd Ed., John Wiley & Sons	1996
3.	Gasiorowicz S, "Quantum Physics", John Wiley	2000
4.	Mathews P. M. and Venkatesan K, "A Text Book of Quantum Mechanics", Tata McGraw Hill	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-504** Course Title: **Condensed Matter Physics**

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: **PCC**

8. Pre-requisite: **PH-304 or equivalent**

9. Objective: To familiarize with the structural and electronic properties of crystalline and non-crystalline materials and their dynamical properties.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Crystalline Materials:** Scattering of x-ray, neutrons and electrons from solids; Atomic scattering factor; Lattice planes and Miller indices.	6
2.	**Lattice Dynamics:** Harmonic and adiabatic approximations; Lattice vibrations of three dimensional crystals; Periodic boundary conditions; Normal modes. Quantization of lattice vibrations; Lattice heat capacity (Einstein and Debye theories) anharmonicity of thermal expansion.	9
3.	**Electronic Energy Bands:** Resume of free-electron model; Fermi energy; Fermi surface and electronic heat capacity, electrical and thermal conductivity, nearly free electron model; Periodic potential and Bloch theorem, extended and reduced zone scheme, tight binding model.	9
4.	**Superconductivity:** Experimental evidence (Meissner effect, heat capacity, energy gap, microwave properties and isotope effect), Thermodynamics of superconductors; London equation; Elementary BCS theory.	9
5.	**Non-crystalline Materials:** Non-crystalline solids – diffraction pattern and radial distribution function, Elementary idea of glass transition, Quasi crystals, Liquid crystals – idea of orientational order and Landau theory of isotropic-nematic phase transition, Physics of Polymers.	9
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Taylor P. L. and Heinonen O., "A Quantum Approach to Condensed Matter Physics", Cambridge University Press	**2004**
2.	Ashcroft N W and Mermin N D, "Solid State Physics", Holt-Saunders	**2000**
3.	Chaikin P M and Lubensky T C, "Principles of Condensed Matter Physics", Cambridge University Press	**2000**
4.	Hamley I. W., "An Introduction to Soft Matter: Polymers, Colloids, Amphiphiles and Liquids" John Wiley	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-505** Course Title: **Mathematical Physics**

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: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: **To familiarize the students with the standard techniques in modern mathematical physics**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Complex variables and applications, analytic functions, contour integration, residue calculus, conformal mapping and its applications. Fourier and Laplace transforms, evaluation of integral transforms and their inverses using contour integrals.	6
2.	Special equations of Mathematical Physics; Legendre and associated Legendre equations; Hermite equation; Laguerre and associated Laguerre equations; Bessel's equation; Hypergeometric equation; Beta and gamma functions.	8
3.	Green's functions and solutions to inhomogeneous differential equations and applications.	8
4.	Covariant and Contravariant tensors, covariant derivatives, affine connections Christoffel symbols, Curvature tensor.	6
5.	Classification and examples of (finite) groups, homomorphisms, isomorphisms, representation theory for finite groups, reducible and irreducible representations, Schur's Lemma and orthogonality theorem,	8
6.	Characters; Lie Groups and Lie algebra; Vector Spaces; Hilbert Space and operators	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Arfken G. B. and Weber H. J., "Mathematical Methods for Physicists" , 5th Ed. Academic Press.	2005
2.	Whittaker E.T.and Watson E.W., "A Course of Modern Analysis", Cambridge University Press	2008
3.	Hammermesh M., "Group Theory and Applications to Physical Problems", Dover publications, NY.	1989
4.	Akhiezer N. I. and Glazman I. M., " Theory of Linear Operator in Hilbert Space", Dover Publications	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-506** Course Title: **Statistical Mechanics**

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: **PCC**

8. Pre-requisite: **PH-503 & PH-509**

9. Objective: To understand the macroscopic behaviour of the classical and quantum thermodynamic systems.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Classical Statistical Mechanics:** Macro and microstates, connection between statistics and thermodynamics, phase space; Liouville's Theorem. Microcanonical, canonical and grand canonical ensembles; Energy and Density fluctuations; equivalence of various ensembles. Equipartition and virial theorem, partition function; Derivation of thermodynamic properties; some examples including (i) classical ideal gas (ii) system of classical harmonic oscillators, (iii) system of magnetic dipoles in magnetic field.	10
2.	**Quantum Statistical Mechanics:** Quantum mechanical ensembles theory, the density matrix and partition function with examples including (i) an electron in a magnetic field (ii) a free particle in a box (iii) a linear harmonic oscillator. Symmetric and Antisymmetric Wavefunctions. Microcanonical ensemble of ideal Bose, Fermi and Boltzmann gases, derivation of Bose, Fermi and Boltzmann statistics; Grand Partition function of ideal Bose and Fermi gases; Statistics of the occupation.	12
3.	**Ideal Bose and Fermi Systems:** Thermodynamic behaviour of an ideal Bose gas; Bose condensation; Liquid Helium; Blackbody radiation and Planck's law of radiation; Thermodynamic behaviour of an ideal Fermi gas; Electrons in metals, specific heat and Pauli susceptibility of electron gas.	10
4.	**Phase Transitions and Critical Phenomenon :** Order parameter, Ist and IInd order phase transitions. Ising model in zeroth and first approximation. Critical exponents, thermodynamic inequalities, Landau theory of phase transitions.	10
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Patharia R K "Statistical Mechanics" (2nd Ed.), Pergaman press	**2001**
2.	Huang K "Statistical Mechanics" (2nd Ed., 2nd reprint), John Wiley & Sons	**2003**
3.	Landau L.D. and Lifshitz E M "Statistical Mechanics", Butteworth-Heinemaun	**1998**
4.	McQuarrie D A "Statistical Mechanics", Harper & Row	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-507** Course Title: **Classical Electrodynamics**

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** 7. Subject Area: **PCC**

8. Pre-requisite: **PH-202 or equivalent**

9. Objective: To emphasize electric and magnetic phenomena and introduce the covariant formulation of Maxwell's theory of electromagnetism

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Maxwell's Equation:** Maxwell's equation, vector and scalar potentials, Gauge transformation, Poynting theorem., plane electro-magnetic waves, waves in non-conducting and conducting medium; Linear and Circular polarization, reflection and refraction.	12
2.	**Covariant Formulation of Vacuum Electrodynamics:** Space-Time symmetry of the field equations; Covariant formulation; Four-vector potential; Electromagnetic field tensor and its invariants; Lorentz-Force equation in a covariant form.	12
3.	**Radiation from Accelerated Charges:** Retarded potentials; Lienard-Wiechert potentials; Fields produced by a charge in uniform and arbitrary motion, radiated power; Angular and frequency distribution of radiation, radiation from charged particle with co-linear velocity and acceleration; Synchrotron radiation; Thomson scattering; Cherenkov radiation.	14
4.	**Multipole Fields:** Inhomogeneous wave equation, multipole expansion of electromagnetic fields, angular distribution, multipole moments.	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Jakson J D, "Classical Electrodynamics", John Wiley	2002
2.	Griffiths D J, "Introduction to Electrodynamics", Prentice Hall	1999
3.	Capri A.Z. and Panat P.V., "Introduction to Electrodynamics" Narosa Publication House	2002
4.	Franklin J., "Classical Electromagnetism", Pearson Education	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-508** Course Title: **Quantum Mechanics-II**

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: **PCC**

8. Pre-requisite: **PH-503**

9. Objective: To introduce various approximation methods for stationary and time-dependent problems; two-particle systems, basic ideas of self-consistent field theoriesand relativistic quantum mechanics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Time-independent Perturbation Theory:** Non-degenerate and degenerate perturbation theory, its application to Stark effect, Zeeman effect, spin-orbit coupling, fine structure and to anharmonic oscillator.	10
2.	**Time-dependent Perturbation Theory:** Transition probability, harmonic perturbation, Fermi-golden rule, semi-classical theory of radiation, stimulated emission cross-section.	10
3.	**Identical Particles:** Indistinguishability, permutation symmetry, two-particle system; Helium atoms, simple idea of Hartee self-consistent field method, Hartee-Fock method.	10
4.	**Relativistic Quantum Mechanics:** Klein-Gordon equation and its applications, Dirac theory of electron, spin of the electron, solution of Dirac equation for free particles, hole (positron)-Dirac equation for Hydrogen atom.	12
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Schiff L I, "Quantum Mechanics", 3rd Ed, McGraw Hill Book Co.	1990
2.	Griffiths D J, "Introduction to Quantum Mechanics", 2nd Ed, Pearson Eduction	2005
3.	Bransden B H and Joachain C J, "Quantum Mechanics", 2nd Ed, Pearson Eduction	2000
4.	Zettili N, "Quantum Mechanics: Concepts and Applications", 2nd Ed, John Wiley	2009
5.	Bjorken J D and Drell S D, "Relativistic Quantum Mechanics", McGraw Hill Book Co.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-509** Course Title: **Classical Mechanics**

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: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **PH-203 or equivalent**

9. Objective: To familiarize students with the various methods of solving problems in classical mechanics using the techniques of Lagrange, Hamilton, Hamilton-Jacobi and Poisson Brackets.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Lagrange's Equation:** Constraints; D'Alembert's principle and Lagrange's equation of motion, dissipation function, Hamilton's principle, calculus of variations, nonholonomic systems, conservation laws, relativistic and covariant formulation.	10
2.	**Hamilton's Equations:** Hamilton's equation of motion, cyclic co-ordinates, Routh's procedure, relativistic formation, variational principle, principle of least action.	8
3.	**Canonical Transformations:** Equations of canonical transformations and examples, sympletic approach, Poisson brackets and equation of motion, conservation laws, angular momentum, symmetry groups & Louville's theorem.	8
4.	**Hamilton-Jacobi Theory:** Hamilton-Jacobi equation's of motion, harmonic oscillations, separation of variables, action-angle variables, Kepler problem, geometrical optics and wave mechanics.	8
5.	**Canonical Perturbation Theory:** Time-dependent perturbation, examples, time-independent theory in first order and higher orders, applications to celestial and space mechanics, Adiabatic invariants.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Goldstein H, "Classical Mechanics", Narosa	2001
2.	Rana W.C. and Jog P.S, "Classical Mechanics" , Tata McGraw Hill	1991
3.	Gupta K.C., "Classical Mechanics of particles and Rigid Bodies", Wiley Eastern	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-512** Course Title: **Physics of Earth's Atmosphere**

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

3. Examination Duration (Hrs.): **Theory : 2** **Practical : 0**

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

5. Credits: **2** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **None**

9. Objective: To introduce the basics of atmospheric physics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Atmospheric Evolution:** Solar radiation, present atmospheric constituents, evolution of the atmosphere, formation of ozone.	6
2.	**Lower Atmosphere:** Variation of temperature, density, ionization and pressure with altitude, hydrostatic equation, green house effect, lapse rate and stability criteria, cloud formation and precipitation.	8
3.	**Upper Atmosphere:** Chapman theory of layer production, formation of ionosphere, photochemistry of the thermosphere, electron, ion and neutral temperatures in the thermosphere, airglow and auroral emissions.	8
4.	**Weather:** weather and climate, weather modification, artificial rain making, cloud suppression, storms.	6
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Seeds M.A., "Solar System", Brooks/Cole Thomson Learning	**2007**
2.	Houghton J.T. "Physics of Atmosphere", Cambridge Univ. Press	**2002**
3.	Rogers R R, "A Short Course in Cloud Physics", Pergamon Press	**1989**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-513** Course Title: **Semiconductor Devices and Applications**

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

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

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

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

8. Pre-requisite: **PH-110 or equivalent**

9. Objective: To introduce the physics of semiconductors, p-n junction, bipolar junction transistors, FET and MOSFET.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Semiconductors:** Energy bands, direct and indirect semiconductors, charge carriers, mobility, drift of carriers in field, Diamond and Zinc-Blende structure, bonds and bands in semiconductors, intrinsic and extrinsic semiconductors, law of mass action, Hall effect and cyclotron resonance in semiconductors.	12
2.	**Optical Injection:** Carrier life time, direct and indirect recombination of electron and holes, steady state carrier generation, diffusion and drift of carriers, the continuity equation, steady state carrier injection, The Haynes-Shockley experiment.	8
3.	**Junctions:** Metal-Semiconductor contact: under equilibrium, and non-equilibrium conditions, the junction diode theory, tunnel diode, photodiode, LED, solar cell, Hetro-junctions and Laser diode.	10
4.	**Bipolar Junction Transistors:** Charge transport and amplification, minority carrier distribution and terminal currents switching behaviour in bipolar transistor.	4
5.	**FET and MOSFET:** Ideal MOS capacitor, effect of work function and interface charge on threshold voltage.	6
6.	**Gunn Diode:** Transferred electron mechanism and drift of space charge domain.	2
	Total	**42**

List of Practical:

S. No.	Particulars	Contact Hours
1.	To draw the I-V characteristics of a p-n junction diode in forward and reverse bias and to determine its DC and AC resistance for a given current.	
2.	To study the temperature dependence of the reverse saturation current of a p-n junction diode and to determine the band gap of semiconductor.	
3.	To study half wave, full wave and bridge rectifiers and to determine ripple factor.	
4.	To design a regulated power supply using Zener diode and fixed voltage regulator.	
5.	(a)To draw input and output characteristic of a bipolar transistor. (b)To design a CE amplifier and study its frequency response.	
6.	To draw input and output characteristic of a JFET and determine g_m, r_d and verify square law.	
7.	To design inverting and non-inverting amplifiers of different gain using operational amplifier and study their frequency response.	
8	To verify truth tables of various logic gates.	
9	To verify Boolean theorems using logic gates	
10	To design and study of astable, monostable multivibrators using Timer 555	

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Streetman B G and Banerjee S "Solid State Electronic Devices", 6th Ed. Prentice Hall	**2005**
2.	Sze S M, "Semiconductor Devices Physics and Technology" 2nd Ed. John Wiley & Sons	**2003**
3.	Tyagi M S, "Semiconductor Materials and Devices", John Wiley & Sons	**2000**
4.	Chattopadhyay D. and Rakshit P. C. , "An advanced course in Practical Physics" 7th Edition; New Central Book Agency (P) Ltd.	**2005**
5.	Gupta S. L. and Kumar V., "Practical Physics" 25th Ed. Pragati Prakashan	**2002**
6.	Paul P., Malvino A. and Miller M., " Basic Electronics: A Text-Lab Manual, Tata McGraw Hill	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-516** Course Title: **Atomic, Molecular and Laser Physics**

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: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To introduce basics of Atomic, Molecular and Laser Physics

10.Details of Course:

S.No.	Contents	Contact Hours
1.	**Atomic Spectroscopy-I:** Spectra of one and two electron system, Alkali spectra, Electron spin and magnetic moment, Fine structure splitting: spin-orbit interaction and relativistic corrections; Lamb shift, hyperfine structure and isotope shifts; Excited states of atoms, exotic atoms.	10
2.	**Atomic Spectroscopy-II:** Many-electron atoms, Pauli exclusion principle, Angular momentum coupling schemes: L-S and j-j coupling, equivalent and non-equivalent electrons, Hund's rules, ground state configurations of elements in periodic table; atoms in electric and magnetic fields, X-ray spectra.	10
3.	**Molecular structure and properties:** The Born-Oppenheimer Approximation, Application to H_2^+, Molecular orbital theory, LCAO approach, homonuclear and heteronuclear diatomic molecules, orbitals of polyatomic molecules; Ionic and Covalent bonds; Mechanical properties: sizes, shapes, masses, specific heat, kinetic energy - of molecules; electric and magnetic properties of molecules.	10
4.	**Laser Physics:** Characteristics of laser light, directionality, intensity, monochromaticity, spatial and temporal coherence, interaction of radiation with matter. Spontaneous and Stimulated emission and Absorption processes and their transition rates. Optical amplification, Population inversion, Basic concepts of 2-, 3- and 4- level systems, optical resonator, characteristics of semiconductor lasers and He-Ne lasers, CO_2 lasers, basic concepts of holography.	12
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Haken H and Wolf H. C, "The Physics of Atoms and Quanta", 6th Ed., Springer	2007
2.	Demtroder W., "Atoms, Molecules and Photons", 2nd edition, Springer-Verlag	2010
3.	Bransden B. H. and Joachian C. J., "Physics of Atoms and Molecules" 2nd Edition, Prentice Hall	2012
4.	Eisberg R. and Resnick R., "Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles", 2nd Edition, Wiley Student Edition	2003
5.	Atkins P. and Friedman R., "Molecular Quantum Mechanics", 5th edition, Oxford University Press	2010
6.	Laud, B. B., "Lasers and Non-linear Optics", 3rd edition, New Age International	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-518** Course Title: **Elements of Nuclear and Particle Physics**

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: **Spring** 7.Subject Area: **PCC**

8. Pre-requisite: **PH-505**

9. Objective: **To introduce the elements of introductory nuclear and particle physics**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Two nucleon problem: General symmetry properties of two nucleon Hamiltonian and two nucleon states, General forms of two nucleon interaction; Nuclear global properties: the N-Z chart, nuclear masses, densities, radii, spin, parities, electric and magnetic moments.	10
2.	Semi empirical (liquid drop) model, Fermi-gas model, nuclear shell model (with the harmonic oscillator potential), spin-orbit coupling and magic numbers.	6
3.	Introduction to nuclear reactions: Kinematics, conservation laws, angular distributions and cross sections, simple models of direct and compound reactions.	5
4.	Concept of elementary particles and their classification. Conservation of the different quantum numbers viz. baryon number strangeness etc. in particle physics. Concept of color and quark model. Deep inelastic scattering of lepton-hadron scattering: discovery of quarks and gluons	5
5.	Representation theory of SU(2) and SU(3) and its generators, preliminary idea of lie algebra, SU(3) flavour symmetry and construction of meson octet, baryon octet & decuplet and calculation of magnetic moments using their wave functions.	5
6.	Fermi theory and V-A theory of β-decay, concept of parity, helicity, non-conservation of parity in β-decay and its experimental verifications. **, Klein-Gordon equation, Dirac equation (derivation not required), Concept of anti-particle. Qualitative descriptions of Feynman diagram and the cross sections for processes *e.g.* Compton scattering, Moller scattering etc.**	8
7.	A brief introduction to the electromagnetic, weak and strong interactions Gauge theory: Abelian gauge theory (QED) and its extension to non-abelian gauge theory. Spontaneous symmetry breaking and electroweak unification	3
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Heyde, K., "Basic Ideas and concepts in Nuclear physics, An introductory approach", Institute of Physics Publishing	**2004**
2.	Bertulani, C.A. and Danielewicz, P, "Introduction to Nuclear reactions", Institute of Physics Publishing	**2004**
3.	Ghoshal, S.N., "Nuclear Physics", S. Chand and Company	**2000**
4.	Griffith D, "Introduction of Elementary Particles", John Wiley	**2000**
5.	Halzen, F. and Martin, A.D. "Quarks and Leptons" John Wiley	**2011**
6.	T.-P. Cheng and L.-F.Li, "Gauge theory of Elementary Particle Physics''Oxford University Press	**1988**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-601** Course Title: **Advanced Condensed Matter Physics**

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** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-504**

9. Objective: To introduce the general aspects of phase transition, electronic transport phenomena, superconductivity, dielectric, optical and magnetic properties of solids.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Surface and Interfaces:** Work function and contact potential; Thermoionic emission; Low-energy electron diffraction; Electronic surface levels; Super lattices; Quantum wells; Quantum wires, Quantum dots and carbon Nanotubes.	9
2.	**Magnetism:** Magnetic properties of insulators, Langevin diamagnetism and Van Vleck paramagnetism, Curie paramagnets and Curie-Weiss ferromagnets, Neel Antiferromagnets, Heisenberg model; Spin Waves, Ising model; Elements of magnetic properties of metals, Landau diamagnetism, Pauli paramagnetism, Stoner ferromagnetism; Magnetic resonance; NMR and EPR.	9
3.	**Transport Properties:** Boltzmann equation; Relaxation time approximation; General transport coefficients; Electronic conduction in metals; Thermoelectric effects; Transport phenomena in magnetic field; Magnetoresistance; Hall effect and Quantum Hall effect.	8
4.	**Phase Transitions:** Order parameter; Critical points; First and second order phase transitions; Mean field theory; Properties near critical point; Landau theory; Bragg-Williams theory; Liquid-gas transition and Isotropic-mematic transition.	8
5.	**Superconductivity:** Cooper pairing and BCS theory; Ginzburg-Landau theory; Flux quantization; Supercurrent tunneling; DC and AC Josephson effects; High-Tc superconductors.	8
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Kittel C, "Introduction to Solid State Physics", 6th Ed. Wiley eastern Ltd	2004
2.	Ashcroft N W and Mermin N D, "Solid State Physics", Holt-Saunders	2000
3.	Chaikin P M and Lubensky T C, "Principles of Condensed Matter Physics", Cambridge University Press	1995
4.	Harrison P, "Quantum Wells, Wires and Dots", Wiley & Sons Ltd.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-602** Course Title: **Nuclear Astrophysics**
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: **PH-503**
9. Objective: To introduce the emerging field of nuclear astrophysics which attempts to understand how nuclear processes generate the energy of stars over their lifetimes and synthesize heavier elements.
10. Details of Course:

S. No.	Particulars	Contact Hours
1.	**Introduction :** Astronomy-Observing the universe, Astrophysics-'Explaining' the universe; General characteristics of Thermonuclear reactions; Sources of nuclear energy; Cross sections, stellar reaction rates, mean lifetime; Maxwell-Boltzmann velocity distribution, Astrophysical S – factor,	10
2.	**Determination of reaction rates :** Neutron and charged particle induced non-resonant reactions; Reactions through narrow and broad resonances	8
3.	**Hydrogen and Helium burning :** p-p chain, CNO cycles, other cycles like NeNa, MgAl; Creation and survival of ^{12}C	9
4.	**Explosive Burning and Nucleosynthesis beyond Iron :** Silicon burning; Nucleosynthesis in massive stars, s – process, r - process	9
5.	**Indirect methods in Nuclear Astrophysics :** Coulomb dissociation, Trojan Horse and ANC methods; Neutron stars; Radioactive Ion Beams	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors/ Books/Publishers	Year of Publication/Re print
1.	Rolfs C E and Rodney W S, "Cauldrons in the Cosmos : Nuclear Astrophysics", The University of Chicago Press	2005
2.	Clayton D D, "Principles of Stellar Evolution and Nucleosynthesis", The University of Chicago Press	1984
3.	Glendenning N K, "Compact Stars", Springer	2000
4.	Boyd R, "An Introduction to Nuclear Astrophysics", The University of Chicago Press	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-603** Course Title: **Advanced Atmospheric Physics**
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** 7. Subject Area: **PEC**
8. Pre-requisite: **PH-512**
9. Objective: To provide the knowledge of advances in atmospheric physics.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Atmospheric Dynamics:** Apparent forces, effective gravity, coriolis force, pressure gradient force, gradient wind, thermal wind, continuity equation, perturbation theory and atmospheric waves, sound waves, gravity waves and Rossby waves, Momentum and energy transports by waves in the horizontal and the vertical.	12
2.	**Atmospheric Instabilities** Atmospheric instabilities, dynamical instabilities, barotropic instability, baroclinic inertial instability, Necessary condition of barotropic and baroclinic instability. Combined barotropic andbaroclinic instability. Kelvin-Helmholtz instability	10
3.	**Ionosphere:** Formation of Ionosphere,Chemical processes, Ionospheric conductivity, Planetary ionospheres, Ionospheric exploration using rockets and satellites, langmuir probe, temperature measurements, airglow and aurora, radio wave propagation in the ionosphere.	10
4.	**Magnetosphere:** Earth as a magnet, solar wind, types and theory of solar wind, frozen-in magnetic field, interaction of solar wind with Earth's magnetic field and formation of magnetosphere, inter planetary magnetic field (IMF), geomagnetic storms, van-allen radiation belts, plasmasphere,coronal holes, CMEs, satellite observations of various plasma domains and plasma instabilities.	10
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Vallace J and Hobbs, P V, "Atmospheric Science", Academic Press	1997
2.	Rees M H, "Physics & Chemistry of Upper Atmosphere", Cambridge Univ. Press	1989
3.	Ratcliffe J A, "An Introduction to the Ionosphere & Magnetosphere, Cambridge Univ. Press	1972
4.	Smithson P, "Fundamentals of Physical Environment", Ken Addison and Attrinson,	2008
5.	Rogers R R, " A short course in Cloud Physics", Pergamon Press	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PH-604** Course Title: **Physics of Nanosystems**

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: **PH-303 or equivalent**

9. Objective: This course on physics of nanosystems is designed to introduce the emerging area of nanotechnology.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	***Introduction*** - An overview of quantum mechanical concepts related to low-dimensional systems.	2
2.	***Hetrostructures*** – Heterojunctions, Type I and Type II heterostructures, Classification of Quantum confined systems, Electrons and holes in Quantum wells, Electronic wavefunctions, energy subbands and density of electronic states in Quantum wells, Quantum wires, and Quantum dots, Effective mass mismatch in heterostructures, Coupling between Quantum wells, Superlattices	5
3.	***Electron states*** - Wavefunctions and Density of States for superlattices, Excitons in bulk, in Quantum structures and in heterostructures, The unit cell for quantum well, for quantum wire and for quantum dot	6
4.	***Nanoclusters and Nanoparticles*** – introduction, Metal nanoclusters- Magic numbers, Geometric structures, Electronic structure, Bulk to nanotransition, Magnetic clusters; Semiconducting nanoparticles; Rare-gas and Molecular clusters.	4
5.	***Carbon Nanostructures*** – Introduction, Carbon molecules, Carbon clusters, Structure of C60 and its crystal, Small and Large Fullerenes and Other Buckyballs, Carbon nanotubes and their Electronic structure	3
6.	**Properties of Nano Materials:** Size dependence of properties, Phenomena and Properties at nanoscale, Mechanical/Frictional, Optical, Electrical Transport, Magnetic properties.	4

7.	**Nanomaterial Characterization:** Electron Microscopy, Scanning Probe Microscopies, near field microscopy, Micro- and near field Raman spectroscopy, Surface-enhanced Raman, Spectroscopy, X-ray photoelectron spectroscopy.	7
8.	**Synthesis of nanomaterials:** Fabrication techniques: Self-Assembly, Self-Replication, Sol-Gels. Langmuir-Blodgett thin films, Nanolithograph, Bio-inspired syntheses, Microfluidic processes, Chemical Vapor Deposition, Pulse laser deposition.	8
9.	**Applications of Nanomaterials:** Nanoelectronics, Nanosensors, Environmental, Biological, Energy Storage and fuel cells.	3
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Edelstein A. A. and Cammarata R .C., "Nanomaterials- Synthesis, Properties and Applications", Institute of Physics Publishing, London	1998
2.	Shik, A, "Quantum Wells: Physics and Electronics of two-dimensional systems", World Scientific	1999
3.	Benedek et al G., "Nanostructured Carbon for advanced Applications", Kluwer Academic Publishers	2001
4.	Harrison, P, "Quantum Wells, Wires, and Dots: Theoretical and Computational Physics", John Wiley	2000
5.	Mitin, VV, Kochelap, VA and Stroscio, MA "Quantum Heterostructures: Microelectronics and Optoelectronics", Cambridge University Press	1999
6.	Poole, Jr. CP and Owens, FJ, "Introduction to Nanotechnology", Wiley India.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-605** Course Title: **Advanced Laser Physics**

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** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-516**

9. Objective: To introduce the concept of laser physics and its applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Quantum theory for the evaluation of the transition rates and Einstein's coefficients, interaction of matter with radiation having broad spectrum, interaction of near monochromatic radiation with an atom having broad frequency response.	6
2.	Line broadening mechanisms, homogeneous and inhomogeneous broadening, natural collision and Doppler broadening mechanisms and line shape functions.	4
3.	Laser rate equations, the three levels and four levels system, variation of power around threshold, optimum output coupling, quality factor, the ultimate line width of the laser.	5
4.	Optical resonators, modes of a rectangular cavity and open planar resonators, confocal resonator system, modes of a confocal resonator using Huygen's principle, planar resonators, Fox and Li theory.	6
5.	Pulsed lasers, Q-switching techniques, active and passive shutters, mode-locking, various techniques for mode-locking of a laser.	5
6.	Mechanism and applications of Ar-ion, CO_2, Nd:YAG, Ti:Sapphire, Dye, Excimer and free electron lasers.	5
7.	Semiconductor lasers, p-n junction diode lasers, hetrojunction lasers.	5
8.	Modulation techniques for laser light, electro-optic and acousto-optic modulation, electro-optic effect in KDP crystal, longitudinal and transverse modes, acousto-optic effect, Raman-Nath and Bragg diffraction, small and large angle Bragg diffraction.	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Laud B B, "Lasers and Nonlinear Optics", Wiley Eastern Ltd.	1992
2.	Ghatak A K and Thyagarajan K., "Optical Electronics", Cambridge University Press	2003
3.	Yariv A, "Quantum Electronics", John Wiley & Sons	1989
4.	Thyagarajan K. and Ghatak A. "Lasers: Theory and Applications", Macmillan	1997
5.	Yariv A, "optical Electronics", Oxford University Press	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-606** Course Title: **Superfluidity and Superconductivity**

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: **PH-504**

9. Objective: It introduces advanced concepts of superfluidity and superconductivity and their interrelationship.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Superfluidity:** Basic properties of superfluid ^{4}He and ^{3}He; Bose-Einstein condensation in an Ideal Bose Gas; Bose-Einstein Condensation in Interacting Gases, Condensate Wave Function.	8
2.	**Theory of Bose Fluids:** Landau Criterion for Superfluidity. Excitations in a uniform Gas – Bogoliubov Transformation; Excitations in a Trapped Gas – Weak Coupling, Excitations in Non-uniform Gases.	9
3.	**Vortex States:** Quantization of Circulation, Quantized Vortices in He-II; Quantized Vortices in Superconductors; Comparison of He-II and Superconducting Vortices; Dynamics of Vortex States.	9
4.	**Ginzburg-Landau Theory:** Ginzburg Landau equations, second order critical fields; Abrikosov vortex lattice; Relation of GL theory with BCS theory; Ginzburg-Pitaevskii equations for He-II; Broken symmetry.	8
5.	**High-Tc Superconductivity:** Nature and various mechanisms of High Tc superconductivity; Equation for the critical temperature and strong electron-phonon coupling; SDW and CDW.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Chaikin P M and Lubensky T C, "Principles of Condensed Matter Physics", Cambridge University Press	**1995**
2.	Tilley D R and Tilley J, "Superfluidity and Superconductivity" (3rd Ed), Overseas Press	**2005**
3.	Suneto T and Nakahara M,"Superconductivity and Superfluidity", Cambridge University Press	**2005**
4.	Pethick C J and Smith H, "Bose-Einstein Condensation in Dilute Gases", Cambridge University Press	**2002**
5.	Pitaevskii L and Stringari S, "Bose-Einstein Condensation", Clarendon Press	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-607** Course Title: **Advanced Nuclear Physics**

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** 7. Subject Area: **PEC**

8. Pre-requisite: **PH 518**

9. Objective: To introduce the advanced concepts of nuclear physics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Yukawa theory of nuclear forces, Deuteron problem and tensor forces, n-p, p-p scattering and partial wave theory, effective range theory.	6
2.	Shell Model and its predictions: magnetic moments of nuclei and Schmidt lines, quadrupole moments; Even-even, odd-even, odd-odd nuclei, pairing interaction; Many-body basis states, Hartree-Fock single-particle Hamiltonian, selection of shell model space and effective Hamiltonian.	8
3.	Deformed nuclei and their shapes; Colletive model Hamiltonian, vibrational and rotational spectra, Nilsson model. High spin phenomena (back bending), superdeformation, octopole deformation Giant dipole resonances.	7
4.	Kinematics of nuclear reaction, reciprocity theorem, compound nuclear reaction, direct reaction and derivation of the crossections in these processes; Statistical theory of nuclear reaction and concept of nuclear temperature and entropy	7
5.	Shape-elastic, compound elastic scattering and dispersion relations, Electromagnetic transitions in nuclei, multipole expansion of the electromagnetic field; Transition probability in semiclassical treatment, Weisskopf estimate.	7
6.	Angular correlation studies; Lifetime measurements; Detection of gamma rays; Hp-Ge and other detectors; Gamma arrays.	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Roy R R and Nigam B P, "Nuclear Physics", John Wiley	2002
2.	Srivastava B B, "Fundamentals of Nuclear Physics", Rastogi Publications	2006
3.	Eisenberg J M and Greiner W, "Nuclear Theory", Vols. 1, North Holland	2002
4.	Eisenberg J M and Greiner W, "Nuclear Theory", Vols. 2, North Holland	2002
5.	Eisenberg J M and Greiner W, "Nuclear Theory", Vols. 3, North Holland	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-608** Course Title: **Fiber and Nonlinear Optics**

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: **PH-201 and PH-202 or equivalent**

9. Objective: To introduce applications of lasers in nonlinear optics, optical fiber communication and sensors.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Fiber optics:** Rectangular waveguides: optical waveguides, planar mirror waveguides, electromagnetic analysis of planar optical waveguides, TE and TM modes of a symmetric and asymmetric planar waveguide, power associated with a mode.	12
2.	Optical fiber: optical fiber waveguide, the numerical aperture, pulse dispersion in a step-index fiber, scalar wave equation and modes of a fiber, LP modes, single-mode fibers, material and waveguide dispersion for a communication link, attenuation, splice loss, methods of fabrication of optical fibers, optical fiber components, directional coupler, multiplexer, demultiplexer, fiber Bragg gratings, long-period fiber gratings, optical fibers in sensors, photonic crystal fibers.	12
3.	**Nonlinear optics:** Nonlinear optical media, nonlinear polarization and susceptibility 2^{nd} order nonlinear optics: optical second harmonic generation, sum frequency generation, difference frequency generation, optical parametric amplification and oscillation, three wave mixing.	10
4.	3^{rd} order nonlinear optics: third harmonic generation, optical Kerr effect, self phase modulation, self focusing, spatial solitons, Raman gain, four wave mixing, optical phase conjugation, Raman and Brillouin scattering.	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Ghatak A K and Thyagarajan K, "Optical Electronics", Cambridge University Press	**2003**
2.	Ghatak A K and Thyagarajan K, "Introduction to Fiber Optics", Cambridge University Press	**1998**
3.	Laud B B, "Lasers and Nonlinear Optics", Wiley Eastern	**1992**
4.	Saleh B E A and Teich M C, "Fundamantals of Photonics", Wiley Interscience	**2007**
5.	Snyder A and Love J, "Optical Waveguide Theory", Chapmann and Hall	**1983**
6.	Keiser G, "Optical Fiber Communications", McGraw Hill	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-609** Course Title: **Experiments in Condensed Matter Physics**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

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

8. Pre-requisite: **PH-502**

9. Objective: To familiarize the students with the advanced experiments in Condensed Matter Physics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Study of variation of resistivity of metal and highly resistive materials with temperature by Four Probe Technique.	14 x 6
2	Mapping and analysis of the resistivity of large samples (thin films, superconductors. etc) by Four probe Technique.	
3	To study the temperature dependence of Hall coefficient of N and P type semiconductors	
4	(a) To measure the dielectric constant and Curie temperature of given ferroelectric samples. (b) To measure the coercive field (E_c), Remanent Polarization (P_r), Curie Temperature (T_c) and Spontaneous Polarization (P_s) of Barium Titanate ($BaTiO_3$).	
5	Thermoluminescence in alkali halides crystals. (a) To produce F centers in the crystal exposing to X-ray /UV source. (b) To determine activation energy of the F-centers from initial rise method.	
6	Verification of Bragg's law and determination of wavelength/energy spectrum of X-rays.	
7	Study of Solar Cell characteristics and to determine (i) Open circuit voltage 'V_{oc}' (ii) Short circuit current 'I_{sc}', (iii)Efficiency 'η',(iv) Fill factor, (v) Spectral characteristics and (vi) Chopper characteristics.	
8	To measure the magnetoresistance of semiconductor and analyze the plots of $\Delta R/R$ and log-log plot of $\Delta R/R$ Vs magnetic field.	
9	To determine the coercivity, saturation magnetization and retentivity of ferromagnetic samples using Magnetic Hysteresis Loop Tracer	
10	To study the temperature dependence of Laser diode characteristics	
11	To determine transition temperature of given superconducting material and study Meissner effect.	
12	To measure critical current density of given superconductor and study	

	its field dependence.	
13	To determine the value of Lande's 'g' factor using ESR spectrometer.	
14	To study C-V characteristics of various solid state devices & materials. (like p-n junctions and ferroelectric capacitors	
	Total	**84**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Melissinos A.C. and Napolitano J, "Experiments in Modern Physics", Academic Press	**2003**
2.	S.M. Sze, "Semiconductor devices Physics & Tech.", Wiley	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-610** Course Title: **Quantum Optics**

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: **PH-503 & PH-508 & PH-516**

9. Objective: The course provides an understanding of the physical principles of quantum optics and its use in laser cooling trapping of atoms.

10. Details of Course:

S.No.	Contents	Contact Hours
1	Two-level atom and classical electric field. Rabi solutions. Comparison to Lorentz atom. Multi-level atoms, selection rules for electric dipole transitions, Raman coupling in 3-level systems, optical pumping.	6
2	Density-matrix formalism: Application to two-level atom , optical Bloch equations, the Bloch vector, Ramsey fringes, photon echoes, adiabatic following, optical Bloch equations with dissipation (Relaxation. Spontaneous emission and collisions).	10
3	Dressed states: ac Stark effect, the Mollow triplet, Electromagnetically Induced Transparency (EIT), "slow light", Coherent Pouplation Trapping (CPT), cavity QED, Jaynes-Cummings model.	10
4	Laser cooling and trapping: scattering force (Light forces on two-level atoms), Doppler cooling limit, magneto-optic trap (MOT), Optical lattices, Polarization gradient cooling overview, Raman transitions,	10
5	Magnetic trapping, evaporative cooling and Bose–Einstein condensation	6
	Total	42

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1	Foot C. J.,"Atomic Physics", Oxford University Press	**2005**
2	Loudon R., "The Quantum Theory of Light", Oxford University Press	**2001**
3	Metcalf H. J. and Straten P. der , "Laser Cooling and Trapping", Springer-Verlag New York, Inc.	**2001**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-611** Course Title: **Experiments in Atmospheric Physics**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

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

8. Pre-requisite: **PH-502**

9. **Objective of Course:** The lab work aims to familiarizing students with the basic experiments in Atmospheric Physics.

10. Details of Course:

Sl.No.	Contents	Contact Hours
1	To measure fair weather electric field and do atmospheric electric field simulation	14 x 6
2	To measure the concentration of salts in the ground water and rain water using Flame Photometer	
3	To measure the rain water precipitation rate and to find rain drop size distribution using Rain Gauge:	
4	To measure attenuation coefficient of a gas for a given wave length of electromagnetic radiation.	
5	To measure the size distribution of aerosol particles.	
6	To measure solar constant using Solarimeter and study the diuranal variation of solar flux in the visible spectrum.	
7	To measure the diuranal variation of sound noise: A case study.	
8	To study and analysis of VLF generated by lightning.	
9	Study and assessment of ambient air quality using spectrophotometer.	
10	To analyze Ionosonds data and obtain electron density is the ionosphere.	
	Total	84

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	McCartney E J, "Optics of the Atmosphere", Wiley	1976
2.	Hulst H C, "Light Scattering by Small Particle", Courier Dover Pub	1964
3.	Lab Manual for Flame Photometer, Elico Ltd.	
4.	Lab Manual for Aerosol Size distribution, Scientific India	
5.	Lab Manual for Attenuation Constant, Spectra Laser	
6.	Lab Manual for Rain Gauge, Weather Measure Corp.	
7.	Lab Manual for Electric Field Simulation, Atmospheric Lab, IITR	

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-612** Course Title: **Advanced Topics in Mathematical Physics**

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: **PH-505**

9. Objective: The objective of this course is to familiarize the students with techniques that are part and parcel in a variety of fields in theoretical physics, specially, theoretical high energy physics, cosmology, etc.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Topology**: topological spaces, connectedness and compactness of spaces, continuous functions, homeomorphisms	8
2.	**Real Manifolds**: definition, vector fields, differential forms, frames, connection, curvature, torsion, integration of differential forms, Stokes theorem, Laplacian on forms.	8
3.	**Homology And Cohomology**: Simplicial Homology and De-Rham Cohomology	6
4.	**Homotopy:** Loops and homotopies, fundamental and higher homotopy groups.	6
5.	**Fibre Bundles**: the concept, tangent and cotangent bundles, vector and principal bundles.	6
6.	**Complex Manifolds And Cohomology**: Definition, Dolbeault Cohomology of complex forms, harmonic analysis, basic ideas about Kähler and Calabi-yau manifolds.	8
	Total	42

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Brian R. Greene, " String Theory on Calabi-Yau Manifolds", Lectures given at Theoretical Advanced Study Institute in Elementary Particle Physics (TASI 96) Published in *Boulder 1996, Fields, strings and duality* 543-726	**1996**
2.	Mukhi S. and Mukunda N., " Introduction to Topology, Differential Geometry and Group Theory for Physicists", Wiley Eastern, New Delhi.	**1990**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-613** Course Title: **Experiments in Laser Physics**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

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

8. Pre-requisite: **PH-502**

9. Objective: The lab work aims to familiarize the students with the advanced experiments in Laser Physics Lab.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	To determine the mode field diameter (MFD) of the fundamental mode of a given single-mode fiber using the far field technique.	14 x 6
2.	To measure the near field intensity profile of a multimode fiber and thereby its refractive index profile.	
3.	To measure the propagation constants of a given optical waveguide using the prism coupling technique.	
4.	To study electrical and optical characteristics of LED and LD.	
5.	To measure power loss at a splice between two multimode fibers and study the variation of splice loss with transverse, longitudinal and angular offsets.	
6.	To study bend-induced loss in a single mode fiber.	
7.	To study faraday effect and to measure the angle of rotation as a function of mean flux density at different wavelengths thereby evaluate Verdet's constant as a function of wavelength.	
8.	To study Kerr effect and to determine Kerr constant of a given material.	
9.	To study fiber grating based pressure sensor.	
10.	To construct EDF ring laser and characterize it in terms of slope efficiency, lasing threshold and intra-cavity loss.	
11.	To record and reconstruct holograms.	
12.	To characterizes a WDM based optical communication system in terms of insertion/return loss, isolation/extinction ratio, narrowband wavelength response of WDM components and chromatic dispersion.	
13.	To construct and characterize a diode pumped Nd:YVO_4/Nd:YAG laser and to do second harmonic generation.	

14.	To study the acousto-optic effect and determine the velocity of acoustic waves in a given medium using a laser beam	
	Total	**84**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Ghatak and Shenoy, "Fiber Optics through experiments", Viva Books	**1994**
2.	Laud B B, "Lasers and Nonlinear Optics", Wiley Eastern Ltd.	**1992**
3.	Ghatak A.K., Pal, B.P., Shenoy M. R. and Khijwania S.K, " Fiber Optics through Experiment", Viva Books	**2009**
4.	Ghatak A. K. and Thyagrajan K., " Optical Electronics", Cambridge University Press	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-614** Course Title: **Introduction to Superstring Theory**

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: **PH-505, PH-619**

9. Objective: The main objective of this course is to prepare the student with the basics of superstring theory.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Bosonic String Theory: Perturbative: free bosonic string in Minkowski space, commutation relation and mode expansion, Virasoro algebra, Light-cone gauge Quantization and no-ghost theorem, analysis of spectrum.	8
2.	Superstring Theory: World-sheet supersymmetry, boundary conditions and mode expansions, light-cone gauge quantization, [no-ghost theorem, GSO condition], extended world-sheet supersymmetry [N=2, 4], super Yang-Mills theory.	14
	Space-time supersymmetry, superparticle and superstring, type I and II superstrings, Light-cone quantization and analysis of open and closed-string spectra.	
	SO(32) and E_8 x E_8 heterotic string theories.	
3.	Basic Mathematics of String Theory: Topological Spaces, Continuous Functions, real (differentiable) manifolds, vector fields, differential forms, Riemannian Geometry, integrals of forms and Stokes theorem, Laplacian on forms, Simplicial Homology, de Rham Cohomology, Fiber Bundles, Homotopy theory, Complex Manifolds, Kählerian geometry, Dolbeault Cohomology, Calabi-Yau manifolds and their Moduli Spaces	8
4.	Nonperturbative: dualities, basic ideas of M- and F -theories, compactifications, dualities, examples and their tests and interrelation between different duality conjectures, M-theory in 11 dimensions and	12

	its compactification, F-theory in 12 dimensions and its compactifications, nonperturbative D-branes and open strings in closed string theories.	
	Total	42

11. Suggested Books:

S.No.	Name of Books/Authors	Year of Publication
1.	Superstring Theory: Volume 1, Introduction by Michael B. Green, John H. Schwarz, Edward Witten Cambridge University Press	1988
2.	String Theory (Cambridge Monographs on Mathematical Physics) (Volumes 1,2), J.Polchinksi	1998
3.	An Introduction to Nonperturbative String Theory, By Ashoke Sen, In *Cambridge 1997, Duality and supersymmetric theories* 297-413	1997
4.	*String theory on Calabi-Yau manifolds*, Brian R. Greene, (Columbia U.) : Lectures given at Theoretical Advanced Study Institute in Elementary Particle Physics (TASI 96): Fields, Strings, and Duality, Boulder, CO, 2-28 Jun 1996, Published in Boulder 1996, Fields, *Strings and* Duality, World Scientific Singapore	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-615** Course Title: **Experiments in Nuclear Physics**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

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

8. Pre-requisite: **PH-502**

9. Objective: The lab work aims to familiarizing students with the advanced experiments in Nuclear Physics.

10. Details of Course:

S. No.	Particulars	Contact Hours
1.	To do the energy analysis of an Unknown Gamma Source by Gamma Ray Spectroscopy using NaI(Tl) - Single Channel Analyzer (i) Energy Calibration (ii) Energy Analysis of an Unknown Gamma Source. (iii) Energy Resolution.	14 x 6
2.	To do Spectrum Analysis of ^{60}Co and ^{137}Cs by Gamma Ray Spectroscopy using NaI(Tl) - Multi Channel Analyzer and study the Energy resolution dependence on detector size.	
3.	To find the Mass Absorption Coefficient of lead for 662 KeV gamma ray	
4.	Alpha Spectroscopy with surface barrier detectors (i) Alpha spectrum and energy calibration. (ii) Energy determination of an Unknown alpha source of alpha particles.	
5.	Spectrum expansion with Multi-channel Analyzer and decay ratios of ^{241}Am.	
6.	Beta spectroscopy (i) Calibration with a pulser (ii) Beta end point determination for ^{204}Tl (iii) Conversion electron ratio.	
7.	Compton Scattering (i) Simple Compton Scattering (Energy Determination)	

	(ii) Simple Compton Scattering (Cross-section Determination)	
8.	To study Rutherford Scattering of alpha particles from thin gold foil and Al foil.	
9.	To determine Half-Lives of Radioactive sources prepared by neutron activation – In and Ag isotopes	
10.	To study Gamma-gamma coincidence by (i) Overlap coincidence method – ^{22}Na (ii) Time to pulse height converter method – ^{22}Na	
	Total	**84**

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	Leo W R, "**Techniques for Nuclear & Particle Physics Experiments**", Narosa	**2000**
2.	Kapoor S S and Ramamurthy V "**Nuclear Radiation Detectors**", New Age Publishers	**1986**
3.	ORTEC Lab Manual, "**Experiments in Nuclear Science**", ORTEC	**1992**

NDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-616** Course Title: **Advanced Electroceramics Technology**

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: **PH-504**

9. Objective: This course will introduce the students to modern day electoceramic materials and their applications and will enable the students to learn about modern applications of electroceramic materials and the underlying physical principles.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	INTRODUCTION: Oxide and non-oxide ceramics, their chemical formulae, crystal and defect structures, non-stoichiometry and typical properties.	4
2.	POWDER PREPARATION: Physical methods (different techniques of grinding), chemical routes - co-precipitation, sol-gel, hydrothermal, combustion synthesis, high temperature reaction (solid state reaction).	6
3.	BASIC PRINCIPLES AND TECHNIQUES OF CONSOLIDATION AND SHAPING OF CERAMICS: powder pressing- uniaxial, biaxial and cold isostatic and hot isostatic, injection moulding, slip casting, tape-casting, calendaring, multilayering.	5
4.	Sintering: different mechanisms and development of microstructure (including microwave sintering) Preparation of single crystal, thick and thin film ceramics Problems of sintering: Inhomogeneties and their effects on sintering, constrained sintering; rigid inclusion, thin film, solid solution additives and the sintering, sintering with chemical reaction, viscous sintering with crystallization.	5
5.	EXOTIC CERAMICS: functionally graded, smart/ Intelligent, bio-mimetic and nano- ceramics - basic principles, preparation and applications, Ceramic Sensors, Transparent ceramics, coatings and films: preparation and applications	8

6	Ceramic Capacitors: Historical Background, Ferro Electricity in Capacitors Technology, Dielectric Properties of Multi-Phase systems, Basic Dielectric Materials, Varieties of Ceramic capacitor, Capacitor performance Parameters, Typical Ceramic Dielectric Compositions, fuel cells and batteries	8
7.	Magnetic Ceramics: Spinal ferrites, Hexagonal ferrites, Rare earth-Garnet, Processing & application in various fields.	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication/Re print
1.	Michel W. Barsoum, M. W., "Fundamental of Ceramics", McGraw Hill International edition	1997
2.	Richerson, D.W., " Modern Ceramic Engineering", Mercel Dekker NY	1992
3.	Rahman, M. N., "Ceramic Processing and Sintering", Mercel Dekker	2003
4.	Somiya, S., "Handbook of Advanced Ceramics", Academic Press	2003
5.	Somiya, S., "Handbook of Advanced Ceramics, Parts 1 and 2, Academic Press	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-617** Course Title: **Advanced Characterization Techniques**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-502**

9. Objective: To introduce the various methods of characterization of materials for their structural, electrical, magnetic and optical properties.

10. Details of Course:

S.No.	Contents	Contact Hours
1	**Crystal Structure Determination:** Brief description of Crystal Lattices; X-ray diffractometer; Determination of Crystal Structure using X-ray diffraction	12
2	**Electron Microscopes:** Brief description of different microscopes like TEM, SEM, AFM; Different modes of operation of microscopes, sample preparation, Interpretation of electron diffraction and determination of Crystal Structure; Morphology of the Crystals.	11
3	**Thermal Analysis:** Thermogravimetric analysis, Differential thermal analysis and Differential scanning calorimetry and methodology; Determination of phase transitions using these methods.	05
4	**Electrical and Magnetic Property:** Measurement of Electrical conductivity in different materials, e.g. insulators, metals and semiconductors. Using Four Probe and Hall Effect method. Vibrating Sample Magnetometer (VSM), Superconducting Quantum interference Devices (SQUID), Magnetodielectric effect	8
5	**Optical Characterization:** Optical characterization of materials using Photoluminescence and UV-visible spectroscopy.	03
6	**Chemical Analysis:** Brief description to X-ray fluorescence, Atomic absorption and electronic spin resonance spectroscopy.	03
	Total	42

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Culity B D, "Elements of X-ray Diffraction", Addison-Wesley.	**2001**
2.	Grundy P J and Jones G A, "Electron Microscopy in the Study of Materials", Edward Arnold	**1976**
3.	Egerton R F, "Physical Principles of Electron Microscopy", Springer	**2008**
4.	Willard, Merritt, Dean and Settle, "Instrumental Methods of Analysis", CBS publications	**1991**
5.	Fultz B and Howe J M, "Transmission Electron Microscopy and Diffractometry of Materials", Springer.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-618** Course Title: **Atomic and Molecular Collision Physics**
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: **Autumn** 7. Subject Area: **PEC**
8. Pre-requisite: **PH-516**
9. Objective: The course aims at introducing the formal scattering theory, and its applications to scattering of projectiles from atoms and molecules.
10. Details of Course:

Sl.No	Contents	Contact Hours
1.	**Potential scattering-I:** General features, partial wave analysis, Optical theorem and unitarity relation, the phase shifts, Absorption processes, Scattering by a complex potential, Coulomb potential in parabolic coordinates, partial wave decomposition, Scattering by a modified Coulomb field	12
2.	**Potential scattering-II:** Schrödinger equation as an integral equation, Green's function, Lippmann-Schwinger equation, Compact solutions of Lippmann-Schwinger equation, Integral representations of scattering amplitude, Partial wave analysis of Lippmann-Schwinger equation, Born expansion as a perturbation series, the first born approximation, Born Series.	10
3.	**Electron – atom collisions:** Electron scattering: general principles, elastic scattering, excitation of atoms to discrete levels, ionization, resonance phenomena	6
4.	**Atom-atom collisions:** Long range interactions between atoms, the classical approximation, the elastic scattering of atoms at low velocities, electronic excitation and charge exchange	8
5.	**Electron - molecule collisions:** Theory of electron-molecule collisions, calculation of differential and integrated cross sections and illustrative results	6
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Joachain C. J., "Quantum Collision Theroy", North Holland, 3rd Edition, Amsterdam	**1983**
2.	Bransden B. H. and Joachain C. J., "Physics of Atoms and Molecules" 2nd Edition, Prentice Hall	**2003**
3.	Gianturco F. A., "Atomic and Molecular Collision Theory", Plenum Press, New York and London	**1982**
4.	Burke P. G. and Joachain C. J., "Theory of electron- Atom Collisions: Potential Scattering", Springer	**1995**
5.	Bransden B. H., "**Atomic Collision Theory**", 2d Ed., Benjamin, New. York	**1983**
6.	Zettili N, "Quantum Mechanics: Concepts and Applications", 2nd Ed, John Wiley	**2009**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-619** Course Title: **A Primer in Quantum Field Theory**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-503**

9. Objective: To familiarize students with applications of relativistic quantum mechanics.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Basics:** Action principle; Euler-Lagrange equations of motion, second quantization; Symmetry (space-time and internal) Conserved Nöther charges.	4
2.	**Tensors:** Definitions of contravariant, covariant and mixed tensors, need to use tensors in relativistic quantum mechanics.	2
3.	**Spin-0 (Klein Gordon Field Theory):** Real scalar field theory and its canonical quantization; Normal Ordering; Charged scalar field theory and its canonical quantization, conserved Nöther current and charge, Propagator (also as vacuum expectation value of a time-ordered product), interpretation of negative-energy solutions as anti-matter; Recasting Klein-Gordon equation as a Schrödinger equation, Zitterbewegung.	7
4.	**Spin-1/2 (Dirac Field Theory):** Dirac Lagrangian for spinor fields, Feynman Gamma matrices and related identities; Covariance of the Dirac equation; Canonical quantization of the spinor fields, positive- and negative-energy spinors, positive- and negative-energy projectors, Lorentz transformations to boost from rest frame to lab frame; Propagator (also as vacuum expectation value of a time-ordered product), Discrete symmetries: Charge conjugation, Parity and Time reversal symmetries.	9
5.	**Spin-1 (Gauge Field Theory):** Covariant formulation of Maxwell's equations, (transverse) canonical quantization of the gauge field (in the Coulomb gauge),	5
6.	**Scattering**: LSZ reduction (for bosons and fermions), Wick's theorem, S-matrix, cross sections.	6
7.	**Quantum Electrodynamics**: Quantization of abelian gauge theories with fermions; Feynman Rules; Compton effect; Møller Scattering, radiative corrections; Anomalous Magnetic Moment; Infrared Divergence; Lamb shift.	9
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Michio K, Quantum Field Theory: A Modern Introduction, Oxford University Press.	**1993**
2.	Claude I and Jean B. Z., "Quantum Field Theory, McGraw Hill College Div.	**2006**
3.	Lewis H R, "Quantum Field Theory", Cambridge University Press	**2001**
4.	Michael E. P, "An Introduction to Quantum Field Theory, Perseus Books Publishing	**2002**
5.	Lahiri A, Pal P B., A First Book of Quantum Field Theory, Narosa Publishing House	**2005**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

Subject Code: **PHN-620** Course Title: **Advanced Quantum Field Theory**

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: **PH-619, PH-505**

9. Objective: The main objective of this course is to prepare the student in terms of techniques extremely useful in a variety of areas in theoretical physics

10. Details of Course:

S.No.	Particulars	Contact Hours
1.	**Path Integrals:** (a) Nonrelativistic QM: Multi-dimensional path integral, time-ordered product, n-point functions, generating functional (b) Field Theory: Generating functional and Green's function, Generating functional for interacting fields, 1 PI graphs, Effective actions, Path integrals for scalar quantum fields, Path integrals for fermion fields	6 8
2.	Non-abelian gauge theories, canonical quantization, path integral quantization and Fadeev-Popov ghost fields, BRST invariance	10
3.	Supersymmetry, superspace formalism: supersymmetry and supersymmetric actions, superspace formalism, supersymmetric Feynman rules, Nonrenormalization theorems, N=1 Supergravity.	10
4.	Conformal field theory: Operator product expansion, Ward identities, Noether's theorem, conformal invariance, free CFT's, Virasaro algebra, vertex operators, operator-state correspondence.	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Books/Authors	Year of Publication/Re print
1.	W. Greiner, J. Reinhardt and D.A.Bromley, "Field Quantization", Springer, 2nd edition	**1997**
2.	Ashok Das, "Lectures on Quantum Field Theory", World Scientific	**2008**
3.	H.J.W.Muller- Kirsten, A. Wiedemann and H. Muller-Kirsten "Supersymmetry: An Introduction with Conceptual and Calculational Details", World Scientific Publishing Co Pte Ltd	**1987**
4.	J.Polchinnksi, "String Theory" (Cambridge Monographs on Mathematical Physics) (Volume 1),	**1998**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-621** Course Title: **Astrophysics**

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: **Autumn** 7. Subject Area: **PEC**\

8. Pre-requisite: **PH-503 and PH-507**

9. Objective: The course exposes the students to a broad field of astrophysics and cosmology at the introductory level.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Celestial sphere, elliptical orbits, Newtonian mechanics, Kepler's laws, Virial theorem, magnitude scales, color index, stellar parallax, distance measurements, astronomical instruments.	8
2.	**Physics of Sun:**Spectralclassification of stars,structure of the Sun, solar cycle, sun spots, properties and structure of our solar system, extrasolar planets.	6
3.	**Physics of Stars:** Star formation, stellar evolution from pre-main sequence throughthe main sequence,binaries, clusters.Final stages of stellar evolution and stellar remnant:giants, white dwarfs, supernovae, neutron stars, pulsars, blackholes.	10
4.	**Physics of Galaxies:** Galactic structure and classification, our galaxy, active galactic nuclei, quasars, galactic rotation curves and dark matter, galaxy clusters and large-scale structure.	10
5.	**Cosmology:**Big bang cosmology, redshift and expansion of the universe,the cosmic microwave background,physics of the early universe.	8
	Total	42

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication
1.	Carroll B W &Ostlie D A, "An introduction to modern astrophysics", 2nd ed., Pearson Education	2007
2.	Basu B,Tanuka C, &Nath B S, "An introduction to astrophysics", 2nd ed., Prentice Hall of India,	2010
3.	Abhyankar K D, "Astrophysics: Stars and Galaxies", 1st ed., Universities Press (India) Limited.	2000
4.	Shu Frank, "The Physical Universe: An Introduction to Astronomy",1st ed., University Science Books	1982
5.	Padmanabhan T, "Theoretical Astrophysics: vol.1,2,3", Cambridge University Press	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-622** Course Title: **Solar-Terrestrial Physics**

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: **PH-603**

9. Objective: **Aspects of solar interaction with Earth's upper atmosphere**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**The sun and interplanetary space:** The sun as a star, solar atmosphere, solar electromagnetic radiations, variance in the solar spectra, solar wind, solar and interplanetary magnetic field, solar cycle variations, cosmic rays in the interplanetary space, interaction of solar wind and other planets.	6
2.	**The Physics of Geospace:** Properties of gases, Magnetoplasma, Gyrofrequency, plasma frequency, waves, radio wave propagation in ionized medium, waves propagation in plasma, Langmuir wave, ion-acoustic wave, electromagnetic wave in unmagnetized plasma, plasma instabilities.	10
3.	**Dynamo action:** Equations of motion of terrestrial atmosphere, the atmospheric circulation, heating of upper atmosphere, tidal oscillations of the atmosphere, the lunar tide, the solar tides, tides at the ionospheric level, motion of charged particles, conductivities, Layer conductivity	10
4.	**Ionosphere:** Physical aeronomy, chemical aeronomy, formation of D, E, F1 and F2 regions in low and mid latitudes, Ionospheric electric currents, F-region drifts, ion drag effects, storms, geomagnetic indices, irregularities in ionosphere, travelling ionospheric disturbances.	10
5.	**Whistlers:** Whistlers and VLF emissions, Emission theories, dispersion relation for whistler mode wave, growth rate calculation, nonlinear effects, quasilinear theory, diffusion into loss cone.	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Seeds M.A., "Solar System", Brooks/Cole Thomson Learning	2007
2.	A. C. Das, "Space Plasma Physics", Narosa Publishing House.	2004
3.	J. K. Hargreaves, "The solar-terrestrial environment", Cambridge Atmospheric and Space Science Series.	2003
4.	Syun-Ichi Akasofu, Sydney Chapman, Solar-Terrestrial Physics, Oxford Press	1972
5.	M.C. Kelley, "The Earth's Ionosphere", Academic Press	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-623** Course Title: **General Relativity**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-505**

9. Objective: To introduce the basics of non-Euclidean Geometry and Einstein's theory of general relativity and its applications.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Inertial mass and gravitational mass, gravitational redshift, action in relativity	3
2.	Principle of equivalence, metric tensor and the affine connection, geodesics.	5
3.	Covariant differentiation, analogy with electromagnetism, p-forms, generalized Stokes theorem.	5
4.	Curvature tensor, parallel transport, algebraic properties of the curvature tensor, Bianchi identities.	7
5	Lorentz transformation, representation of Lorentz group, conserved currents and energy momentum tensor	5
6	Einstein's field equations and some of their solutions: Robertson-Walker metric, Schwarzschild metric, black holes, deflection of light by Sun, precession of perihelia of planets. Expanding universe	8
7.	Expanding universe, Tetrad formalism, Killing vectors, maximally symmetric spaces.	5
8.	Kaluza-Klein theories an approach towards unification of, e.g., electromagnetism and gravity.	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Landau L D and Lifshitz E M, "The Classical Theory of Fields", 4th Ed. Elsevier.	2005
2.	Weinberg S, "Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity", Wiley	1972
3.	Kaku M, "Quantum Field Theory: A Modern Introduction", Oxford University Press.	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-624** Course Title: **Computational Nuclear Physics**

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: **PH-607**

9. Objective: To understand the concepts of nuclear physics through numerical solutions obtained by writing computer programs

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Harmonic oscillator, wave functions, evaluation of special functions using recurrence relations and optimization, spherical harmonics, shapes of atomic orbitals, Coupling of angular momenta.	**5**
2.	Simulation of Rutherford scattering, Semi empirical mass formula, estimation of the constants in mass formulae using atomic mass evaluations, mapping of drip lines. Quantum tunneling: application of WKB approach to alpha and proton decays.	**5**
3.	Numerical evaluation of Eigen states for different potentials by solving coupled differential equations with boundary conditions, harmonic oscillator, square-well and Woods-Saxon potentials. Complex Eigen values and resonances	**5**
4.	Independent particle models, Eigen states, Solutions for Nilsson model. Single-j shell approximation and Cranking model. Effective interaction: Simple estimates, Evaluation of matrix elements in sd shell. Superconductivity: Solution for BCS equations at $T = 0$. Hot nuclei: Application of Fermi-Dirac distribution. Quantum Hadrodynamics: Walecka model, Equation of State for symmetric, asymmetric and neutron star matter	**10**
5.	Setting up large codes, parallel and distributed computing, open access codes, libraries	**3**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books/Authors	Year of Publication
1.	Greiner W and Maruhn J A, "Nuclear models", Springer-Verlag	**1997**
2.	Arfken G B, Weber H J and Harris F E, "Mathematical Methods for Physicists 7ed", Academic Press	**2013**
3.	Abramowitz M and Stegun I A, "Handbook of mathematical functions with formulas, graphs and mathematical tables", Dover Publications	**1972**
4.	Giordano N and Nakanishi H "Computational Physics, 2ed", Pearson/Prentice Hall	**2006**
5.	Pang T, "An Introduction to Computational Physics", Cambridge Univ. Press	**2006**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-625** Course Title: **Particle Physics**
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: **Autumn** 7. Subject Area: **PEC**
8. Pre-requisite: **PH-518**
9. Objective: To introduce the basics of elementary particle physics.
10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Qualitative preview**: A preview of particle physics, basic ideas of the four interactions – gravitational, electromagnetic, strong and weak.	2
2.	**Tools** (i) **Tensors:** Definitions of contravariant, covariant and mixed tensors, need to use tensors in relativistic quantum mechanics and particle physics; (ii) **Relativistic Kinematics**: Lorentz transformations, 4-Vectors, energy and momentum, collisions; (iii) **Scattering**: Lifetimes and Cross Sections, Fermi's Golden Rule, Feynman Rules, evaluation of scattering amplitudes and cross sections using Feynman Rules.	8
3.	**Symmetries**: Symmetries, Groups and Conservation Laws; Spin and Orbital Angular Momentum, Addition of Angular Momentum; Flavor symmetries; Parity; Charge Conjugation; CP violation; Time reversal symmetry; CPT Theorem; Noether's Theorem: Symmetry and conservation laws.	6
4.	**Electromagnetic Interaction**: (i) **Gauge Field Theory**: Covariant formulation of Maxwell's equations, (transverse) canonical quantization of the gauge field (in the Coulomb gauge); (ii) **QED** (quantization of abelian gauge theories with fermions): Feynman Rules, Compton effect, Møller Scattering, radiative corrections, Anomalous Magnetic Moment, Lamb shift.	8
5.	**Strong Interaction**: (i) **Pre-QCD**: The structure of Hadrons, Probing a charge distribution with electrons: Inelastic electron -proton scattering, Partons and Bjorken scaling;	8

	(ii) **QCD** (quantization of non-abelian gauge theories with fermions): Yang-Mills theory, Parton model revisited, Feynman rules, Asymptotic freedom.	
6.	**Weak Interaction**: (i) **Phenomenology**: Parity violation and the V-A form of the weak current, Muon decay, Pion decay, charged current, neutral currents, Cabibbo angle, weak mixing angle, CP Invariance, CP violation; (ii) **Electroweak Unification (Glashow-Salam-Weinberg model)**: The basic electroweak interaction, effective current-current Interaction, Spontaneous symmetry breaking, Higgs mechanism and choice of the Higgs field, masses of gauge bosons and fermions, the complete Lagrangian.	10
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1	Halzen F and Martin A D, "Quarks and Leptons: Introductory Course in Modern Particle Physics", John Wiley and Sons, Inc	1990
2	Griffiths D, "Introduction to Elementary Particles", John Wiley and Sons Inc.	1987
3	Perkins D H, "Introduction to High Energy Physics", Cambridge University Press	2000
4	Georgi H, "Weak Interactions and Modern Particle Theory", Benjamin-Cummings Pub Co	1984
5	Kane G L and Kane G, "Modern Elementary Particle Physics", Westview Press	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-627** Course Title: **Quantum Theory of Solids**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-504 and PH-508**

9. Objective: To provide deeper understanding of cooperative phenomenon in solids using the many body technique.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Many Body Techniques and the Electron Gas:** Creation and annihilation operators, many particle wave function in occupation number representation, commutation relations, N-electron Hamiltonian in creation- annihilation operators form; One electron and two-electron, parts. Hartree-Fock ground state energy, free electron gas; Ground State energy in Ist order. Elementary idea of Greens functions.	12
2.	**Plasma Oscillations in Free Electron Gas:** Resume of plasma theory, quantum mechanical plasma theory, Energy of the ground state; Correlation Energy; Short range and long range correlation energy.	10
3.	**Magnetism:** Magnetism in Insulators; Heisenberg model; Spin waves; quantization of spin waves; Acoustic and optical magnons; Magnon specific heat; Antiferromagnitic Magnons; Magnetism in metals; Itinerant Ferromagnetism.	10
4.	**Superconductivity:** Electron-phonon interactions; Bound electron-pairs in a Fermi gas; Superconducting ground state; Hamiltonian solution of BCS equation for the energy-gas; Electrodynamics of superconductors, coherence length.	10
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication /Reprint
1.	Raimes S, "Many Electron Systems", North Holland Publishing Co.	2000
2.	Kittel C, "Quantum Theory of Solids", John Wiley and Sons	1987
3.	Ziamn J M, "Principles of Theory of Solids", Cambridge Univ. Press	2000

4.	Chaikin P M and Lubensky T C, "Principles of Condensed Matter", Cambridge Univ. Press	2000
5.	Kantorovich L, "Quantum Theory of the Solid State:An Introduction", Kluwer Academic Publishers	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-629** Course Title: **Weather Forecasting**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **None**

9. Objective: To familiarize with the dynamic meteorology of earth's atmosphere

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Atmospheric Dynamics:** Equation of motion, the geostrophic approximation, cyclostrophic motion; The thermal wind equation; The equation of continuity.	8
2.	**The General Circulation:** A symmetric circulation, Inertial instability, Barotropic instability; Baroclinic instability; Sloping convection; The general circulation of the middle atmosphere.	8
3.	**Numerical Modelling of Weather:** A barotropic model; Baroclinic models; Primitive equation models; Moist processes; Radiation transfer; Forecasting models.	10
4.	**Global Observations:** Conventional observations; Remote sounding from satellites; Remote sounding of atmospheric temperature; Remote measurements of composition.	8
5.	**Atmospheric Predictability and Climate change:** Short term predictability; Variations of climate; Atmospheric feedback processes; Different kind of predictability	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Houghton J T, "The physics of atmospheres", Cambridge University Press	**1997**
2.	Holton J R, "Introduction to dynamic meteorology", Academic Press,	**1992**
3.	Zdunkowski W and Boot A, "Dynamics of the Atmosphere", Cambridge University Press,	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-631** Course Title: **Nuclear Instrumentation**

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: **03** 6. Semester: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To provide comprehensive knowledge on instrumentation related to nuclear physics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Radioactive decay, Source of charged and uncharged radiation, Interaction of radiation with matter: heavy charged particle, electron, gamma-rays and neutrons, stopping power, Bragg curve, Radiation exposure, absorbed dose, equivalent dose, Counting statistics, Error analysis	9
2.	Properties of radiation detectors: operation mode, pulse height spectra, energy resolution, detection efficiency and dead time. Ionization chambers, Proportional counters, Geiger Mueller counters Scintillation detectors: Inorganic and Organic scintillators, photomultiplier tube, Response of scintillation detectors to gamma-rays and neutrons. Application of scintillation detectors	11
3.	Semiconductor diode detector and its use in alpha spectrometry, fission fragment spectroscopy, particle identification, X-ray spectroscopy. Gamma spectroscopy with Silicon(Si(Li)) and Germanium (Ge(Li), HPGe) detectors, Fast and slow neutron detection Pulse processing electronics: NIM: Amplifier, SCA, CFD, CAMAC: ADC, TDC, Timing and coincidence measurements.	12
4.	Linear and circular accelerators, Nuclear reactor: neutron source and power generator. Applications in tracing, material modification, sterilization, material modification; neutron activation analysis, medicine: CT, PET, SPECT, MRI, therapy	10
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	Glenn F. Knoll, "**Radiation Detection and Measurement" 4th Ed.**	**2010**
2.	W.R. Leo, "**Techniques for Nuclear and Particle Physics experiments**", Springer-Verlag	**1994**
3.	S Ahmed, **"Physics and Engineering of Radiation Detection"** Academic press	**2007**
4.	S.S. Kapoor, V. Ramamurthy, "**Nuclear Radiation Detectors**" New Age International (P) Ltd.	**2005**
5.	John R. Lamarsh, Anthony J. Baratta, "**Introduction To Nuclear Engineering"**, Prentice Hall.	**2011**
6.	Gordon R. Gilmore, "**Practical Gamma-ray Spectrometry**", John Wiley & Sons (2nd Ed.)	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-633** Course Title: **Physics and Technology of Thin Films**

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: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize students with basic understanding of science and technology of thin films and their potential device applications.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Vacuum Technology:** Role of Thin films in Technology and Devices; Introduction to Vacuum, Gas impingement on surfaces, Gas transport and pumping, Vacuum Pumps: Rotary pump, Diffusion Pump, Turbomolecular and Cryopumps.Vacuum systems, Vacuum gauges: Pirani gauge, Pennning gauge.	10
2.	**Thin Film Deposition:** PVD & CVD, Evaporation: Thermal & Electron beam evaporation , Glow discharge and plasmas-Plasma structure, Sputtering processes-Mechanism and sputtering yield, DC, RF & Reactive Sputtering, Pulsed laser deposition, Molecular beam epitaxy, Atomic layer deposition, CVD film growth, Thermal CVD Processes: Atmospheric Pressure CVD, Low Pressure CVD, Metalorganic CVD, Plasma enhanced CVD	12
3.	**Nucleation & Growth Kinetics**: Adsorption, Surface diffusion, Film growth modes, models for 3D and 2D nucleation, coalescence and depletion, grain structure and microstructure and its dependence on deposition parameters. Role of energy enhancement in nucleation; Characterization methods: XRD, SEM, AES, STM & thickness measurement. Epitaxy, homo- and hetero-epitaxy, lattice misfit and imperfections, superlattice structures	12
4.	**Applications & Emerging Technologies:** Semiconductor thin films for Micro and Nanoelectronics, Superconducting thin films for Josephson devices, Magnetic Multilayers for GMR & Spintronics, Quantum Well devices, Thin film solar cells, Sensor & Actuators.	08
	Total	**42**

11. Suggested Books:

Sl. No.	Authors/Name of Books/ Publisher	Year of Publications/ Reprint
1	J.L. Vassen, W. Kem, Thin Film Process, Academic Press	1990
2	R.K. Waits, Thin film deposition and patterning, American Vacuum Society	1998
3	J.A. Venables, Introduction to Surface and thin film processes, Academic Press	2000
4	M. Ohring, Materials science of thin films, Academic Press	2006
5	W.R. Fahrner, Nanotechnology and Nanoelectronics, Springer	2005
6	Thin Film Phenomena by K. L. Chopra, McGraw Hill	1979
7	H. Luth, Solid Surfaces, Interfaces and Thin Films, Springer	2010
8	V. Agranovich, Thin Films & Nanostructures, Elsevier	2012
9	G.Decher, J.B.Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag GmbH & Co. KGaA	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-635** Course Title: **Advanced Nuclear Reactions**
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: - **Autumn** 7. Subject Area: - **PEC**
8. Pre-requisite: **Nil**
9. Objective: The course is designed to provide the advance knowledge of nuclear reactions and its applications.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Formal Scattering theory: introduction, Lipmann-Schwinger equation, operator algebra, Born series, Analytic properties of the S-matrix: Jost-function, Analytic continuation in the complex plane, bound states, resonances, Kinematics (non relativistic) of two- and three bodies, 2 body and 3-body phase space of scattering processes	8
2.	Direct reaction theory: Two-potential formula, DWBA, various applications: rearrangement reactions, inelastic scattering, breakup reactions: post, prior and alternate prior form. Various models of breakup reactions, Coupled channel formalism, Introduction to transfer reactions: angular momentum transfer and single particle structure information, Introduction to the theory of Coulomb excitation.	10
3.	Intermediate energy collisions: Relativistic Kinematics: Use of invariants in calculations of energy momentum and velocity relations among various frame of references, Transformation of differential cross sections, variables and coordinates systems of elastic scattering (s-, u- and t-channel variables), Eikonal approximation, Coulomb corrected eikonal approximation	8
4.	Compound reaction theory: Compound reaction formation, R-matrix, Compound nucleus decay, Reciprocity theorem, Hauser-Feshbach theory	6
5.	Nuclear physics at the extremes of stability: weakly bound quantum systems and exotic nuclei, nuclear halos, neutron skins, proton rich nuclei, Radioactive ion beams as a new experimental technique, ISOL and in-flight fragment separation	7
4.	Nuclei in the Cosmos: thermonuclear cross sections and nuclear reaction rates in non-degenerate stars, Gamow peak, nuclear burning stages in stars.	3
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Bertulani, C.A. and Danielewicz, P, "Introduction to Nuclear reactions", Institute of Physics Publishing	2004
2.	Glendenning, N.K., Direct Nuclear Reactions, World-Scientific	2004
3.	Thompson, I.J., Nunes F.M., "Nuclear Reactions for Astrophysics", Cambridge	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-637** Course Title: **Semiconductor Photonics**

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: **Autumn** 7.Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: The course is aimed at introducing to students the concepts of semiconductor photonic devices and various devices based on these.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Interaction of photons with atoms, spontaneous emission, stimulated emission and absorption, semiconductors, energy bands and charge carriers, semiconductor materials, elemental, binary, ternary and quaternary semiconductors, interaction of photons with semiconductors, generation, recombination and injection processes, junctions, hetrojunctions, quantum wells, superlattices, interaction of photons with electrons and holes, band-to-band absotption and emission, rates of absorption and emission, refractive index.	8
2.	Light emitting diode (LED), operation of LED, carrier injection and spontaneous emission, internal quantum efficiency, external quantum efficiency, P-I characteristics, slope efficiency, output spectrum, radiation pattern, temperature dependence, modulation of LED, temporal response, advanced LED structures, heterojunction LED, edge and surface emitting LEDs, applications of LEDs as light sources, displays, and in communication.	10
3.	Semiconductor optical amplifier (SOA), basic configuration , stimulated emission in a semiconductor, optical gain, effect of optical reflections, limitations of SOA	3
4.	Laser diode (LD), semiconductor laser basics, optical gain in forward biased p-n junction, laser oscillations and threshold current, P-I characteristics, slope efficiency, differential external quantum efficiency, temperature dependence, output spectrum, longitudinal modes, single frequency operation, DFB laser, DBR laser, radiation pattern, modulation, heterojunction LD, quantum well laser	7
5.	Properties of semiconductor photodetectors, quantum efficiency, responsivity, response time, photoconductors, photodiodes, p-n	7

	photodiode, p-i-n photodiode, hetrostructure photodiodes, array detectors, avalanche photodiodes, noise in photodetectors.	
6.	Solar photovoltaic, solar energy spectrum, photovoltaic device principle, p-n junction photovoltaic, I-V characteristics, series resistance and equivalent circuit, temperature effects, solar cell materials, devices and efficiencies.	7
	Total	42

11. Suggested Books:

S. No.	Authors/Name of Books/Publisher	Year of Publication
1.	Saleh B E A and Teich M C, "**Fundamentals of Photonics**", John Wiley & Sons, Inc.	**1991**
2.	Jaspreet Singh, " **Optoelectronics: An Introduction to Materials and Devices**". McGraw Hill International Edition	**1996**
3.	Safa O. Kasap, "**Optoelectronics and Photonics**", Pearson.	**2009**
4.	Streetman B G and Banerjee S K, **"Solid State Electronic Devices,"** Pearson Prentice Hall	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-639** Course Title: **Advanced Atomic and Molecular Physics**

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** 7. Subject Area: **PEC**

8. Pre-requisite: **PH-503, PH-516**

9. Objective: To introduce the mean-field methods necessary for studying the physics of many electron systems, to study interaction of atoms with electromagnetic radiation, molecular spectroscopy and the applications of group theory.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Many-electron Atoms :** The central field approximation, Thomas-Fermi potential, Hartree- and Hartree-Fock approximation, self-consistent field procedure, Dirac-Hartree-Fock method, Breit interaction, electron correlation effects, basic concepts of post-mean field methods, Qualitative ideas of density functional theory.	**12**
2.	**Interaction of atoms with radiation :** Transition rates, Einstein coefficients, electric dipole (E1) approximation, E1 selection rules, oscillator strengths, line intensities, line shapes and line widths; retardation effects, magnetic dipole and electric quadrupole transitions, lifetimes of excited states; photoelectric effect, Bremsstrahlung.	**08**
3.	**Molecular rotations and vibrations:** Spectroscopic transitions, rotational spectra of molecules, rotational selection rules; vibrational spectra of diatomic molecules, vibrational selection rules, vibration-rotation spectra of diatomic molecules.	**08**
4.	**Molecular electronic transitions :** Vibronic transitions, Franck-Condon principle, rotational structure of vibronic transitions, Fortrat diagram, dissociation energy of molecules, continuous spectra, Raman transitions and Raman spectra.	**08**

5.	**Molecular Symmetry and Symmetry Groups :** Symmetry elements and symmetry operations, symmetry classification of molecules, point groups; reducible and irreducible representations; character tables for point groups; normal modes of molecular vibrations; applications of group theory to molecular vibrations.	**06**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Bransden B. H. and Joachain C. J., "Physics of Atoms and Molecules", 2nd edition, Pearson Education	2004
2.	Atkins P. and Friedman R., "Molecular Quantum Mechanics", 5th edition, Oxford University Press	2011
3.	Haken H and Wolf H. C., "Molecular Physics and Elements of Quantum Chemistry", 2nd edition Springer-Verlag	2004
4.	Hollas J. M., "Modern Spectoscopy", 4th edition, Wiley	2004
5.	Atkins P. and Paula J. D., "Physical Chemistry", 9th edition, Oxford University Press	2010
6.	Cotton F. A., "Chemical Applications of Group Theory", 3rd edition, Wiley 1990	1990

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-701** Course Title: **Laboratory Work**

2. Contact Hours: **L: 0** **T: 0** **P: 6**

3. Examination Duration (Hrs.): **Theory : 0** **Practical : 6**

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

5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart practical knowledge in Solid Sate Electronic Materials

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Study of variation of resistivity with temperature of metal and highly resistive materials by Four Probe Technique.	14 x 6
2.	Mapping and analysis of the resistivity of large samples (thin films, superconductors) by Four probe Technique.	
3.	To study the temperature dependence of Hall coefficient of n- and p-type semiconductors.	
4.	(a) To measure the dielectric constant and Curie temperature of given ferroelectric samples. (b) To measure the coercive field (E_c), remanent polarization (P_r), Curie temperature (T_c) and spontaneous polarization (P_s) of Barium Titanate ($BaTiO_3$).	
5.	Thermoluminescence in alkali halides crystals. (a) To produce F centers in the crystal exposing to X-ray /UV source. (b) To determine activation energy of the F-centers by initial rise method.	
6.	Verification of Bragg's law and determination of wavelength/energy spectrum of X-rays.	
7.	Study of solar cell characteristics and to determine open circuit voltage 'V_{oc}' , short circuit current 'I_{sc}', Efficiency (η), fill factor, spectral characteristics and chopper characteristics.	
8.	To measure the magnetoresistance of semiconductor and analyze the plots of $\Delta R/R$ and log-log plot of $\Delta R/R$ Vs magnetic field.	
9.	To determine the coercivity, saturation magnetization and retentivity of ferromagnetic samples using magnetic hysteresis loop tracer	
10.	To study the temperature dependence of Laser diode characteristics	
11.	To determine transition temperature of given superconducting material and study Meissner effect.	
12.	To measure critical current density of given superconductor and study its field dependence.	
13	To determine the value of Lande's 'g' factor using ESR spectrometer.	
14	To study C-V characteristics of various solid state devices and materials (like p-n junctions and ferroelectric capacitors).	
	Total	**84**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication/Reprint
1.	Melissinos, A.C. and Napolitano, J., "Experiments in Modern Physics", Academic Press.	**2003**
2.	Sze, S.M., "Semiconductor Devices Physics and Technology", John Wiley and Sons.	**2002**
3.	Nakra, B.C. and Chaudhary, K.K., "Instrumentation Measurements and Analysis", Tata McGraw Hill.	**2002**
4.	Sayer, M. and Mansingh, A., "Measurement, Instrumentation and Experiment Design in Physics and Engineering", Prentice Hall.	**2000**
5.	Runyan, W.R., "Semiconductor Measurements and Instrumentation", McGraw Hill	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-702** Course Title: **Nanomaterials and Technology**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **NIL**

9. Objective: To impart knowledge of nanomaterials and technology

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Physics of Low-dimensional Materials:** An overview of quantum mechanical concepts related to low dimensional systems, classifications of quantum confined systems, electrons and holes in quantum wells, electronic wave functions, energy sub-bands and density of electronic states in quantum wells, quantum wires and quantum dots	10
2.	**Synthesis and Characterization of Nanomaterials:** various top down and bottom up approaches for synthesis of nanomaterials, overview of thin film technology for nanotechnology applications, physical vapour deposition and chemical vapour deposition techniques, synthesis of zero, one dimensional and two dimensional nano structures, characterization of nano materials using XRD, AFM, STM, FESEM and SQUID	12
3.	**Properties of Nano Materials:** Phenomena and properties at nanoscale, mechanical/frictional, optical, electrical and magnetic properties	08
4.	**Nanofabrication and Device Applications**: Miniaturization of electrical and electronic devices, Moore's law, nanofabrication using lithography techniques- electron beam lithography, X-ray lithography, soft nanolithography and dip pen nanolithography; electronic devices based on nanostructures, single electron transistor, future of silicon computer technology, heat dissipation and Rapid Single Flux Quantum (RSFQ) technology, quantum dot lasers, superconducting Josephson junctions, energy storage and fuel cells	12
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Edelstein A. A. and Cammarata R .C., "Nanomaterials-Synthesis, Properties and Applications", Institute of Physics Publishing, London	**1998**
2.	Nalwa H.S., "Handbook of Nanostructured Materials and Nanotechnology", Vols. 1-5, Academic Press	**2000**
3.	Benedek G., Milani P. and Ralchenko V. G., "Nanostructured Carbon for advanced Applications", Kluwer Academic Publishers	**2001**
4.	Dresselhaus M.S., Dresselhaus G. and Eklund P., "Science of Fullerenes and Nanotubes", Academic Press	**1996**
5.	Wilson M, Kannangawa K, Smith G, Simmons M and Raguse B., "Nanotechnology: Basic Science and Emerging Technologies", Chapman and Hall	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-703** Course Title: **Semiconductor Materials and Devices**

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** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize with semiconducting materials and devices

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Fundamentals of Semiconductors: Energy bands, direct and indirect band gap semiconductors, concept of density of states and Fermi-level, carrier concentrations at equilibrium, Temperature dependence of carrier concentrations, conductivity and mobility, Effects of temperature and doping on mobility, excess carriers, recombination mechanisms, carrier lifetime, steady state carrier generation, concept of quasi-Fermi level, drift and diffusion of carriers, Einstein relation, Continuity equation, Solution of diffusion equation for steady state carrier injection, diffusion length, Haynes-Shockley experiment.	10
2.	Junctions: Homo p-n junctions at equilibrium, forward and reverse biased p-n junction, Carrier injection across p-n junction under forward bias; Derivation of ideal p-n diode current equation; reverse saturation current, Real p-n diode V-I characteristics, Reverse breakdown, capacitances in p-n diode; Hetero p-n junctions, metal-semiconductor contacts. Bipolar Junction Transistors: Minority carrier distributions and terminal currents, Ebers – Moll equations and charge-control analysis. Heterojunction Bipolar Transistors.	12
3.	Field Effect Transistors: Junction Field Effect Transistor (JFET): Structures of n and p-channel JFET, Pinch-off and saturation, Gate Control, Current Voltage characteristics; Metal-Semiconductor FET (MESFET): GaAs MESFET, High Electron Mobility Transistor (HEMT). Metal Oxide Semiconductor FETS (MOSFETs): Structure and working principle of Enhancement type and depletion type MOSFETs. Ideal MOS diode, inversion layer, threshold voltage, MOS C-V curve, Effects of work function difference and interface charge on threshold voltage, Output and transfer characteristics of enhancement MOSFET, Control of threshold voltage, charge-coupled devices (CCD).	12

4.	Quantum Effect and Hot Electron Devices: Tunnel diode, Resonant tunneling diode (RTD), Unipolar Resonant Tunneling Transistor, Hot electron heterojunction bipolar transistors (HEHBT), Transferred Electron Devices, Gunn diode and its applications.	8
	Total	42

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication/Reprint
1.	Streetman, B.G., Banerjee, S. K. "Solid State Electronic Devices", Sixth Edition, PHI Learning Private Limited.	2013
2.	Sze, S.M., "Semiconductor Devices: Physics and Technology", Second Edition, John Wiley and Sons.	2002
3.	Tyagi, M.S., "Semiconductor Materials and Devices", John Wiley and Sons.	2008
4.	Millman J, Halkias C. C., Satyabrata J, "Electronic Devices & Circuits", Tata McGraw Hill	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-704** Course Title: **Quantum Heterostructures**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **NIL**

9. Objective: To impart knowledge of size-quantization in nanosystems and semiconductor heterostructure quantum devices.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Electrons in Quantum Confined Systems:** Density of states function in quantum wells, quantum wires, quantum dots and super lattices, coupling of quantum wells, Type-I and Type-II heterostructures	10
2.	**Electron Transport in nanostructures:** Parallel and perpendicular transport in quantum structures, linear electron transport, hot electron transport, real space transfer of hot electrons	08
3.	**Quantum Tunneling:** Single and double barrier cases, resonant tunneling, resonant tunnel diode characteristics and mechanisms, resonant tunnel transistors	08
4.	**Heterostructure Devices:** Super lattices and ballistic-injection devices, Block oscillations, Wannier-Stark energy ladder, single electron transfer and Coulomb blockade, velocity modulation interference transistors (vmt)	08
5.	**Quantum Optical Devices:** Quantum well lasers, multiple quantum well lasers, cascade lasers, optical modulators and quantum well photodetectors	08
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Mitin V.V., Kochelap V. A. and Stroscio M. A., "Quantum Heterostructures: Microelectronics and Optoelectronic Devices", Cambridge University Press	**1999**
2.	Ferry D.K. and Goodnick S.M., "Transport in Nanostructures", Cambridge University Press	**1997**
3.	Shik A., "Quantum Wells: Physics and Electronics of Two-Dimensional Systems", World Scientific	**1998**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-705** Course Title: **Characterization of Materials**
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** 7. Subject Area: **PCC**
8. Pre-requisite: **Nil**
9. Objective: To introduce various methods of characterization of materials for their structural, electrical, magnetic and optical properties.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Crystal Structure Determination:** Brief description of crystal lattices; X-ray diffractometer; Determination of crystal structure using X-ray diffraction	12
2.	**Electron Microscopes:** Brief description of different microscopes like TEM, SEM, AFM; Modes of operation of microscopes, sample preparation, Interpretation of electron diffraction and determination of crystal structure; morphology of the crystals.	11
3.	**Thermal Analysis:** Thermogravimetric analysis, Differential thermal analysis and Differential scanning calorimetry and methodology; Determination of phase transitions using these methods.	5
4.	**Electrical and Magnetic Property:** Measurement of electrical conductivity in different materials- insulators, metals and semiconductors using four probe and Hall effect method. Vibrating Sample Magnetometer (VSM), Superconducting Quantum interference Devices (SQUID)	8
5.	**Optical Characterization:** Optical characterization of materials using photoluminescence and UV-visible spectroscopy.	3
6.	**Chemical Analysis:** Brief description to X-ray fluorescence, atomic absorption and electronic spin resonance spectroscopy.	3
	Total	42

11. Suggested Books.

S. No.	Name of Authors/Book/Publisher	Year of Publication/Reprint
1.	Culity, B. D., "Elements of X-ray Diffraction", Addison-Wesley.	2001
2.	Grundy, P. J. and Jones, G. A., "Electron Microscopy in the Study of Materials", Edward Arnold.	1976
3.	Egerton, R. F., "Physical Principles of Electron Microscopy", Springer.	2008
4.	Willard, H. H., Merritt, L. L. and Dean, J. A., "Instrumental Methods of Analysis", CBS publications.	1991
5.	Fultz, B. and Howe, J. M., "Transmission Electron Microscopy and Diffractometry of Materials", Springer.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-706** Course Title: **Functional Materials and Devices**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **NIL**

9. Objective: To impart knowledge of functional materials and devices

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Scope of functional ceramics, classification according to their different functions, electrical and electronic conduction in ceramics, defect chemistry, ionic conductivity, ceramic electrolytes and fast ion conductors, ceramic insulators; Ceramic Capacitors, piezoelectric, ferroelectric and electro optic ceramics - material systems, processing and fabrication	10
2.	Electroceramic thin film technology, materials and deposition methods, application of thin films in microelectronics and microsystems; Multilayer ceramic technology- processing of multi layer ceramics, sintering of multilayer structure, low temperature co-fired glass ceramics	10
3.	Smart functional role of the materials in devices which depends on their electrical, optical and thermal properties, smart transducers, optical fibers, optical coatings, liquid crystal displays, optical storage devices, ruby laser, solar cell, ceramic insulators, Peltier cooler	8
4.	Ceramic sensors and resistors- classification, operating principles of different sensors, preparation and applications; Positive and negative temperature coefficient ceramic thermistors, gas, humidity and pressure sensors, ZnO-varistors technology, varistor microstructure and fabrication, Varistor application	7
5.	Ceramic membranes- classifications, material requirements, preparation and applications, special glass and glass ceramics for defence applications	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Buchanan R. C., "Ceramic Materials for Electronics", 3rd Ed, Marcel Dekker, NY	**2004**
2.	Moulson A. J. and Herbert J. M., "Electroceramics: Materials, Properties and Applications", Wiley; 2nd Ed.	**2003**
3.	Bachs H. and Krause D., "Low Thermal Expansion Glass Ceramics", Springer	**2005**
4.	Setter N., "Electroceramic based MEMS: Fabrication Technology and Applications", Springer	**2005**
5.	Nenov T. G., Yordanov S. P. and Nenov N., "Ceramic Sensors: Technology and Applications", CRC Press	**1996**
6.	Wang Z. L., Wang W. Z. L. and Kang Z. C., "Functional and Smart Material", Springer	**1998**
7.	Jaffe B., Cook W. R., Jaffe H. and Jaffe H. L. C., "Piezoelectric Ceramics", R.A.N Publishers	**1990**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PH-707** Course Title: **Computational Techniques and Programming**

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

3. Examination Duration (Hrs.): **Theory : 2** **Practical : 2**

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

5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To provide the knowledge of computation with suitable mathematical software. and its applications to solve the problems of condensed matter physics

10. Details of Course

S. No.	Contents	Contact Hours
1.	**Introduction to mathematical software/language:** Concept of programming in FORTRAN/Matlab/Mathematica, input/output, interactive input, loading and saving data, loops, branches and control flow, matrix and array operations, eigenvalues and eigenvectors.	6
2.	**Sub programs:** Array of dimensional variables, subroutines, sub-programming, functions sub-programming, Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules.	5
3.	**Graphics:** 2D plots, style options, axis control, overlay plots, subplot, histogram, 3D plots, mesh and surface plots, contour plots.	4
4.	**Numerical computation:** Computer programs for: solving linear system of simultaneous equations, nonlinear algebraic equation, roots of polynomials, curve fitting, polynomial curve fitting, least square curve fitting, interpolation, data analysis and statistics. Numerical integration, Quadrature, Monte-Carlo simulation, ordinary differential equation, first order and second order ODEs, partial differential equation methods (the finite difference method & the finite element method).	13
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication/Reprint
1.	Pratap, R., "Getting started with MATLAB 7", Oxford University Press.	2006
2.	Gilat, A., "Matlab: An Introduction with Applications", Wiley.	2008
3.	Tao, P., "Computational Physics", Cambridge University Press.	2005
4.	David, P., "Computational Physics", John Wiley & Sons	1973
5.	Wolfram, S., "The Mathematica Book," 5th Ed., Wolfram Media	2003
6.	Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 7th Ed, Addison Wesley	2003

S. No.	List of Experiments
1.	Eigen-value problem: 1-D square potential well
2.	Stochastic methods for multidimensional integrals
3.	Study of systems with chaotic dynamics
4.	Solving Kronig-Penny Model
5.	Study of doping profile in semiconductors
6.	Variation of dielectric constant for composite materials
7.	Calculation of modes of an optical waveguide
8.	Monte-Carlo simulations (Ising Model of magnetism)
9.	Molecular Dynamics Simulations

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-708** Course Title: **Solar Photovoltaics**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To learn the fundamentals, design and application of solar photovoltaic systems for power generation on small and large scale electrification.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Semiconductor Physics:** Electrons and holes in semiconductors, doping, electrical transport, Photo carrier generation and recombination; p-n and p-i-n Junctions; metal semiconductor contacts, band bending, Ohmic and rectifying contacts, Surface and interface states, homo and hetero-junctions; Depletion region, depletion capacitance, Carrier and current densities, Current voltage characteristics in dark and light	9
2.	**Device Physics of Solar Cells:** Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Semiconductor properties, energy levels, basic equations. Solar cell, p-n junction, structure. Solar radiation, conversion efficiency, p-n junction model, Effect of Parasitic resistance, irradiation and temperature on I-V characteristics. Numerical solar cell modeling	9
3.	**Principle of cell design:** Cell type, Optical design, surface and bulk recombination losess, design and fabrication of metal contacts, Crystalline Silicon and III-V Solar cells: Single, tandem and multi-junction solar cells, Thin Film Solar cells: Amorphous silicon, cadmium telluride and copper indium gallium diselenide based solar cells	9
4.	**Photovoltaic System Engineering:** Thermo-photovoltaic generation of electricity, Concentration and storage of electrical energy, photovoltaic modules, system and application	5

5.	**NANOMATERIALS FOR PHOTOVOLTAICS** Photochemical solar cells, PV panels with nanostructures. Phase compositions on nanoscale microstructures – role of nanostructures and materials – nanomaterials in solar photovoltaic technology- band gap engineering and optical engineering - tandem structures - quantum well and quantum dot solar cells - photo-thermal cells – organic solar cells. Performance and reliability of nanomaterials based solar cells.	10
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication/ Reprint
1.	Jasprit Singh, "Semiconductor Devices, Basic Principles", Wiley	**2001**
2.	Jenny Nelson, "The Physics of Solar Cells", Imperial College Press	**2003**
3.	Stephen J. Fonash , "Solar Cell Device Physics", 2nd edition, Academic Press	**2010**
4.	A. Luque and S. Hegedus, "Handbook of Photovoltaic Science & Engineering", Wiley	**2003**
5.	Tsakalakos.L., "Nanotechnology for Photovoltaic's", CRC	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-710** Course Title: **Advanced Ceramics & 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** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: The course is aimed to impart basic understanding about ceramics, fibres and composites with their properties, manufacturing routes and applications.

10. Details of Course

S.No.	Contents	Contact Hours
1.	INTRODUCTION: oxide and non-oxide ceramics, their chemical formulae, crystal and defect structures, non-stoichiometry and typical properties.	4
2.	POWDER PREPARATION: Physical methods (different techniques of grinding), chemical routes - co-precipitation, sol-gel, hydrothermal, combustion synthesis, high temperature reaction (solid state reaction).	5
3.	BASIC PRINCIPLES AND TECHNIQUES OF CONSOLIDATION AND SHAPING OF CERAMICS: powder pressing- uniaxial, biaxial and cold isostatic and hot isostatic, injection moulding, slip casting, tape-casting, calendaring, multilayering. Sintering: different mechanisms and development of microstructure (including microwave sintering) Preparation of single crystal, thick and thin film ceramics	5
4.	EXOTIC CERAMICS: functionally graded, smart/ Intelligent, bio-mimetic and nano- ceramics - basic principles, preparation and applications	6
5.	COMPOSITES: Introduction to composite materials – definition, characteristics, classification; Matrix Materials – polymers, metals and ceramics; Fabrication of thermosetting resin matrix composites, thermoplastic resin matrix composites, metal matrix composites, ceramic matrix composites, carbon – carbon composites, their preparation and properties (including nano-composites); Engineering applications: at room and high temperatures (including armour application)	8
6.	Transparent ceramics, coatings and films: preparation and	3

	applications	
7.	SPACE CERAMICS: Materials aspects of missile and satellite reentry, auxiliary space powder devices- rocket nozzle technology- the space environment and its effects. Quantitative analysis of texture, nature of grain boundaries, development of microstructure, grain growth, microstructure in glass ceramics, effect of particle size, pressure and sintering, dependence of mechanical and thermal properties on microstructure.	**6**
8.	CERAMIC FIBRES Introduction – difference between material in bulk form and fibre form, types of fibres, fibre flexibility, fibre manufacturing technology, glass fibres: manufacture & applications, carbon and graphite fibres, grades of carbon fibres.	**5**
	Total	**42**

11. Suggested Books:

S.No	Name of Authors/Book/Publisher	Year of Publication/Reprint
1.	Michel W. Barsoum, M. W., "Fundamental of Ceramics", McGraw Hill International edition	**1997**
2.	Richerson, D.W., " Modern Ceramic Engineering", Mercel Dekker NY	**1992**
3.	Rahman, M. N., "Ceramic Processing and Sintering", Mercel Dekker	**2003**
4.	Somiya, S., "Handbook of Advanced Ceramics", Academic Press	**2003**
5.	Somiya, S., "Handbook of Advanced Ceramics, Parts 1 and 2, Academic Press	**2006**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-712** Course Title: **Optoelectronics**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of photons and semiconductors physics of optoelectronic devices

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Interaction of photons with atoms, spontaneous emission, stimulated emission and absorption, line broadening, the laser amplifier, theory of laser oscillation, characteristics of laser output, characteristics of common lasers	6
2.	Semiconductors- energy bands and charge carriers, binary, ternary and quaternary semiconductors, generation, recombination and injection processes, junctions, hetrojunctions, quantum wells, superlattices, interaction of photons with electrons and holes, band-to-band absorption and emission, rates of absorption and emission, refractive index	8
3.	Light emitting diodes, injection electroluminescence, LED characteristics, semiconductor laser amplifier, gain, pumping, hetrostructures, semicunductor injection lasers, amplification, feedback and oscillation, power, spectral distribution, mode selection, characteristics of typical semiconductor lasers, quantum well lasers	8
4.	Properties of semiconductor photodetectors, quantum efficiency, responsivity, response time, Photoconductors- photodiodes, p-n and p-i-n photodiode, hetrostructure photodiodes, array detectors, avalanche photodiodes, noise in photodetectors	7
5.	Principles of electron optics, Pockels and Kerr effects, electro-optic modulators and switches, scanners, directional couplers, spatial light modulators, electro-optics of anisotropic media and liquid crystals, photorefractive materials	6
6.	Integrated optic planar waveguides, mechanism of light guidance, integrated optic components, directional coupler, optical fiber, step-index, graded-index, single-mode fibers, optical fiber components, fused fiber coupler, fiber Bragg gratings, long-period fiber gratings, sources for optical transmitters, detectors for optical receivers, fiber-optic systems	7
	Total	42

11. Suggested Books:

S. No.	Authors/Name of Books/Publisher	Year of Publication
1.	Saleh B. E. A. and Teich M. C., "Fundamentals of Photonics", John Wiley and Sons, Inc.	1991
2.	Ghatak A. and Thyagarajan K., "Optical Electronics", Cambridge University Press	2003
3.	Yariv A, "Quantum Electronics", 3 Ed., John Wiley and Sons	1988
4.	Streetman B.G. and Banerjee S., "Solid State Electronic Devices", 6 Ed. Prentice Hall	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **DEPARTMENT OF PHYSICS**

1. Subject Code: **PHN-714** Course Title: **Semiconductor Micro-Electronic Technology**

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: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. **Objective:** To impart knowledge of physics of semiconductor devices and their fabrication Technologies

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Crystal Growth and Epitaxy:** Single crystal growth techniques of Silicon and GaAs, epitaxial growth techniques, structures and defects in epitaxial layers, thermal oxidation of silicon including the Deal-Grove model	**10**
2.	**Film Formation:** Vacuum science, vacuum technology and basic physics of a plasma, thermal oxidation of Si, deposition of SiO_2 film by CVD technique	**7**
3.	**Lithography:** Optical and nonoptical lithography, electron beam lithography, X-ray lithography, etching techniques- wet and dry etch processes including reactive ion and high density plasma etching	**8**
4.	**Impurity Doping:** Impurity diffusion in semiconductors, diffusion mechanisms, and rapid thermal processes, diffusion process, diffusion equation, diffusion profiles, evaluation of diffused layers, ion implantation- range of implanted ions, ion distribution, ion stopping, ion channeling, implant damage and annealing	**9**
5.	**Integrated devices:** Fabrication of active and passive components in an integrated circuit, bipolar, MOSFET and MESFET technologies	**8**
	Total	**42**

11. Suggested Books

S. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Sze S.M., "Semiconductor Devices: Physics and Technology", John Wiley and Sons	**2002**
2.	Streetman B.G. and Banerjee S., "Solid State Electronic Devices", 6 Ed. Prentice Hall	**2006**
3.	Gandhi S.K., "VLSI Fabrication Principles", John Wiley and Sons	**1994**
4.	Nagchoudhuri D., "Microelectronic Devices", Pearson	**2001**
5.	Jaeger R. C., "Introduction to Microelectronic Fabrication", 2nd Ed., Prentice Hall	**2001**

Department Elective Courses/Open Elective Courses

Department: Department of Earthquake Engineering

Open Elective Courses

S.No.	Code	Title
1.	IEQ-01	Theory of Vibration
2.	IEQ-02	Engineering Seismology
3.	IEQ-03	Geotechnical Earthquake Engineering
4.	IEQ-04	Vulnerability and Risk Analysis
5.	IEQ-05	Earthquake Resistant Design of Structures

Department: Department of Physics

Open Elective Courses

S.No.	Code	Title
1.	IPH-01	Fundamental of Nanoscience and Technology
2.	IPH-02	Fibre Optics
3.	IPH-03	Superconducting Materials and Devices
4.	IPH-04	Quantum Computing
5.	IPH-05	Reactor Physics

Department: Department of Biotechnology

Department Elective Courses : Category I

S.No.	Code	Title
1.	BTN-441	Biodiversity, Bioprospecting and Organic-farming
2.	BTN-442	Molecular Biophysics
3.	BTN-443	Gene Regulation
4.	BTN-444	Instrumental Methods of Analysis
5.	BTN-451	Cell and Tissue Engineering
6.	BTN-456	Industrial Biotechnology
7.	BTN-458	Nanobiotechnology
8.	BTN-460	Separation and Analysis of Biomolecules
9.	BTN-461	Advanced Transfer Processes
10.	BTN-463	Biological Spectroscopy

Department Elective Courses : Category II

1.	BTN-445	Genomics and Proteomics
2.	BTN-446	Metabolic Engineering
3.	BTN-447	Protein Engineering
4.	BTN-448	Structural Analysis by NMR
5.	BTN-449	Diagnostics
6.	BTN-450	Bimolecular Modelling
7.	BTN-452	Bioreactor design and analysis

8.	BTN-453	Genetically Modified Organisms
9.	BTN-454	Vaccine Biotechnology
10.	BTN-455	Drug Designing
11.	BTN-457	X-Ray Crystallography
12.	BTN-459	Bioprocess Modeling and Simulation
13.	BTN-462	Food Biotechnology
14.	BTN-464	Bioprocess Economics and Plant Design
15.	BTN-465	Bimolecular NMR

Department: Alternate Hydro Energy Centre

Open Elective Courses

1.	IAH-301	Small Hydro Power Development
2.	IAH-302	Renewable Energy Resources Development Technology

Department: Department of Civil Engineering

Department Elective Courses : Category I

1.	CEN-411	Construction Planning and Management
2.	CEN-614	Theory and Application of GIS
3.	CEN-412	Water Recourses Engineering
4.	CEN-413	Building material and Construction Technology
5.	CEN-414	System Analysis

Department Elective Courses : Category I

Stream 1

1.	CEN-544	Structural Dynamics
2.	CEN-543	Advance Concrete Design
3.	CEN-501	Environment Modelling and Simulation
4.	CEN-421	Advanced Water and Wastewater Treatment
5.	CEN-422	Dam Engineering
6.	CEN-514	Geodesy and GPS Surveying
7.	CEN-642	Analysis and Design of Bridges
8.	CEN-545	Finite Element Methods
9.	CEN-601	Air Pollution and Control
10.	CEN-605	Solid Waste Management
11.	CEN-423	Ground Water Hydrology
12.	CEN-636	Hydropower Engineering
13.	CEN-424	Digital Image Processing

Stream 2

1.	CEN-544	Structural Dynamics
2.	CEN-543	Advanced Concrete Design
3.	CEN-625	Ground Improvement Design

4.	CEN-524	Soil Dynamics and Machine Foundations
5.	CEN-431	Advanced Highway Engineering
6.	CEN-564	Geometric Design
7.	CEN-514	Geodesy and GPS Surveying
8.	CEN-642	Analysis and Design of Bridges
9.	CEN-545	Finite Element Methods
10.	CEN-433	Rock Engineering
11.	CEN-434	Traffic Engineering and management
12.	CEN-424	Digital Image Processing

Open Elective Courses

13.	CEN-333	Probability Methods in Engineering Problems

Department: Department of Electrical Engineering

Department Elective Courses : Category I

S.No.	Code	Title
1.	EEN-351	Artificial Neural Networks
2.	EEN-352	Digital Image Processing
3.	EEN-353	Digital Design with VHDL
4.	EEN-354	Digital Control Systems
5.	EEN-355	Digital Signal Processing
6.	EEN-356	Signals and Systems
7.	EEN-357	Advanced Microprocessors and Interfacing
8.	EEN-358	Data Structures
9.	EEN-359	Single Chip Microcontroller and Its Applications
10.	EEN-360	Embedded Systems
11.	EEN-361	Optimization Techniques
12.	EEN-363	Fuzzy Logic Systems
13.	EEN-364	Utilization and Traction
14.	EEN-365	Digital Signal Processors

Department Elective Courses : Category II : Research Area Specific Courses

a) Power Apparatus and Electric Drives

S.No.	Code	Title
1.	EEN-541	Analysis of Electrical Machines
2.	EEN-542	Advanced Electric Drives
3.	EEN-643	Electric Drives for Hybrid Vehicles
4.	EEN-644	Design of Electric Drives
5.	EEN-645	Instrumentation in Electric Drives
6.	EEN-646	Drive System in Electric Traction
7.	EEN-652	CAD of Power Apparatus
8.	EEN-653	Selected Topics in Machines and Transformers
9.	EEN-654	Synchronous Machines and System Stability
10.	EEN-655	Special Machines

11.	EEN-656	Testing and Commissioning of Electrical Equipment

b) Power Electronics and Electric Drives

S.No.	Code	Title
1.	EEN-540	Advanced Power Electronics
2.	EEN-542	Advanced Electric Drives
3.	EEN-543	FACTS Devices
4.	EEN-641	Microcontroller and Its Applications to Power Converters
5.	EEN-642	DSP Controlled Electric Drives
6.	EEN-643	Electric Drives for Hybrid Vehicles
7.	EEN-647	Control Techniques in Power Electronics for AC Drives
8.	EEN-648	Pulse Width Modulation for Power Converters
9.	EEN-649	Enhanced Power Quality AC-DC Converters
10.	EEN-650	Switch Mode Power Supply
11.	EEN-651	Power Quality Improvement Techniques
12.	EEN-690	Advanced Computer Controlled Systems

c) Transmission and Distribution

S.No.	Code	Title
1.	EEN-560	Computer Aided Power System Analysis
2.	EEN-562	Distribution System Analysis and Operation
3.	EEN-561	Power System Operation and Control
4.	EEN-563	EHV AC Transmission Systems
5.	EEN-564	HVDC Transmission Systems
6.	EEN-660	High Voltage Technique
7.	EEN-661	Power System Planning
8.	EEN-663	Flexible AC Transmission Systems
9.	EEN-664	Wind Energy
10.	EEN-665	Relaying and Switchgear
11.	EEN-666	Distribution System Automation
12.	EEN-667	Power System Reliability
13.	EEN-668	Digital Protection of Power Systems
14.	EEN-669	Power System Dynamics
15.	EEN-670	Substation Automation
16.	EEN-671	Power System Deregulation
17.	EEN-543	FACTS Devices
18.	EEN-651	Power Quality Improvement Techniques
19.	EEN-681	Wide Area System Monitoring Control

d) Instrumentation and Signal Processing

S.No.	Code	Title
1.	EEN-520	Advanced Industrial and Electronic Instrumentation
2.	EEN-522	Biomedical Instrumentation
3.	EEN-523	Intelligent Sensors and Instrumentation
4.	EEN-620	Process Instrumentation and Control
5.	EEN-621	Noise and Interference in Instrumentation
6.	EEN-622	Power System Instrumentation
7.	EEN-623	Measurement Errors and Statistical Analysis
8.	EEN-624	Telemetry and SCADA

9.	EEN-625	Virtual Instrumentation
10.	EEN-626	Advances in Signal and Image Processing
11.	EEN-627	Ultrasonic and Laser Instrumentation
12.	EEN-628	Medical Imaging
13.	EEN-629	Bioelectric Signals and Processing
14.	EEN-630	Computer Applications in Medical Engineering
15.	EEN-631	Microprocessor Based Medical Instruments
16.	EEN-632	Hospital Informatics and safety Measures
17.	EEN-633	Clinical Engineering

e) Systems & Control

S.No.	Code	Title
1.	EEN-580	Advanced Linear Control Systems
2.	EEN-582	Advanced System Engineering
3.	EEN-583	Non Linear and Robust Control
4.	EEN-680	Machine Learning
5.	EEN-681	Wide Area System Monitoring Control
6.	EEN-682	Advanced Digital System Design
7.	EEN-683	Introduction Robotics
8.	EEN-684	System Reliability
9.	EEN-685	Stochastic Systems
10.	EEN-686	Optimal Systems
11.	EEN-687	Operation Research
12.	EEN-688	Interval Control Systems
13.	EEN-689	Modeling and Simulation
14.	EEN-690	Advanced Computer Controlled Systems
15.	EEN-692	Graph Theory and Applications

Program Code : 215 Integrated Dual Degree: B. Tech. (Civil Engineering) & M.Tech. (Structural Engineering)
Department : Department of Civil Engineering
Year : IV

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.	CEN-401	Training and Seminar	DCC	2	-	-	-	-	-	-	-	-	-	-
2	CEN-541	Matrix Structural Analysis	PCC	4	3	-	2	3	-	15	25	20	40	-
3.	CEN-542	Continuum Mechanics	PCC	4	3	1	-	3	-	25	-	25	50	-
4.	CEN-543	Advanced Concrete Design	PCC	4	3	-	2	3	-	15	25	20	40	-
5.	CEN-544	Structural Dynamics	PCC	4	3	1	-	3	-	25	-	25	50	-
6.		Programme Elective-1	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		22										
Semester-II (Spring)														
1.	CEN-545	Finite Element Analysis	PCC	4	3	-	2	3	-	15	25	20	40	-
2.	CEN-700	Seminar	SEM	2	0	0	2	-	-	-	-	-	100	-
3.		Programme Elective-II	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Programme Elective-III	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		18										

Program Code : 215 Integrated Dual Degree: B. Tech. (Civil Engineering) & M.Tech. (Structural Engineering)
Department : Department of Civil Engineering
Year : V

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.	CEN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	CEN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

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

Program Elective Courses: Integrated Dual Degree: B. Tech. (Civil Engineering) & M.Tech. (Structural Engineering)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	CEN-521	Advanced Numerical Analysis (Autumn)	PEC	4	3	-	2	3	-	15	25	20	40	-
2.	CEN-641	Behaviour & Design of Steel Structures (Autumn)	PEC	4	3	-	2	3	-	15	25	20	40	-
3.	CEN-642	Analysis and Design of Bridges	PEC	4	3	-	2	3	-	15	25	20	40	-
4.	CEN-643	Analysis and Design of High rise Buildings	PEC	4	3	-	2	3	-	15	25	20	40	-
5.	CEN-644	Analysis and Design of Plates and Shells	PEC	4	3	-	2	3	-	15	25	20	40	-
6.	CEN-645	Mechanics of Composites	PEC	4	3	1	-	3	-	25	-	25	50	-
7.	CEN-646	Engineering Design Optimization and Reliability	PEC	4	3	-	2	3	-	15	25	20	40	-
8.	CEN-647	Condition Assessment and Retrofitting of Structures	PEC	4	3	-	2	3	-	15	25	20	40	-
9.	CEN-648	Concrete Technology	PEC	4	3	-	2	3	-	15	25	20	40	-
10.	CEN-649	Fracture Mechanics in Quasi-Brittle Materials	PEC	4	3	1	-	3	-	25	-	25	50	-
11.	CEN-650	Design of Bridge Sub-structure	PEC	4	3	-	2	3	-	15	25	20	40	-
12.	CEN-651	Wind Engineering	PEC	4	3	-	2	3	-	15	25	20	40	-

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **24** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)]**
Department: **EE** **Department of Electrical Engineering**
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.	MAN-001	Mathematics-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-003	Electromagnetic Field Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CEN-105	Introduction to Environmental Science	GSC	3	2	1	0	2	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advanced)	HSSMC	2	1	0	2	2	0	-	25	25	50	-
5.	HSN-002	Ethics and Self-Awareness	HSSMC	2	2	0	0	2	0	15	-	35	50	-
6.	EEN-101	Introduction to Electrical Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	EEN-103	Programming in C++	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		21	16	3	4							
Semester-II (Spring)														
1.	MAN-002	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-004	Modern Physics	BSC	4	3	1	2/2	3	2	20	20	20	40	-
3.	MIN-106	Engineering Thermodynamics	ESC	4	3	1	0	3	0	25	-	25	50	-
4.	EEN-102	Network Theory	DGC	4	3	1	0	3	0	25	-	25	50	-
5.	EEN-104	Electrical Measurement and Measuring Instruments	DCC	4	3	0	2	3	2	15	25	20	40	-
6.	EEN-106	Analog Electronics	DCC	4	3	1	2/2	2	2	20	20	20	40	-
		Total		24	18	5	4							

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIDAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **24** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)]**
Department: **EE** **Department of Electrical Engineering**
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.	EEN-201	Electrical Machines-I	DCC	5	3	1	2	3	3	15	25	20	40	-
2.	EEN-203	Digital Electronics and Circuits	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	EE-205	Design of Electronic Circuits	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	EEN-211	Control Systems	ESC	4	3	1	0	3	0	25	-	25	50	-
5.	HSN-ELE	Humanities and Social Sciences Elective Course	HSSMC	3	2	1	0	2	0	-	25	25	50	-
6.	EEN-291	Engineering Analysis and Design	DCC	3	2	0	2	2	0	15	25	20	40	-
		Total		23	16	5	6							
Semester-II (Spring)														
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	EEN-202	Electrical Machines-II	DCC	5	3	1	2	3	3	15	25	20	40	-
3.	EEN-204	Microprocessors and Peripheral Devices	DCC	5	3	1	2	3	2	15	25	20	40	-
4.	EEN-206	Power Transmission and Distribution	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	EEN-208	Applied Instrumentation	DCC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		22	15	5	5							

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIDAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **24** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)]**
Department: **EE** **Department of Electrical Engineering**
Year: **III**

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.	EEN-301	Power System Analysis & Control	DCC	4	3	1	2/2	3	0	20	20	20	40	-
2.	EEN-303	Power Electronics	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	EEN-305	Advanced Control Systems	DCC	5	3	1	2	3	3	15	25	20	40	-
4.	EEN-ELE1	Departmental Elective Course-I	DEC	4	-	-	-	-	-	-	-	-	-	-
5.	-	Open Elective Course	OEC	3	2	1	0	2	0	25	-	25	50	-
6.	EEN-391	Technical Communication	DCC	2	0	0	4	0	0	-	-	-	100	-
		Total		22	11	4	8							
Semester-II (Spring)														
1.	EEN-300	Industry Oriented Problem	DCC	3	-	-	-	-	-	-	-	-	-	100
2.	EEN-302	Electric Drives	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	EEN-304	Protection & Switchgear	DCC	4	3	0	2	3	2	15	25	20	40	-
4.	EEN-306	General Viva	DCC	2	-	-	-	-	-	-	-	-	100	-
5.	EEN-ELE2	Departmental Elective Course-II	DEC	4	-	-	-	-	-	-	-	-	-	-
6.	BM-ELE	Management Studies Elective Course	HSSMEC	3	2	1	0	2	0	25	-	25	50	-
7.	EEN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		20	8	2	3							

Note: The course structure will be same as that of B.Tech.(Electrical) upto III Yr. After III Yr students having CGPA more than 7.5 can shift to IDD program and study IV Yr and V Yr alongwith M.Tech. students. No separate course will run for them.

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **24** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)]**
Department: **EE** **Department of Electrical Engineering**
Year: **IV**

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.	EEN-540	Advanced Power Electronics	MSC	4	3	1	2/2	3	-	15	25	20	40	-
2.	EEN-580	Advanced Linear Control Systems	MSC	4	3	1	2/2	3	-	15	25	20	40	-
3.	EEN-xxx	Program Elective Course-I	PEC	4	-	-	-	-	-	-	-	-	-	-
4.	EEN-xxx	Program Elective Course-II	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	EEN-401	Training Seminar	DCC	2	-	-	-	-	-	-	-	-	-	-
		Total		18										
Semester-II (Spring)														
1.	EEN-564	HVDC Transmission Systems	MSC	4	3	1	0	3	-	25	-	25	50	-
2.	EE-543	FACTS Devices	MSC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-xxx	Program Elective Course-III	PEC	4	-	-	-	-	-	-	-	-	-	-
4.	EEN-xxx	Program Elective Course-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	EEN-500	Seminar	SEM	2	-	-	-	-	-	-	-	-	-	-
		Total		18										

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **24** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Power Electronics)]**
Department: **EE** **Department of Electrical Engineering**
Year: **V**

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.	EEN-600A	Dissertation –I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	EEN-600B	Dissertation –II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary

Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**24**	**23**	**22**	**22**	**20**	**18**	**18**	**12**	**18**
Total Credits	**198**									

List of Departmental Electives Under Category-I

(Autumn/Spring Semester)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	EEN-351	Artificial Neural Networks	DEC	4	3	1	2/2	3	-	20	20	20	40	-
2.	EEN-352	Digital Image Processing	DEC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-353	Digital Design with VHDL	DEC	4	3	0	2	3	-	15	25	20	40	-
4.	EEN-354	Digital Control Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
5.	EEN-355	Digital Signal Processing	DEC	4	3	1	2/2	3	-	20	20	20	40	-
6.	EEN-356	Signals and Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
7.	EEN-357	Advanced Microprocessors and Interfacing	DEC	4	3	1	2/2	3	-	20	20	20	40	-
8.	EEN-358	Data Structures	DEC	4	3	0	2	3	-	15	25	20	40	-
9.	EEN-359	Single Chip Microcontroller and Its Applications	DEC	4	3	0	2	3	-	15	25	20	40	-
10.	EEN-360	Embedded Systems	DEC	4	3	0	2	3	-	15	25	20	40	-
11.	EEN-361	Optimization Techniques	DEC	4	3	1	0	3	-	25	-	25	50	-
12.	EEN-362	Fuzzy Logic Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
13.	EEN-363	Utilization and Traction	DEC	4	3	1	0	3	-	25	-	25	50	-
14.	EEN-364	Digital Signal Processors	DEC	4	3	1	2/2	3	-	20	20	20	40	-

Program Specific Elective Courses

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	EEN-542	Advanced Electric Drives	PEC	4	3	0	2	3	-	15	25	20	40	-
2.	EEN-561	Power System Operation and Control	PCC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-563	EHV AC Transmission Systems	PCC	4	3	1	0	3	-	25	-	25	50	-
4.	EEN-641	Microcontroller and Its Applications to Power Converters	PEC	4	3	0	2	3	-	15	25	20	40	-
5.	EEN-642	DSP Controlled Electric Drives	PEC	4	3	0	2	3	-	15	25	20	40	-
6.	EEN-643	Electric Drives for Hybrid Vehicles	PEC	4	3	1	0	3	-	25	-	25	50	-
7.	EEN-647	Control Techniques in Power Electronics for AC Drives	PEC	4	3	0	2	3	-	15	25	20	40	-
8.	EEN-648	Pulse Width Modulation for Power Converters	PEC	4	3	1	0	3	-	25	-	25	50	-
9.	EEN-649	Enhanced Power Quality AC-DC Converters	PEC	4	3	0	2	3	-	15	25	20	40	-
10.	EEN-650	Switch Mode Power Supply	PEC	4	3	1	0	3	-	25	-	25	50	-
11.	EEN-651	Power Quality Improvement Techniques	PEC	4	3	0	2	3	-	15	25	20	40	-
12.	EEN-660	High Voltage Technique	PEC	4	3	1	0	3	-	25	-	25	50	-
13.	EEN-662	Power System Harmonics	PEC	4	3	1	0	3	-	25	-	25	50	-
14.	EEN-663	Flexible AC Transmission Systems	PEC	4	3	1	0	3	-	25	-	25	50	-
15.	EEN-690	Advanced Computer Controlled Systems	PEC	4	3	1	0	3	-	25	-	25	50	-

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **XX** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)]**
Department: **EE** **Department of Electrical Engineering**
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.	MAN-001	Mathematics-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-003	Electromagnetic Field Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CEN-105	Introduction to Environmental Science	GSC	3	2	1	0	2	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advanced)	HSSMC	2	1	0	2	2	0	-	25	25	50	-
5.	HSN-002	Ethics and Self-Awareness	HSSMC	2	2	0	0	2	0	15	-	35	50	-
6.	EEN-101	Introduction to Electrical Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	EEN-103	Programming in C++	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		21	16	3	4							
Semester-II (Spring)														
1.	MAN-002	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-004	Modern Physics	BSC	4	3	1	2/2	3	2	20	20	20	40	-
3.	MIN-106	Engineering Thermodynamics	ESC	4	3	1	0	3	0	25	-	25	50	-
4.	EEN-102	Network Theory	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	EEN-104	Electrical Measurement and Measuring Instruments	DCC	4	3	0	2	3	2	15	25	20	40	-
6.	EEN-106	Analog Electronics	DCC	4	3	1	2/2	2	2	20	20	20	40	-
		Total		24	18	5	4							

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIDAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: XX **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)]**
Department: EE **Department of Electrical Engineering**
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.	EEN-201	Electrical Machines-I	DCC	5	3	1	2	3	3	15	25	20	40	-
2.	EEN-203	Digital Electronics and Circuits	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	EEN-205	Design of Electronic Circuits	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	EEN-211	Control Systems	ESC	4	3	1	0	3	0	25	-	25	50	-
5.	HSN-ELE	Humanities and Social Sciences Elective Course	HSSMC	3	2	1	0	2	0	-	25	25	50	-
6.	EEN-291	Engineering Analysis and Design	DCC	3	2	0	2	2	0	15	25	20	40	-
		Total		23	16	5	6							
Semester-II (Spring)														
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	EEN-202	Electrical Machines-II	DCC	5	3	1	2	3	3	15	25	20	40	-
3.	EEN-204	Microprocessors and Peripheral Devices	DCC	5	3	1	2	3	2	15	25	20	40	-
4.	EEN-206	Power Transmission and Distribution	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	EEN-208	Applied Instrumentation	DCC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		22	15	5	5							

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIDAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **XX** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)]**
Department: **EE** **Department of Electrical Engineering**
Year: **III**

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.	EEN-301	Power System Analysis & Control	DCC	4	3	1	2/2	3	0	20	20	20	40	-
2.	EEN-303	Power Electronics	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	EEN-305	Advanced Control Systems	DCC	5	3	1	2	3	3	15	25	20	40	-
4.	EEN-ELE1	Departmental Elective Course-I	DEC	4	-	-	-	-	-	-	-	-	-	-
5.	-	Open Elective Course	OEC	3	2	1	0	2	0	25	-	25	50	-
6.	EEN-391	Technical Communication	DCC	2	0	0	4	0	0	-	-	-	100	-
		Total		22	11	4	8							
Semester-II (Spring)														
1.	EEN-300	Industry Oriented Problem	DCC	3	-	-	-	-	-	-	-	-	-	100
2.	EEN-302	Electric Drives	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	EEN-304	Protection & Switchgear	DCC	4	3	0	2	3	2	15	25	20	40	-
4.	EEN-306	General Viva	DCC	2	-	-	-	-	-	-	-	-	100	-
5.	EEN-ELE2	Departmental Elective Course-II	DEC	4	-	-	-	-	-	-	-	-	-	-
6.	BM-ELE	Management Studies Elective Course	HSSMEC	3	2	1	0	2	0	25	-	25	50	-
7.	EE-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		20	8	2	3							

Note: The course structure will be same as that of B.Tech.(Electrical) upto III Yr. After III Yr students having CGPA more than 7.5 can shift to IDD program and study IV Yr and V Yr alongwith M.Tech. students. No separate course will run for them.

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **XX** **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)]**
Department: **EE** **Department of Electrical Engineering**
Year: **IV**

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.	EEN-520	Advanced Industrial and Electronic Instrumentation	MSC	4	3	0	2	3	-	15	25	20	40	-
2.	EEN-582	Advanced System Engineering	MSC	4	3	0	2	3	-	25	-	25	50	-
3.	EEN-xxx	Program Elective Course-I	PEC	4	-	-	-	-	-	-	-	-	-	-
4.	EEN-xxx	Program Elective Course-II	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	EEN-401	Training Seminar	DCC	2	-	-	-	-	-	-	-	-	-	-
		Total		18	6	0	4							
Semester-II (Spring)														
1.	EEN-523	Intelligent Sensors and Instrumentation	MSC	4	3	0	2	3	-	15	25	20	40	-
2.	EEN-583	Non Linear and Robust Control	MSC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-xxx	Program Elective Course-III	PEC	4	-	-	-	-	-	-	-	-	-	-
4.	EEN-xxx	Program Elective Course-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	EEN-500	Seminar	SEM	2	-	-	-	-	-	-	-	-	-	-
		Total		18	6	1	2							

DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: XX **Integrated Dual Degree [B.Tech. (Electrical Engineering) and M.Tech. (Instrumentation & Control)]**
Department: EE **Department of Electrical Engineering**
Year: V

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.	EEN-600A	Dissertation –I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	EEN-600B	Dissertation –II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary

Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**24**	**23**	**22**	**22**	**20**	**18**	**18**	**12**	**18**
Total Credits	**198**									

List of Departmental Electives Under Category-I

(Autumn/Spring Semester)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	EEN-351	Artificial Neural Networks	DEC	4	3	1	2/2	3	-	20	20	20	40	-
2.	EEN-352	Digital Image Processing	DEC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-353	Digital Design with VHDL	DEC	4	3	0	2	3	-	15	25	20	40	-
4.	EEN-354	Digital Control Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
5.	EEN-355	Digital Signal Processing	DEC	4	3	1	2/2	3	-	20	20	20	40	-
6.	EEN-356	Signals and Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
7.	EEN-357	Advanced Microprocessors and Interfacing	DEC	4	3	1	2/2	3	-	20	20	20	40	-
8.	EEN-358	Data Structures	DEC	4	3	0	2	3	-	15	25	20	40	-
9.	EEN-359	Single Chip Microcontroller and Its Applications	DEC	4	3	0	2	3	-	15	25	20	40	-
10.	EEN-360	Embedded Systems	DEC	4	3	0	2	3	-	15	25	20	40	-
11.	EEN-361	Optimization Techniques	DEC	4	3	1	0	3	-	25	-	25	50	-
12.	EEN-362	Fuzzy Logic Systems	DEC	4	3	1	0	3	-	25	-	25	50	-
13.	EEN-363	Utilization and Traction	DEC	4	3	1	0	3	-	25	-	25	50	-
14.	EEN-364	Digital Signal Processors	DEC	4	3	1	2/2	3	-	20	20	20	40	-

Program Specific Elective Courses

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	EEN-522	Biomedical Instrumentation	PCC	4	3	1	0	3	-	25	-	25	50	-
2.	EEN-620	Process Instrumentation and Control	PEC	4	3	1	0	3	-	25	-	25	50	-
3.	EEN-621	Noise and Interference in Instrumentation	PEC	4	3	1	0	3	-	25	-	25	50	-
4.	EEN-622	Power System Instrumentation	PEC	4	3	1	0	3	-	25	-	25	50	-
5.	EEN-623	Measurement Errors and Statistical Analysis	PEC	4	3	1	0	3	-	25	-	25	50	-
6.	EEN-624	Telemetry and SCADA	PEC	4	3	1	0	3	-	25	-	25	50	-
7.	EEN-625	Virtual Instrumentation	PEC	4	3	1	0	3	-	25	-	25	50	-
8.	EEN-626	Advances in Signal and Image Processing	PEC	4	3	1	0	3	-	25	-	25	50	-
9.	EEN-627	Ultrasonic and Laser Instrumentation	PEC	4	3	1	0	3	-	25	-	25	50	-
10.	EEN-580	Advanced Linear Control Systems	PCC	4	3	1	2/2	3	-	20	20	20	40	-
11.	EEN-680	Machine Learning	PEC	4	3	1	0	3	-	25	-	25	50	-
12.	EEN-681	Wide Area System Monitoring Control	PEC	4	3	1	0	3	-	25	-	25	50	-
13.	EEN-682	Advanced Digital System Design	PEC	4	3	0	2	3	-	25	-	25	50	-
14.	EEN-683	Introduction to Robotics	PEC	4	3	1	0	3	-	25	-	25	50	-
15.	EEN-686	Optimal Systems	PEC	4	3	1	0	3	-	25	-	25	50	-
16.	EEN-688	Interval Control Systems	PEC	4	3	1	0	3	-	25	-	25	50	-
17.	EEN-689	Modeling and Simulation	PEC	4	3	1	0	3	-	25	-	25	50	-
18.	EEN-690	Advanced Computer Controlled Systems	PEC	4	3	1	0	3	-	25	-	25	50	-
19.	EEN-694	Advances in Model Order Reduction Techniques	PEC	4	3	1	0	3	-	25	-	25	50	-

Appendix-E

Fixing of PG seats for main GATE discipline and allied GATE discipline
Modified Table

S.No	Deptt.	Code	Main Gate Discipline(s)					Other GATE Disciplines				
				GE	OB	SC	ST		GE	OB	SC	ST
1.	ARD	10	AR(18)	9	5	3	1	-	-	-	-	-
		11	AR(14)	7	4	2	1	CE(4)	2	1	1	0
2.	AHC	12	CE(5)	3	1	1	0	AG/CH/EC/ME/PI/XE(20)	10	5	3	2
		13	CE(5)	3	1	1	0	AG/CH/EE/ME/PI/XE/AR/CBT/PH/MA/XL(10)	5	3	1	1
3.	CHD	14	CH(28)	14	8	4	2	-	-	-	-	-
		15	CH(24)	12	6	4	4	CE(4)	2	1	1	0
4.	CED	16	CE(15)	8	4	2	1	CH(3)	1	1	1	0
		17	CE(12)	6	3	2	1	AR/CS/EC/EE/MN/SG(12)	6	3	2	1
		18	CE/MN(24)	12	6	4	2	-	-	-	-	-
		19	CE(15)	8	4	2	1	AG(3)	1	1	1	0
		20	CE(36)	18	10	5	3	-	-	-	-	-
		21	CE(24)	12	6	4	2	-	-	-	-	-
5.	EQD	22	CE(18)	9	5	3	1	-	-	-	-	-
		23	CE(31)	16	8	5	2	-	-	-	-	-
		24	CE(15)	8	4	2	1	-	-	-	-	-
6.	EED	25	EE(23)	12	6	3	2	-	-	-	-	-
		26	EE(12)	6	3	2	1	EC/IN(11)	5	3	2	1
		27	EE(23)	12	6	3	2	-	-	-	-	-
		28	EE(16)	9	4	2	1	EC/IN(5)	3	1	1	-
7.	ECD	29	EC(18)	9	5	3	1	-	-	-	-	-
		30	EC(15)	8	4	2	1	-	-	-	-	-
		31	EC(15)	8	4	2	1	-	-	-	-	-
8.	CSD	32	CS(54)	27	15	8	4	-	-	-	-	-
9.	HYD	33	CE/AG(12)	6	3	2	1	ME/GG/XE(3)	1	1	1	0
10.	MED	34	ME/PI(15)	8	4	2	1	-	-	-	-	-
		35	ME/PI(18)	9	5	3	1	-	-	-	-	-
		36	ME/PI(18)	9	5	3	1	-	-	-	-	-
		37	ME/PI(18)	9	5	3	1	-	-	-	-	-
		38	ME/PI(18)	9	5	3	1	-	-	-	-	-
11.	MTD	39	MT(4)	2	1	1	0	ME/PI(14)	7	4	2	1
		40	MT(3)	1	1	0	1	PH/MI/PI/CY/XE(15)	8	4	3	0
12.	PPD	41	CH(10)	5	3	1	1	ME/BT/TF(8)	4	2	1	1
		43	CH(10)	5	3	1	1	BT/CY/ME/TF(10)	5	3	1	1
13.	WRD	43	CE/AG(3)	1	1	1	0	-	-	-	-	-
		44	CE/EE/ME(12)	6	3	2	1	-	-	-	-	-
14.	CYD	45	CY/CH(15)	8	4	2	1	-	-	-	-	-
15.	PHD	46	PH(12)	6	3	2	1	EE/EC/MT(6)	3	2	1	0
16.	NTC	47	MT/ME/EC/CH(6)	3	2	1	0	CY/PH/BT/XL(9)	5	2	1	1
17.	DMC	48	CE/ME/PI/CS/CH/A/GG/PH/MA/XL/XE(15)	8	4	2	1	-	-	-	-	-
18.	TSC	49	CE/AR(10)	5	3	2	1	ME/PI/CH/EE/EC/CS(5)	3	1	1	0

Appendix-A

Ph.D. - O

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Department of: _____

APPLICATION FOR FINALIZATION OF SUPERVISOR(s)

1. Name of the Research Scholar : .....

2. Date of Registration : ..... 3. Status: Full-Time ☐ Part-Time ☐

4. Sponsored/Self Finance/IITR Assistantship /Assistantship from other sources. _____

5. Proposed area of research : .....

6. Supervisor 1 Name: .....
   Designation: .....
   Department: .....

   Supervisor 2 Name: .....
   Designation: .....
   Department: .....

   Supervisor 3 Name: .....
   Designation: .....
   Department: .....

Note: 1. Please enclose the justification in case of joint supervision.
2. Third Supervisor, if any, shall be from outside IITR.

DATED: **Signature of Research Scholar**

Quantum of supervision in case of Joint Supervision

Supervisor 1..... Supervisor 2 ..... Supervisor 3.....

Signature of the Supervisor (s)

Chairman, DRC/CRC **HEAD OF THE DEPARTMENT/CENTRE**
DATED:

Note: The Proforma-0 be sent to Academic Section for record and approval if required, by Dean, Academics in case of Joint Supervision only.

ORDER OF DEAN, ACADEMICS

Approved/Non Approved

Dean (Academics)

Annexure-B

Ph.D. Ordinances and Regulations

Existing	Modified	Remark
R.5 REGISTRATION, APPOINMENT OF SUPERVISOR AND SRC **Note:** Names for 4(b) and 4(c) shall be proposed by the supervisor(s).	**R.5 REGISTRATION, APPOINMENT OF SUPERVISOR AND SRC** **Note 1:** Names for 4(b) and 4(c) shall be proposed by the supervisor(s) and recommended by the Chairman, DRC. **Note 2:** Once approved, the member of SRC committee can be changed only by Dean, Academics on the recommendation of Chairman, DRC and HoD.	**Need to be incorporated due to recent cases.**
R.7 SUPERVISOR(S) 1. Supervisor(s) can be any full-time faculty member of the Institute with a Ph.D. degree. Regular/full time faculty members who do not have Ph.D. degree may be allowed to supervise a research student/ candidate provided such faculty members have been engaged in research at least for five years as evidenced by publications in refereed/reputed journals. No person who himself is registered for Ph.D. degree at this Institute or any other Institution, would qualify to act as a supervisor. Those without a Ph.D. degree, if appointed Supervisor(s), would cease to be Supervisor(s) if they themselves register for Ph.D. Faculty on contract is not allowed to supervise	**R.7 SUPERVISOR(S)** 1. Supervisor(s) can be any full-time faculty member of the Institute with a Ph.D. degree. No person who himself is registered for Ph.D. degree at this Institute or any other Institution, would qualify to act as a supervisor.	**Supervisor shall have Ph.D. degree to supervise.**

research student/candidate singly.	G. If a new supervisor has been appointed after the candidacy and new SRC has been constituted, the research proposal has to be presented for fresh candidacy	**Changed as per new guidelines**
R.11 RESEARCH PERFORMANCE MONITORING 1. The research progress of each research candidate in a semester will be monitored by the supervisor(s), who will assess the performance to be 'satisfactory' or 'unsatisfactory' at the end of each semester. For this purpose, each research candidate will be asked to submit a progress report to the supervisor(s) by the dates stipulated in R11.6. 2. The supervisor(s) shall forward his/her recommendation regarding the performance of the research candidate to the Chairman, DRC/CRC in the Department/ Centre before the beginning of the next semester. The Chairman, DRC/CRC will forward the recommendation to the Dean, Academic Research for necessary action. There is no need to send progress report to Dean, Academic Research. Only those cases where some action is required be sent to the Dean, Academic Research.	**R.11 RESEARCH PERFORMANCE MONITORING** 1. The research progress of each research candidate in a semester will be monitored by the supervisor(s), who will assess the performance to be 'satisfactory' or 'unsatisfactory' at the end of each semester. For this purpose, each research candidate will be asked to submit a progress report to the supervisor(s) by the dates stipulated in R11.6. 2. The supervisor(s) shall forward his/her recommendation regarding the performance of the research candidate to the Chairman, DRC/CRC in the Department/ Centre before the beginning of the next semester. The Chairman, DRC/CRC will forward the recommendation to the Dean, Academics for necessary action.	**No change** **The progress report need to be sent irrespective of performance of candidate**

3. If the progress of a research candidate in a semester is evaluated as 'satisfactory' by the supervisor, 'S' grade will be awarded to the research candidate for that semester and need not be forwarded to Dean, Academic Research.	3. The progress of a research candidate in a semester is evaluated as 'satisfactory' or 'unsatisfactory' by the supervisor and forwarded to Dean, Academics through Chairman, SRC, Chairman, DRC and Head of the Department/Centre. However, the candidate has to give seminar once in a year before the SRC for progress evaluation.	**Point 3,4 and 5 are changed as there is no provision to award a grade in every semester**
4. If the progress is evaluated as 'unsatisfactory' by the supervisor(s), the evaluation will then be submitted to SRC, which will make suitable recommendation to the Chairman, DRC/CRC for the award of 'U' grade and other appropriate actions for forwarding it to the Dean, Academic Research. For the first award of 'U' grade, a warning will be issued to the Research Candidate by the office of Dean, Academic Research.	4. If the progress is evaluated as 'unsatisfactory' by the supervisor(s)for the first time, a warning will be issued to the Research Candidate by the office of Dean, Academics.	
5. If there are 'U' grades awarded in two consecutive semesters to a research candidate, his/her registration for Ph.D. programme will stand terminated.	5. If the performance is evaluated unsatisfactory in two consecutive semesters to a research candidate, his/her registration for Ph.D. programme will stand terminated.	**Changed to make it clear.**
6. The academic calendar will include the following dates for the submission of the progress reports by the research candidate. Such as:	6. The academic calendar will include the dates for the submission of the progress reports by the research candidate.	

Autumn Semester: 1st November (Receiving of blank progress forms from the office of Dean, Academic Research / Department / Centre) 15th December (submission of progress report by the research candidate to the supervisor) **Spring Semester:** 1st May (Receiving of blank progress forms from the office of Dean, Academic Research/ Department/Centre) 15th June (submission of progress report by the research candidate to the supervisor)	7. A special meeting of student research committee may be called by the supervisor at any time during the entire period of Ph.D. for the following: a) Mid-term review of progress of the student b) Any type of change of topic or research area c) Addition or deletion of supervisor. d) To consider the request of student for doing work in industry of in some other institute for short period. e) To consider the extension of period f) To consider the enhancement of fellowship or change of status from JRF to SRF. Proforma Ph.D-VIII need to be filled every time by the SRC for the approval of Dean, Academics.	**Included to make it clear.**

R.16 FINANCIAL ASSISTANCE (Institutional Assistantship) 2. The maximum duration for which assistantship can be awarded to any Ph.D. research student/candidate is 4/5 years or till the end of the semester in which the thesis is submitted, whichever is earlier. Continuation of the fellowship is contingent on satisfactory academic and research performance and satisfactory performance in the discharge of responsibilities for assistance assigned under the scheme. It is to be noted that admission to the Programmes and award of assistantship are not linked. Admission to any programme does not guarantee the award of fellowship/ assistantship. Those who are not awarded assistantship can continue with the programmes as a self financing student. However, based on their performance as evaluated and recommended by DRC, eligible students may be awarded assistantship for the remaining part of their four year registration period, if available. Such performance shall be evaluated after first year of admission.	**R.16 FINANCIAL ASSISTANCE (Institutional Assistantship)** 2. The maximum duration for which assistantship can be awarded to any Ph.D. research student is 4/5 years or till the end of the semester in which the thesis is submitted, whichever is earlier. Continuation of the fellowship is contingent on satisfactory academic and research performance and satisfactory performance in the discharge of responsibilities for assistance assigned under the scheme. It is to be noted that admission to the Programmes and award of assistantship are not linked. Admission to any programme does not guarantee the award of fellowship/ assistantship. Those who are not awarded assistantship can continue with the programmes as a self financing student.	**Dropped as no candidate is admitted without assistantship.**
	R.24 DUAL DEGREE (M.TECH. + Ph.D) Programme 1. The students admitted in postgraduate programme in	**New clause introduced as**

	engineering departments and Architecture & Planning department have an option to switch over to Ph.d. under dual degree program. 2. After completing two semesters of M.Tech. I Year, the students having CGPA more than 7.50 will be given the choice to apply for Ph.D. programme, if he/she desires. 3. Once admitted for Ph.D. program, normal Ph.D. rules, including fellowship, leaves etc., will be applicable. 4. These students will get two degrees both M.Tech. and Ph.D. after successful completion of Ph.D. 5. The students admitted for Ph.D. may have to do extra courses as recommended by SRC to carry out the research work. 6. These students will have to go through comprehensive written and comprehensive oral examination after completing the extra courses, if any. 7. Only after successfully completing the comprehensive examination, the students can present the research proposal. 8. These students will not be eligible for campus placement alongwith M.Tech. students. However, they can appear for campus placement alongwith Ph.D. students. 9. If the student fails in comprehensive examination, he/she may continue with M.Tech. 10. In case, if a student is asked to leave the Ph.D.	**approved by chairman, Senate**

	program in between due to some reason, after the candidacy, he/she can leave the program with M.Tech. degree only provided he/she submits the work completed till then as M.Tech. dissertation work satisfying the requirement of M.Tech. degree. However, if a student leaves the program on his/her own, he/she will not be entitled for any degree.	

58/5

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. / CENTRE : DEPARTMENT OF MANAGEMENT STUDIES

1. **Subject Code : BM-681** **Course Title :** Six Sigma and Applications
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. **Pre-requisite:** Nil **8. Subject Area:** PEC
9. **Objective:** The objective of this subject is to acquaint students about tools and techniques in implementing six sigma in a manufacturing and service organization.
10. **Details of the Course:**

Sl. No	Contents	Contact Hours
1	Introduction –Six Sigma Basics – Overview & Implementation, Define phase, Measure phase, Process Flow Charting/Process Mapping, Basic Tools, Probability, Overview of Distributions and Statistical Process, Six Sigma Measurements, Basic Control Charts, Process Capability and Process Performance Metrics.	10
2	Six Sigma Analysis Phase – Visualization of Data, Confidence Intervals, Six Sigma Improve Phase – Benefiting from Design of Experiments (DOE) Understanding the Creation of Full and Fractional Factorial 2K DOEs	12
3	Planning 2K DOEs Design and Analysis of 2K DOEs, Response Surface Methodology. Lean Six Sigma – Lean and its Integration with Six Sigma process, Integrating of Theory of Constraints	10
4	Design for Six Sigma – Manufacturing applications, Service/Transactional Applications, DFSS Overview and Tools, Product DFSS, Process DFSS. Management of Six Sigma – Change Management, Project Management and Financial Analysis, Team Effectiveness, Creativity	10
	Total	42 Hrs

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1	Breyfogle, Forrest, Implementing : Six Sigma : Smarter Solutions Using Statistical Methods, New York – John Wiley & Sons	1999
2	Harry, Mikel and Rich Schroeder, Six Sigma : The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, New York – Doubleday	2000
3	Besterfield, D C and Besterfield C, "Total Quality Management", Pearson Education Asia	1999
4	Montgomery, D.C, "Statistical Quality Control- A modern introduction", 6th Edition, Wiley India	2010
5	Feigenbaum, "Total Quality Control", 3rd Edition, McGraw Hill	1991
6	Hansen B L, and Ghare P M, "Quality Control and Application", Prentice Hall India	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. / CENTRE : DEPARTMENT OF MANAGEMENT STUDIES

1. **Subject Code :** BM-682 **Course Title : Data Analytics**
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. **Pre-requisite:** Nil **8. Subject Area:** PEC
9. **Objective:** The course is designed to provide in-depth knowledge of handling data and business analytics tools that can be used for fact-based decision-making using real case studies.
10. **Details of the Course:**

Sl. No	Contents	Contact Hours
1	**Data Visualization and Interpretation:** Different types of data; Data summarization and visualization methods; Data visualization and Storytelling with Data.	5
2	**Data Preparation and Imputation:** Data quality check, data cleaning and imputation.	5
3	**Predictive Analytics:** Logistic and Multinomial Regression: Logistic function, Estimation of probability using logistic regression, Deviance, Wald Test, Hosmer Lemshow Test, Classification table, Gini co-efficient.	5
4	**Multi-criteria decision making (MCDM) techniques**: Goal Programming (GP) and analytic hierarchy process (AHP) and applications of GP and AHP in solving problems with multiple objectives.ANP, ANN, Non-linear programming, portfolio theory.	5
5	**Stochastic Models:** Markov models, Classification of states, Steady-state probability estimation, Brand switching and loyalty modelling, Market share estimation in the short and long run. Poisson process and Cumulative Poisson process and their Applications in operations, marketing and insurance. Measuring effectiveness of retail promotions, warranty analytics. Renewal theory, Applications of renewal theory in operations and supply chain management.	5
6	**Operations Analytics:** MDS, Conjoint analysis, Cluster analysis, Discriminant analysis, ARCH (autoregressive conditional heteroscedasticity) and GARCH (Generalised autoregressive conditional heteroscedasticity), Monte Carlo simulation. Supply chain analytics. Six Sigma as a problem solving methodology, DMAIC and DMADV methodology, Six Sigma Tool Box: Logit Analysis Seven quality tools, Quality function, deployment (QFD), SIPOC, Statistical,	5

	process control, TRIZ,Classification and regression trees, (CART), Chi-squared automatic, interaction detector (CHAID), Value stream mapping.	
7	**Big Data Analytics:** Introduction to big data; sources of big data; big data technologies: Hadoop distributed file system; Employing Hadoop Map Reduce; Statistical Analysis of Big Data	6
8	**Advanced Analytics Modules:** complex decision-making scenario under uncertainty and how to deal with such problems using advanced tools and big-data. Discussion problems will be drawn from many sectors such as finance, banking, insurance, IT, ITeS, retail, service, manufacturing, pharmaceuticals, etc.	6
	Total	42

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1	**Big Data: A Revolution That Will Transform How We Live, Work and Think** by Viktor Mayer-Schonberger,Kenneth Cukier; Paperback , John Murray Pbl;isher,	2013
2	**Big Data Big Analytics** by Michael Minelli , Michele Chambers, Ambiga Dhiraj , John Wiley & Sons, Inc.	2013
3	**Data Analytics: Models and Algorithms for Intelligent Data Analysis** by Thomas A. Runkler , Springer publication.	2012
4	**Big Data Analytics** by D Loshin , Elseviers publication	2013
5	**Business Analytics for Managers** by Jank, Wolfgang, Springer publication.	2011
6	**A Practitioner's Guide To Business Analytics:** Using Data Analysis Tools to Improve Your Organization's Decision Making and Strategy, by Randy Bartlett . McGraw-Hill.	2013

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : DEPARTMENT OF MANAGEMENT STUDIES

1. **Subject Code : BM-683** **Course Title :** **STRATEGIC HUMAN RESOURCE 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. **Credits:** 3 **6. Semester:** Both

7. **Pre-requisite:** Nil **8. Subject Area:** PEC

9. **Objective:** To develop the perspective of strategic human resource management and understand the relationship of HR strategy with overall corporate strategy.

10. **Details of the Course:**

S. No.	Contents	Contact Hours
I	**Overview of Strategic Management :** Need and Importance, The resource based view of the firm, Strategic Fit: A conceptual framework, Mission, Values and Objectives, Analysis of organizational resources and capabilities	3
2	**Strategic Human Resource Management** – Theoretical perspectives on Strategic HRM, HRM in the Knowledge Economy, Linking HR strategies with business strategies	3
3	**Business environment and Human Resource strategies :** Human Resource based competitive advantage and external labor market, Suppliers of Human Resource, Users of Human Resource, Technological environment and its impact on Human Resource, Meaning of Human Resource systems, Inter-relationship between different systems and creating a HR based competitive advantage, Human Resource strategy options.	3
4	**Strategic Human Resource planning:** Classification of organizations based on the purpose of HR plan, Integration of HR plan and business plan, Activities related to strategic HR planning, Techniques of HR planning, Significance of HR planning in Indian industries	4
5	**Strategic approach to manpower acquisition and selection:** Introduction to Strategic recruitment, Location based employee market segmentation : Internal vs. External market, HR strategy driven employee market choice, External market: Advantages and Disadvantages, Business strategy driven external employee market choice, Segmenting employee market on the basis of time chosen to source market, Segmenting external market using instruments of contact, Segmenting the job seekers on basis of advertisement message used to attract them, Developing knowledge stock for future use. Objectives of strategic selection, Selection error and strategic implementation of cut-off score, Commonly used selection instruments and their advantages and disadvantages, Managerial selection for supporting the strategy of diversity.	4

6	**Strategic approach to management structure, job design and work systems:** Introduction to organizational structure, Evolution of structure, Structure when market knowledge assets are more valuable than purchased assets, Structure and organizational culture, Job Design, Alternative and high performance work systems, Developing knowledge resource for management of manpower.	4
7	**Strategic management of performance:** Introduction to Strategic management of performance, Linking strategy to results at different levels, Assessing performance at different levels, Assessing the performance of organization's human infrastructure, Developing effective performance management systems, Correcting the performance gaps.	4
8	**Strategic approach to compensations and benefits:** Introduction to employee compensation, Generic approach to strategic compensation, Strategic approach to compensation, Trends in Top-level Executive Compensation, Business Strategy and Compensation, Total Compensation and Rewards Strategy, Executive compensation.	4
	Mergers & acquisitions and HRM: Introduction, Mergers & Acquisition and resource driven strategies, Why a company acquires or merges with other company, Common problems in mergers and acquisitions, Role of HR in managing human capital stock: pre-acquisition planning, Post acquisition manpower planning and deployment, Approach towards HR system integration.	4
9	**Developing HR as strategic value addition Function** Gaining competitive advantage through HR, HR as a strategic business partner, the VRIO framework, Changing role of HR, Future challenges of HR	3
10	**Outsourcing and its HR implications:** Introduction, Why companies resort to outsourcing, Types of outsourcing, Outsourcing of HR management services.	3
12	**Strategies for quality of life for employees:** Changing notions of the work family relationship, Role of HR in creating work life balance, Family friendly work place, HRD perspective on work life integration, Development of work life initiatives, Towards a strategic approach to work life integration.	3
	Total	**42 hrs**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Das, Pulak. "Strategic Human Resource Management", 3rd Edition, Cengage Learning	2012
2.	Agarwala, T., "Strategic Human Resource Management", 4th Edition, Oxford University Press	2007
3.	Mello, Jeffrey A. "Strategic Human Resource Management", 3rdEdition, Cengage Learning	2010
4	Armstrong, M., "Armstrong's Handbook of Strategic Human Resource Management ", 5th Edition, Kogan Page	2011
5	Stewart, L. Greg and Brown, Kenneth, "Human Resource Management: Linking strategy to practice, 2nd edition, John Wiley	2012
6	Bratton, J.; Gold, J., "Human Resource Management: Theory and Practice", 5th Edition, Palgrave Macmillan	2012
7	Mondy, W. "Human Resource Management", 10th Edition, Pearson	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : DEPARTMENT OF MANAGEMENT STUDIES

1. **Subject Code** : BM-684 **Course Title** : **MARKETING METRICS**
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
5. **Credits:** 3 **6. Semester:** Both
7. **Pre-requisite:** Nil **8. Subject Area:** PEC

9. **Objective:** To help students utilize the theoretical knowledge of marketing in the real world by being able to calculate the different measures and thus help in decision making.

10. **Details of the Course:**

S. No.	Contents	Contact Hours
1	Customer focus and profitability metrics: De-averaging customer satisfaction and customer profitability, Profit impact of customer dissatisfaction, Lifetime value of a customer, Net promoter score, Measuring customer loyalty.	5
2	Marketing performance and marketing profitability: Marketing performance versus financial performance, Measuring Marketing performance, Marketing profitability metrics, Marketing ROI, Profit impact of marketing profitability metrics	5
3	Market potential, demand and market share: Calculating market potential, Market development index, Market demand and prices, Calculating margin across PLC Market share metrics	5
4	Customer experience and value creation: Empathic design, Reverse innovation, Cost of purchase index, Mass collaboration, Life cycle cost and customer value	5
5	Market segmentation and segmentation strategies: Need based segmentation, The demographic trap, Calculating the profitable segment,Customer relationship marketing	4

6	Value based pricing and pricing strategies: Price margin management, Product pricing across life cycle, Pricing and profitability, Pricing and breakeven volume, Pricing substitute products	5
	Marketing channels and channel mapping: Customer reach calculation, Operating efficiency, Improving cost efficiency across channel, Calculating size of sales force, Alternative channel marketing profitability	5
8	Marketing communications and customer response metrics: Customer response, index, Message frequency and customer awareness, Estimating Advertising elasticity, Promotional price elasticity, Statistical methods to estimate advertisement effects	4
9	Performance metrics and strategy implementation: Leveraging core capabilities, Resource allocation, Develop a revenue plan and marketing budget, Margin per customer, Customer volume, Gross profit, Return measures of profitability	4
	Total	**42 hrs**

11. Suggested Books:

S. No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Marketing Metrics, 2nd edition by Paul Farris, Neil Bendle, Philip Pfeifer and David Reibstein, Pearson Publication	2010
2.	Profitable customer engagement concept, metrics and strategies by V. Kumar, Sage Publications	2013
3	Market based management by Roger J Best, PHI Publications	2012

Program Code : **2XX - B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science & Engineering)**

Department : **Department of Computer Science and Engineering**

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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-005	Electrodynamics and Optics	BSC	4	3	0	2	3	2	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	35	50	-
4.	HSN-101A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-101B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self Awareness	HSSC	2	2	0	0	2	0	25	-	25	50	-
6.	CSN-101	Introduction to Computer Science and Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	CSN-103	Fundamentals of Object Oriented Programming	ESC*	4	3	0	2/2	3	0	20	20	20	40	-
		Total		**21**	**17**	**1**	**5**							
(Spring)														
1.	MAN-010	Optimization Techniques	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-006	Quantum Mechanics and Statistical Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	ECN-104	Digital Logic Design	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-102	Data Structures	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	CSN-106	Discrete Structures	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	ECN-102	Fundamentals of Electronics	ESC	4	3	1	0	3	0	25	-	25	50	-
		Total		**24**	**18**	**4**	**0**							

*Open to ECE and CSE disciplines only

Program Code : **2XX - B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science & Engineering)**

Department : **Department of Computer 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
(Autumn)														
1.	MIN-108	Engineering Thermodynamics	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-203	Signals and Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CSN-221	Computer Architecture and Microprocessors	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-261	Data Structures Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
5.	CSN-291	Object Oriented Analysis and Design	DCC	4	3	0	2	3	0	15	25	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**18/21**	**15**	**3**	**5**							
(Spring)														
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	CSN-212	Design and Analysis of Algorithms	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	CSN-232	Operating Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CSN-252	System Software	DCC	3	2	1	0	2	0	25	-	25	50	-
4.	CSN-254	Software Engineering	DCC	4	3	1	0	3	0	25	-	25	50	
6.	ECN-252	Digital Electronic Circuits Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
7.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**24/21**	**17**	**5**	**3**							

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

Program Code : **2XX - B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science & Engineering)**

Department : **Department of Computer 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
(Autumn)														
1.	CSN-341	Computer Networks	DCC	4	3	1	0	3	0	25	-	25	50	-
2.	CSN-351	Data Base Management Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CSN-353	Theory of Computation	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-361	Computer Networks Laboratory	DCC	2	0	0	3	0	0	-	100	-	-	-
5.	CS-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	OEC/ BMN-ELE	Open Elective Course/Management Studies Elective Course*	OEC/ HSSMEC	3	3	0	0	3	0	25	-	25	50	-
7.	CSN-391	Technical Communication	DCC	2	0	2	0	0	0	-	-	-	100	-
		Total		**23**	**15**	**6**	**3**							
(Spring)														
1.	CSN-300	Industry-oriented Problem / Lab-based Project / Software Engineering-based Project	DCC	4	0	0	6	0	0	-	100	-	-	-
2.	CSN-312	Principles of Programming Languages	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	CSN-352	Compiler Design	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-362	Compiler Laboratory	DCC	2	0	0	3	0	0	-	100	-	-	-
5.	CSN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	OEC/ BMN-ELE	Open Elective Course/Management Studies Elective Course*	OEC/ HSSMEC	3	3	0	0	3	0	25	-	25	50	-
7.	MSC1/ DHC1	Minor Specialization Course-I / Departmental Honours Course-I	MSC / DHC	4	3	1	0	3	0	25	-	25	50	-
8.	CSN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**19/23**	**12/ 15**	**2/3**	**9/9**							

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

Program Code : **2XX - B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science & Engineering)**

Department : **Department of Computer Science and Engineering**

Year : **IV**

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.	CSN-501	Advanced Algorithms	PCC	4	3	1	0	3	0	25	-	25	50	-
2.	CSN-502	Advanced Operating Systems	PCC	4	3	1	0	3	0	25	-	25	50	-
3.	CSN-503	Advanced Computer Networks	PCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-504	Lab I (Programming Lab)	PCC	2	0	0	3	0	0	-	100	-	-	-
5.	CSN-505	Lab II (Project Lab)	PCC	2	0	0	3	0	0	-	100	-	-	-
6.		Programme Elective 1	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		20	9	3	6							
Semester-II (Spring)														
1.	CSN-506	Advanced Computer Architecture	PCC	4	3	1	0	3	0	25	-	25	50	-
5.	CSN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
2.		Programme Elective 2	PEC	4	3	1	0	3	0	25	-	25	50	-
3.		Programme Elective 3	PEC	4	3	1	0	3	0	25	-	25	50	-
4.		Programme Elective 4	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	3	1	0							

Program Code : **2XX - B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science & Engineering)**

Department : **Department of Computer Science and Engineering**

Year : **V**

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.	CSN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	CSN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

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

Program Elective Courses (CSE)

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
Department Elective-I														
1.	CSN-510	Network Programming	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	CSN-511	Advanced Data Based Management Systems	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	CSN-512	Formal Methods and Software Verification	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-513	Information and Network Security	PEC	4	3	1	0	3	0	25	-	25	50	-
Department Elective-II,III, IV														
5.	CSN-514	Advanced Automata Theory	PEC	4	3	1	0	3	0	25	-	25	50	-
6.	CSN-515	Data Mining and Warehousing	PEC	4	3	1	0	3	0	25	-	25	50	-
7.	CSN-516	Modeling and Simulation	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	CSN-517	Advanced Topics in Software Engineering	PEC	4	3	1	0	3	0	25	-	25	50	-
9.	CSN-518	Logic and Automated Reasoning	PEC	4	3	1	0	3	0	25	-	25	50	-
10.	CSN-519	Social Network Analysis	PEC	4	3	1	0	3	0	25	-	25	50	-
11.	CSN-520	Cloud Computing	PEC	4	3	1	0	3	0	25	-	25	50	-
12.	CSN-521	Mobile and Pervasive Computing	PEC	4	3	1	0	3	0	25	-	25	50	-
13.	CSN-522	Advanced Graph Theory	PEC	4	3	1	0	3	0	25	-	25	50	-
14.	CSN-523	Computational Geometry	PEC	4	3	1	0	3	0	25	-	25	50	-

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)

Department : Department of Chemical Engineering

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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	CYN-001	Physical Chemistry	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self-awareness	HSSC	2	1	1	0	2	0	15	-	35	50	-
6.	CHN-101	Introduction to Chemical Engineering	DCC	2	2	0	0	0	0	-	-	-	100	-
7.	CHN-103	Computer Programming and Numerical Methods	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**2**	**6**							
(Spring)														
1.	CYN-002	Organic and Inorganic Chemistry	BSC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-102	Material and Energy Balance	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CHN-104	Fluid Dynamics	DCC	4	3	1	2/2	3	2	20	20	20	40	-
5.	CHN-106	Thermodynamics and Chemical Kinetics	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		**24**	**18**	**6**	**3**							

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)

Department : Department of Chemical 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
(Autumn)														
1.	CHN-201	Heat Transfer	DCC	4	3	1	2/2	3	3	20	20	20	40	-
2.	CHN-203	Mechanical Operations	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	CHN-205	Chemical Engineering Thermodynamics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CHN-207	Transport Phenomena	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MIN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	-	25	25	-	50
6.	HS-ELE	HSS Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**23**	**17**	**4**	**6**							
(Spring)														
1.	CHN-202	Mass Transfer -I	DCC	3	2	1	2/2	2	3	20	20	20	40	-
2.	CHN-204	Reaction Engineering	DCC	5	3	1	4/2	3	4	20	20	20	40	-
3.	CHN-206	Chemical Technology	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	CHN-210	Industrial Instrumentation	DCC	2	2	0	0	2	0	25	-	25	50	-
5.	CHN-112	Energy Engineering	ESC	4	3	1	0	3	0	25	-	25	50	-
6.	CHN-291	Equipment Design*	DCC	4	3	0	2	4	0	15	25	20	40	-
		Total		**21**	**16**	**3**	**5**							

Open book examinations of four hours duration

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)

Department : Department of Chemical 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
(Autumn)														
1.	CHN-301	Mass Transfer-II	DCC	5	3	1	3/2	3	3	20	20	20	40	-
2.	CHN-303	Process Dynamics and Control	DCC	4	3	1	2/2	3	3	20	20	20	40	-
3.	CHN-305	Process Equipment Design*	DCC	4	3	0	2	4	0	15	25	20	40	-
4.	CHN-ELE1	Departmental Elective Course-1	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
6.	CHN-391	Technical Communication	DCC	2	0	2	0	0	0	-	100	-	-	-
		Total		**22**	**15**	**5**	**4.5**							
(Spring)														
1.	CHN-300	Industry Oriented Problem/Case Study/Lab Based Project/Practical Problem	DCC	3	0	0	3	0	0	-	50	-	-	50
2.	CHN-302	Engineering Analysis and Process Modeling	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-304	Process Economics and Plant Design	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	CHN-306	Process Utilities and Safety	DCC	3	3	0	0	3	0	25	-	25	50	-
5.	CHN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	MSC1/ DHC1	Minor Specialization Course-I/ Departmental Honours Course-I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
7.	BMN-ELE	Any one Elective course from 'Management Studies'	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
8.	CHN-399	Educational Tour	DCC	0	0	0	0	0	0	-	50	-	-	50
		Total		**20/24**	**15/18**	**2/3**	**3**							

Open book examinations of four hours duration

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)

Department : Department of Chemical Engineering

Year: : IV

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.	CHN-501	Numerical Methods in Chemical Engineering	PCC	4	3	0	2	3	0	15	25	20	40	-
2.	CHN-503	Advanced Transport Phenomena	PCC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-505	Chemical Reactor Analysis	PCC	4	3	1	0	3	0	25	-	25	50	-
4.	CHN-507	CAD of Heat Transfer Equipment	PCC	4	3	0	2	3	0	15	25	20	40	-
5.		Programme Elective-I	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		20	12	2	4							
Semester-II (Spring)														
1.	CHN-502	CAD of Mass Transfer Equipment	PCC	4	3	0	2	3	0	15	25	20	40	-
2.	CHN-700	Seminar	SEM	2	0	0	-	-	-	-	-	-	100	-
3.		Programme Elective-II	PEC	4	3	1	0	3	0	25	-	25	50	-
4.		Programme Elective-III	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Programme Elective-IV	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	3	0	2							

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Computer Aided Process Plant Design)

Department : Department of Chemical Engineering

Year: : V

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.	CHN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	CHN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary

Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**24**	**23**	**21**	22	20/24	22	18	12	18
Total Credits	**201/205**									

Program Elective Courses (CAPPD)

PROGRAM ELECTIVE – I (For Autumn Semester)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	CHN-561	Computational Fluid Dynamics	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	CHN-563	Process Integration	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-565	Optimization of Chemical Processes	PEC	4	3	1	0	3	0	25	-	25	50	-

PROGRAM ELECTIVES – II, III and IV (For Spring Semester)

4.	CHN-562	Modeling of Chemical Engineering Systems	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	CHN-564	Heterogeneous Catalysis & Reactor Design	PEC	4	3	1	0	3	0	25	-	25	50	-
6.	CHN-566	Design of Piping Systems	PEC	4	3	1	0	3	0	25	-	25	50	-
7.	CHN-568	Advanced Process Control	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	CHN-570	Natural Gas Engineering	PEC	4	3	1	0	3	0	25	-	25	50	-
9.	CHN-572	Waste to Energy	PEC	4	3	1	0	3	0	25	-	25	50	-
10	CHN-574	Novel Separation Techniques	PEC	4	3	1	0	3	0	25	-	25	50	-

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)

Department : Department of Chemical Engineering

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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	CYN-001	Physical Chemistry	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self-awareness	HSSC	2	1	1	0	2	0	15	-	35	50	-
6.	CHN-101	Introduction to Chemical Engineering	DCC	2	2	0	0	0	0	-	-	-	100	-
7.	CHN-103	Computer Programming and Numerical Methods	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**2**	**6**							
(Spring)														
1.	CYN-002	Organic and Inorganic Chemistry	BSC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MAN-002A	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-102	Material and Energy Balance	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CHN-104	Fluid Dynamics	DCC	4	3	1	2/2	3	2	20	20	20	40	-
5.	CHN-106	Thermodynamics and Chemical Kinetics	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	MEN-003	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	0	25	25	-	50
		Total		**24**	**17**	**5**	**6**							

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)

Department : Department of Chemical 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
(Autumn)														
1.	CHN-201	Heat Transfer	DCC	4	3	1	2/2	3	3	20	20	20	40	-
2.	CHN-203	Mechanical Operations	DCC	4	3	1	2/2	3	2	20	20	20	40	-
3.	CHN-205	Chemical Engineering Thermodynamics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CHN-207	Transport Phenomena	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	EEN-001	Elecirical Science	ESC	4	3	1	2/2	3	2	15	15	15	40	15
6.	HS-ELE	HSS Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**23**	**17**	**4**	**6**							
(Spring)														
1.	CHN-202	Mass Transfer -I	DCC	3	2	1	2/2	2	3	20	20	20	40	-
2.	CHN-204	Reaction Engineering	DCC	5	3	1	4/2	3	4	20	20	20	40	-
3.	CHN-206	Chemical Technology	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	CHN-210	Industrial Instrumentation	DCC	2	2	0	0	2	0	25	-	25	50	-
5.	CHN-001	Energy Engineering	ESC	4	3	1	0	3	0	25	-	25	50	-
6.	CHN-208	Equipment Design*	DCC	4	3	0	2	3	2	-	25	25	50	-
		Total		**21**	**16**	**3**	**5**							

Open book examinations of four hours duration

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)

Department : Department of Chemical 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
				(Autumn)										
1.	CHN-301	Mass Transfer-II	DCC	5	3	1	3/2	3	3	20	20	20	40	-
2.	CHN-303	Process Dynamics and Control	DCC	4	3	1	2/2	3	3	20	20	20	40	-
3.	CHN-305	Process Equipment Design*	DCC	4	3	0	2	4	0	15	25	20	40	-
4.	CHN-ELE1	Departmental Elective Course-1	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
6.	CHN-309	Technical Communication	DCC	2	0	2	0	0	0	-	100	-	-	-
		Total		**22**	**15**	**5**	**4.5**							
				(Spring)										
1.	CHN-308	Industry Oriented Problem/Case Study/Lab Based Project/Practical Problem	DCC	3	0	0	3	0	0	-	50	-	-	50
2.	CHN-302	Process Modeling and Simulation	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	CHN-304	Process Economics and Plant Design	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	CHN-306	Process Utilities and Safety	DCC	3	3	0	0	3	0	25	-	25	50	-
5.	CHN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	MSC1/ DHC1	Minor Specialization Course-I/ Departmental Honours Course-I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
7.	BMN-ELE	Any one Elective course from 'Management Studies'	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
8.	CHN-310	Educational Tour	DCC	0	0	0	0	0	0	-	50	-	-	50
		Total		**20/24**	**12/15**	**2/3**	**3**							

Open book examinations of four hours duration

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)

Department : Department of Chemical Engineering

Year: : IV

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.	CHN-511	Air Pollution Control Engineering	PCC	4	3	1	0	3	0	25	-	25	50	-
2.	CHN-513	Water Pollution Control Engineering	PCC	4	3	0	2	3	0	15	25	20	40	-
3.	CHN-515	System Approach to Environmental Engineering	PCC	4	3	0	2	3	0	15	25	20	40	-
4.	CHN-517	Biochemical Engineering	PCC	4	3	1	0	3	0	25	-	25	50	-
5.		Programme Elective-I	PEC	4	3	1	0	3	0	25	-	25	50	-
6.	CHN-401	Training Seminar	DCC	2	0	2	0	0	0	10	-	-	-	-
			Total	22	15	5	4							
Semester-II (Spring)														
1.	CHN-512	Solid and Hazardous Waste Management	PCC	4	3	1	0	3	0	25	-	25	50	-
2.	CHN-700	Seminar	SEM	2	0	0	2	-	-	-	-	-	100	-
3.		Programme Elective-II	PEC	4	3	1	0	3	0	25	-	25	50	-
4.		Programme Elective-III	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Programme Elective-IV	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	15	4	0							

Program Code : 2XX - B.Tech. (Chemical Engineering) and M.Tech. (Industrial Pollution Abatement)

Department : Department of Chemical Engineering

Year: : V

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.	CHN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	CHN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary										
Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**24**	**23**	**21**	**22**	**20/24**	**22**	**18**	**12**	**18**
8otal Credits	**201/205**									

Program Elective Courses (IPA)

PROGRAM ELECTIVE – I (For Autumn Semester)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	CH-561	Computational Fluid Dynamics	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	CH-571	Data Acquisition and Monitoring Techniques	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	CH-573	Design of Experiments and Parameter Estimation	PEC	4	3	1	0	3	0	25	-	25	50	-

LIST OF **PROGRAM ELECTIVES – II, III and IV** (For Spring Semester)

4.	CH-572	Waste to Energy	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	CH-574	Novel Separation Techniques	PEC	4	3	1	0	3	0	25	-	25	50	-
6.	CH-582	Environmental Impact Assessment	PEC	4	3	1	0	3	0	25	-	25	50	-
7.	CH-584	Industrial Safety and Hazards Management	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	CH-586	Design of Pollution Control Systems	PEC	4	3	1	0	3	0	25	-	25	50	-
9.	CH-588	Clean Technology	PEC	4	3	1	0	3	0	25	-	25	50	-
10	CH-590	Environmental Chemistry	PEC	4	3	1	0	3	0	25	-	25	50	-

Program Code : **2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)**
Department : **Department of Electronics and Communication**
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-005	Electrodynamics and Optics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	ECN-101	Introduction to Electronics and Communication Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	CSN-103	Fundamentals of Object Oriented Programming	ESC*	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**3**	**4**							
			(Spring)											
1.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-006	Quantum Mechanics and Statistical Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CSN-102	Data Structures	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-104	Digital Logic Design	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-142	Semiconductor Devices	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		**24**	**18**	**5**	**4**							

*Open to ECE and CSE disciplines only.

Program Code : **2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)**
Department : **Department of Electronics and Communication**
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.	MEN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	-	50	-	-	50
2.	ECN-203	Signals and Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-205	Analog Circuits	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-221	Computer Architecture and Microprocessors	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-291	Electronic Network Theory (Engineering Analysis and Design course)	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	HS-ELE	HSS Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**23**	**17**	**4**	**4**							
(Spring)														
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-212	Principles of Digital Communication	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-222	Automatic Control Systems	DCC	4	3	0	3	3	0	20	20	20	40	-
5.	ECN-232	Engineering Electromagnetics	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	ECN-252	Digital Electronic Circuits Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
		Total		**22**	**15**	**4**	**6**							

Program Code : **2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)**
Department : **Department of Electronics and Communication**
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.	ECN-311	Communication Systems and Techniques	DCC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-331	Antenna Theory	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-333	Microwave Engineering	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-341	Microelectronic Devices, Technology and Circuits	DCC	2	1	0	2	0	2	15	35	-	-	50
5.	ECN-351	IC Application Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	BMN-ELE	Management Studies Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
8.	ECN-391	Technical Communication	DCC	2	0	2	0	0	0	-	-	-	100	-
		Total		**23**	**16**	**4**	**5**							
(Spring)														
1.	ECN-300	Industry-oriented Problem / Case study / Lab-based Project / Practical Problem	DCC	3	0	0	6	0	0	-	100	-	-	-
2.	ECN-312	Digital Signal Processing	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-342	RF and Mixed Signals Circuits	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-352	Communication Systems Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
5.	ECN-354	Microwave Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
8.	MSC1/DHC1	Minor Specialization Course-I/ Departmental Honours Course-I	MSC/ DHC	3	3	0	0	3	0	25	-	25	50	-
9.	ECN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**20/23**	**12/ 15**	**1**	**12**							

Program Code : **2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)**
Department : **Department of Electronics and Communication**
Year : **IV**

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.	ECN-511	Digital Communication Systems	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-512	Information and Communication Theory	PCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-510	Laboratory	PCC	2	0	0	3	0	0	-	100	-	-	-
4.	ECN-600	Lab-based Project	PCC	2	0	0	3	0	0	-	100	-	-	-
5.		PROGRAM ELECTIVE - I	PEC	4	-	-	-	-	-	-	-	-	-	-
6.		PROGRAM ELECTIVE – II	PEC	3	-	-	-	-	-	-	-	-	-	-
7.		PROGRAM ELECTIVE - III	PEC	3	-	-	-	-	-	-	-	-	-	-
8.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		22	6	0	6							
Semester-II (Spring)														
1.	ECN-515	Coding Theory and Applications	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-612	Wireless Networks	PCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-601	Lab-based Project	PCC	2	0	0	3	0	0	-	100	-	-	-
4.	ECN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
5.		PROGRAM ELECTIVE - IV	PEC	3	-	-	-	-	-	-	-	-	-	-
6.		PROGRAM ELECTIVE - V	PEC	3	-	-	-	-	-	-	-	-	-	-
		Total		16	6	0	3							

Program Code : **2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Communication Systems)**
Department : **Department of Electronics and Communication**
Year : **V**

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.	ECN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	ECN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits	**66**			

Program Elective Courses (Communication Systems)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	ECN-516	Advanced Digital Communication Techniques	PEC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-521	Advanced Mathematics	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-522	Digital Signal Processing & Applications	PEC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-523	Robotics & Computer Vision	PEC	3	3	0	0	3	0	25	-	25	50	-
5.	ECN-539	Fiber Optic Systems	PEC	3	3	0	0	3	0	25	-	25	50	-
6.	ECN-513	Telecommunication Networks	PEC	3	3	0	0	3	0	25	-	25	50	-
7.	ECN-518	Speech and Audio Processing	PEC	3	3	0	0	3	0	25	-	25	50	-
8.	ECN-614	Adaptive Signal Processing Techniques	PEC	3	3	0	3	0	0	15	25	20	40	-

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
Department : Department of Electronics and Communication
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-005	Electrodynamics and Optics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	ECN-101	Introduction to Electronics and Communication Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	CSN-103	Fundamentals of Object Oriented Programming	ESC*	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**3**	**4**							
			(Spring)											
1.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-006	Quantum Mechanics and Statistical Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CSN-102	Data Structures	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-104	Digital Logic Design	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-142	Semiconductor Devices	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		**24**	**18**	**5**	**4**							

*Open to ECE and CSE disciplines only.

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
Department : Department of Electronics and Communication
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.	MEN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	-	50	-	-	50
2.	ECN-203	Signals and Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-205	Analog Circuits	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-221	Computer Architecture and Microprocessors	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-291	Electronic Network Theory (Engineering Analysis and Design course)	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	HS-ELE	HSS Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**23**	**17**	**4**	**4**							
			(Spring)											
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-212	Principles of Digital Communication	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-222	Automatic Control Systems	DCC	4	3	0	3	3	0	20	20	20	40	-
5.	ECN-232	Engineering Electromagnetics	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	ECN-252	Digital Electronic Circuits Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
		Total		**22**	**15**	**4**	**6**							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
Department : Department of Electronics and Communication
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.	ECN-311	Communication Systems and Techniques	DCC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-331	Antenna Theory	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-333	Microwave Engineering	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-341	Microelectronic Devices, Technology and Circuits	DCC	2	1	0	2	0	2	15	35	-	-	50
5.	ECN-351	IC Application Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	BMN-ELE	Management Studies Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
8.	ECN-391	Technical Communication	DCC	2	0	2	0	0	0	-	-	-	100	-
		Total		**23**	**16**	**4**	**5**							
(Spring)														
1.	ECN-300	Industry-oriented Problem / Case study / Lab-based Project / Practical Problem	DCC	3	0	0	6	0	0	-	100	-	-	-
2.	ECN-312	Digital Signal Processing	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-342	RF and Mixed Signals Circuits	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-352	Communication Systems Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
5.	ECN-354	Microwave Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
8.	MSC1/DHC1	Minor Specialization Course-I/ Departmental Honours Course-I	MSC/ DHC	3	3	0	0	3	0	25	-	25	50	-
9.	ECN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**20/23**	**12/ 15**	**1**	**12**							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
Department : Department of Electronics and Communication
Year : IV

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.	ECN-571	Semiconductor Device Modelling	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-572	MOS Device Physics	PCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-573	Digital VLSI Circuit Design	PCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-574	Semiconductor Materials, Devices & Characterization	PCC	3	3	0	0	3	0	25	-	25	50	-
5.	ECN-575	Microelectronics Lab-1	PCC	2	0	0	3	0	3	-	100	-	-	-
6.	ECN-576	Simulation Lab-1	PCC	2	0	0	3	0	3	-	100	-	-	-
7.		PROGRAM ELECTIVE-I	PEC	4	-	-	-	-	-	-	-	-	-	-
8.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		22	12	0	6							
Semester-II (Spring)														
1.	ECN-577	VLSI Technology	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-700	Seminar	SEM	2	0	0	0	0	3	-	100	-	-	-
3.		PROGRAM ELECTIVE-II	PEC	3/4	-	-	-	-	-	-	-	-	-	-
4.		PROGRAM ELECTIVE-III	PEC	3/4	-	-	-	-	-	-	-	-	-	-
5.		PROGRAM ELECTIVE-IV	PEC	3/4	-	-	-	-	-	-	-	-	-	-
6.		PROGRAM ELECTIVE-V	PEC	2	-	-	-	-	-	-	-	-	-	-
		Total		16/19	3	0	0							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (Microelectronics and VLSI)
Department : Department of Electronics and Communication
Year : V

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.	ECN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	ECN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (Microelectronics & VLSI)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	ECN-581	Analog VLSI Circuit Design	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-582	Semiconductor Microwave Devices & Applications	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-583	Optoelectronic Materials & Devices	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-584	Mixed Signal Circuit Design	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-585	VLSI System Design	PEC	4	3	1	0	3	0	25	-	25	50	-
6.	ECN-586	Device & Circuit Interaction	PEC	4	3	1	0	3	0	25	-	25	50	-
7.	ECN-587	Nano Scale Devices	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	ECN-588	Performance and Reliability of VLSI Circuits	PEC	4	3	1	0	3	0	25	-	25	50	-
9.	ECN-589	Advanced VLSI Interconnects	PEC	4	3	1	0	3	0	25	-	25	50	-
10.	ECN-590	Organic Electronics	PEC	4	3	1	0	3	0	25	-	25	50	-
11.	ECN-591	VLSI Physical Design	PEC	4	3	1	0	3	0	25	-	25	50	-
12.	ECN-592	Compound Semiconductors and RF Devices	PEC	4	3	1	0	3	0	25	-	25	50	-
13.	ECN-593	CAD for VLSI	PEC	4	3	1	0	3	0	25	-	25	50	-
14.	ECN-594	VLSI Digital Signal Processing	PEC	4	3	1	0	3	0	25	-	25	50	-
15.	ECN-595	VLSI Testing and Testability	PEC	4	3	1	0	3	0	25	-	25	50	-
16.	ECN-596	MEMS and NEMS	PEC	4	3	1	0	3	0	25	-	25	50	-
17.	ECN-597	Microelectronics Lab.-2	PEC	2	-	-	2	-	-	-	100	-	-	-
18.	ECN598	Simulation Lab.-2	PEC	2	-	-	2	-	-	-	100	-	-	-

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
Department : Department of Electronics and Communication
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-005	Electrodynamics and Optics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A	Communication Skills (Basic)	HSSC	2	1	0	2	2	0	25	-	25	50	-
	HSN-001B	Communication Skills (Advance)												
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	ECN-101	Introduction to Electronics and Communication Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	CSN-103	Fundamentals of Object Oriented Programming	ESC*	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**3**	**4**							
			(Spring)											
1.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-006	Quantum Mechanics and Statistical Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CSN-102	Data Structures	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-104	Digital Logic Design	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-142	Semiconductor Devices	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
		Total		**24**	**18**	**5**	**4**							

*Open to ECE and CSE disciplines only.

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
Department : Department of Electronics and Communication
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.	MEN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	0	4	-	50	-	-	50
2.	ECN-203	Signals and Systems	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-205	Analog Circuits	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	CSN-221	Computer Architecture and Microprocessors	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-291	Electronic Network Theory (Engineering Analysis and Design course)	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	HS-ELE	HSS Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**23**	**17**	**4**	**4**							
			(Spring)											
1.	MTN-105	Electrical and Electronic Materials	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-212	Principles of Digital Communication	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-222	Automatic Control Systems	DCC	4	3	0	3	3	0	20	20	20	40	-
5.	ECN-232	Engineering Electromagnetics	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	ECN-252	Digital Electronic Circuits Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
		Total		**22**	**15**	**4**	**6**							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
Department : Department of Electronics and Communication
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.	ECN-311	Communication Systems and Techniques	DCC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-331	Antenna Theory	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-333	Microwave Engineering	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-341	Microelectronic Devices, Technology and Circuits	DCC	2	1	0	2	0	2	15	35	-	-	50
5.	ECN-351	IC Application Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	BMN-ELE	Management Studies Elective Course	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
8.	ECN-391	Technical Communication	DCC	2	0	2	0	0	0	-	-	-	100	-
		Total		**23**	**16**	**4**	**5**							
(Spring)														
1.	ECN-300	Industry-oriented Problem / Case study / Lab-based Project / Practical Problem	DCC	3	0	0	6	0	0	-	100	-	-	-
2.	ECN-312	Digital Signal Processing	DCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-342	RF and Mixed Signals Circuits	DCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-352	Communication Systems Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
5.	ECN-354	Microwave Laboratory	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	ECN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
7.	OEC	Open Elective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
8.	MSC1/DHC 1	Minor Specialization Course-I/ Departmental Honours Course-I	MSC/ DHC	3	3	0	0	3	0	25	-	25	50	-
9.	ECN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**20/23**	**12/ 15**	**1**	**12**							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
Department : Department of Electronics and Communication
Year : IV

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.	ECN-531	Microwave Engineering	PCC	4	3	0	0	3	0	25	-	25	50	-
2.	ECN-532	Advanced EMFT	PCC	3	3	0	0	3	0	25	-	25	50	-
3.	ECN-534	Antenna Theory & Design	PCC	3	3	0	0	3	0	25	-	25	50	-
4.	ECN-530	Microwave Lab	PCC	2	0	0	3	0	0	0	100	-	-	-
5.		Elective - I	PEC	3/4	-	-	-	-	-	-	-	-	-	-
6.		Elective - II	PEC	3/4	-	-	-	-	-	-	-	-	-	-
7.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		20/22	9	1	3							
Semester-II (Spring)														
1.	ECN-631	RF Receiver Design	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	ECN-630	Wireless Comm. Lab.	PCC	2	0	0	3	0	0	-	100	-	-	-
3.	ECN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
4.		Elective – III	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Elective – IV	PEC	4	-	-	-	-	-	-	-	-	-	-
6.		Elective - V	PEC	3/4	-	-	-	-	-	-	-	-	-	-
		Total		18/19	3	0	3							

Program Code : 2XX - B. Tech. (Electronics and Communication Engineering) and M.Tech. (RF and Microwave Engineering)
Department : Department of Electronics and Communication
Year : V

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.	ECN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	ECN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (RF and Microwave Engineering)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	ECN-541	Computational Techniques for Microwaves	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	ECN-542	Microwave Integrated Circuits	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	ECN-543	High Power mm/THz Wave Engineering	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	ECN-544	Advanced Radar Engineering	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	ECN-539	Fiber Optic Systems	PEC	3	3	0	0	3	0	25	-	25	50	-
6.	ECN-511	Digital Communication Systems	PEC	3	3	0	0	3	0	25	-	25	50	-
7.	ECN-521	Advanced Maths	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	ECN-548	RF & Microwave MEMS	PEC	3	3	0	0	3	0	25	-	25	50	-
9.	ECN-549	RF CMOS Transceiver Design	PEC	3	3	0	0	3	0	25	-	25	50	-
10.	ECN-550	Radar Signal Processing	PEC	4	3	1	0	3	0	25	-	25	50	-
11.	ECN-551	Adaptive Beam Forming and Smart Antennas	PEC	4	3	1	0	3	0	25	-	25	50	-
12.	ECN-552	Soft Computing Techniques for RF Engineering	PEC	3	3	0	0	3	0	25	-	25	50	-
13.	ECN-516	Advanced Digital Communication Techniques	PEC	3	3	0	0	3	0	25	-	25	50	-
14.	ECN-554	Microwave and Millimeter Wave Circuits	PEC	3	3	0	0	3	0	25	-	25	50	-
15.	ECN-555	Microwave Imaging	PEC	3	3	0	0	3	0	25	-	25	50	-

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-001	Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MIN-101A	Introduction to Mechanical Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	MIN-103	Programming and Data Structure	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**06**							
(Spring)														
1.	MAN-004	Numerical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-008	Electromagnetic Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-104	Manufacturing Technology-I	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-106	Engineering Thermodynamics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-108	Mechanical Engineering Drawing	DCC	4	2	0	4	3	0	-	25	25	50	-
6.	MTN-106	Material Science	ESC	4	3	1	0	3	0	25	-	25	50	-
		Total		**24**										

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	CEN-102	Solid Mechanics	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MIN-201	Kinematics of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-203	Manufacturing Technology-II	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-205	Fluid Mechanics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-291	Engineering Analysis and Design	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	2	1	0	3	0	50	-	-	50
		Total		**20-23**										
(Spring)														
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-204	Machine Drawing	DCC	4	2	0	4	4	0	-	25	25	50	-
3.	MIN-206	Mechanics of Materials	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-208	Theory of Production Processes	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-210	Energy Conversion	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	2	1	0	3	0	50	-	-	50
		Total		**23-20**										

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

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	MIN-301	Dynamics of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-303	Principles of Industrial Engineering	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-305	Heat and Mass Transfer	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
6.	MIN-391	Technical Communication	DCC	2	0	2	0	-	-	-	-	-	100	-
		Total		**21**										
(Spring)														
1.	MIN-300	Industry Oriented Problem/Case Study/ Lab based project/ Practical Problem	DCC	4	0	0	6	-	-	100	-	-	-	-
2.	MIN-302	Machine Design	DCC	6	4	0	4	4	-	20	20	20	40	-
3.	MIN-304	Fluid Machinery	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC1	Minor Specialization Course- I Departmental Honours Course-I	MSC/DHC	4	3 3	1 1	0 0	3 3	0 0	25 25	- -	25 25	50 50	- -
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
7.	MIN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**21/25**										

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

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **IV**

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.	MIN-511A	Modeling and Simulation	PCC	4	3	1	2/2	3	--	20	20	20	40	--
2.	MIN-520	Advanced Thermodynamics	PCC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-521	Advanced Fluid Mechanics	PCC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-522	Advanced Heat Transfer	PCC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-527	Computational Fluid Dynamics & Heat Transfer	PCC	4	3	1	0	3	--	25	--	25	50	--
6.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		22	15	5	1							
Semester-II (Spring)														
1.		Program Elective-I	PEC	4	-	-	-	-	-	-	-	-	-	-
2.		Program Elective-II	PEC	4	-	-	-	-	-	-	-	-	-	-
3.		Program Elective-III	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Program Elective-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	MIN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
		Total		18										

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **V**

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.	MIN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MIN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (Thermal Engineering)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MIN-523	Gas Turbines & Compressors	PEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-524	Two Phase Flow & Heat Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-525	Solar Energy	PEC	4	3	1	2/2	3	--	20	20	20	40	--
4.	MIN-526	Advanced Gas Dynamics	PEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-528	Boundary Layer Theory	PEC	4	3	1	2/2	3	--	20	20	20	40	--
6.	MIN-529	Turbulent Flow	PEC	4	3	1	2/2	3	--	20	20	20	40	--
7.	MIN-530	Cold Preservation of Food	PEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-531	Hydro-dynamic Machines	PEC	4	3	1	2/2	3	--	20	20	20	40	--
9.	MIN-532	Renewable Energy Systems	PEC	4	3	1	2/2	3	--	20	20	20	40	--
10.	MIN-533	Refrigeration & Air-Conditioning System Design	PEC	4	3	1	2/2	3	--	20	20	20	40	--
11.	MIN-534	Air Conditioning and Ventilation	PEC	4	3	1	2/2	3	--	20	20	20	40	--
12.	MIN-535	Cryogenic Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-536	Convective Heat and Mass Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--

14.	MIN-537	I. C. Engines	PEC	4	3	1	2/2	3	--	20	20	20	40	--
15.	MIN-538	I. C. Engine Combustion Processes Modeling	PEC	4	3	1	2/2	3	--	20	20	20	40	--
16.	MIN-539	Micro and Nano Scale Thermal Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-540	Combustion	PEC	4	3	1	2/2	3	--	20	20	20	40	--
18.	MIN-541	Bio-Fluid Mechanics	PEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-542	Energy Management	PEC	4	3	1	2/2	3	--	20	20	20	40	--
20.	MIN-543	Fluid Power Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-544	Design of Heat Exchangers	PEC	4	3	1	0	3	--	25	--	25	50	--
22.	MIN-545	Fuel Cells	PEC	4	3	1	2/2	3	--	20	20	20	40	--
23.	MIN-500	Instrumentation and Experimental Methods	PEC	4	3	1	2/2	3	--	20	20	20	40	--
24.	MIN-603	Finite Element Method for Thermal Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-604	Fire Dynamics	PEC	4	3	1	2/2	3	--	20	20	20	40	--

Department Elective Courses (MI-ELE1/ ELE2/ ELE3/ ELE4)

Teaching Scheme					Contact Hrs Per Week			Exam Duration (Hrs)		Relative Weightage (%)				
S No.	Course No.	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1.	MIN-320	Automobile Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-321	Vibration and Noise	DEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-322	Principles of Lubrication Technology	DEC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-323	Design of Pressure Vessels & Piping	DEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-324	FEM applications in Mechanical Engg.	DEC	4	3	1	0	3	--	25	--	25	50	--
6.	MIN-325	Numerical Methods in Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
7.	MIN-326	Value Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-327	Reverse Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
9.	MIN-328	Manufacturing System Analysis	DEC	4	3	1	0	3	--	25	--	25	50	--
10.	MIN-329	Computer Integrated Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
11.	MIN-330	Ergonomics	DEC	4	3	1	0	3	--	25	--	25	50	--
12.	MIN-331	Total Quality Management	DEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-332	Industrial Hazards and Safety	DEC	4	3	1	0	3	--	25	--	25	50	--

14.	MIN-333	Industrial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
15.	MIN-334	Facilities Design	DEC	4	3	1	0	3	--	25	--	25	50	--
16.	MIN-335	Concurrent Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-336	Financial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
18.	MIN-337	Processing of Non-Metals	DEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-338	Measurement and Instrumentation	DEC	4	3	1	2/ 2	3	--	20	20	20	40	--
20.	MIN-339	Design of Heat Exchangers	DEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-340	Refrigeration and Air-Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
22.	MIN-341	Thermal Systems Design	DEC	4	3	1	0	3	--	25	--	25	50	--
23.	MIN-342	Environmental Pollution and Control	DEC	4	3	1	0	3	--	25	--	25	50	--
24.	MIN-343	Power Plants	DEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-344	Industrial Combustion	DEC	4	3	1	0	3	--	25	--	25	50	--
26.	MIN-345	Compressible Flow	DEC	4	3	1	0	3	--	25	--	25	50	--
27.	MIN-346	Waste Heat recovery Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
28.	MIN-347	Fluid Power Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
29.	MIN-348	Energy Management	DEC	4	3	1	2/ 2	3	--	20	20	20	40	--

30.	MIN-349	Fire Dynamics	DEC	4	3	1	0	3	--	25	--	25	50	--
31.	MIN-350	Industrial Ventilation and Air Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
32.	MIN-351	Gas Turbines	DEC	4	3	1	0	3	--	25	--	25	50	--
33.	MIN-352	Experimental Methods in Thermal Engineering	DEC	4	3	1	2/ 2	3	--	20	20	20	40	--
34.	MIN-354	Automatic Control	DEC	4	3	1	2/ 2	3	--	20	20	20	40	--

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-001	Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MIN-101B	Introduction to Production and Industrial Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	MIN-103	Programming and Data Structure	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**06**							
(Spring)														
1.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-008	Electromagnetic Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-104	Manufacturing Technology-I	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-108	Engineering Drawing	DCC	4	2	0	4	3	0	-	25	25	50	-
5.	MIN-110	Fluid Mechanics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	MTN-106	Material Science	ESC	4										
		Total		**24**										

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	CEN-102	Solid Mechanics	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MIN-203	Manufacturing Technology-II	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-209	Thermal Engineering	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-211	Theory of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-291	Engineering Analysis and Design	DCC	4	-	-	-	-	-	-	-	-	-	-
6.	HS- ELE	HSS Elective Course*	HSSMEC*	3	3	2	1	0	3	-	25	-	25	50
		Total		**20/23**										
(Spring)														
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-210	Production Planning and Control	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-212	Machine Design	DCC	4	2	0	4	3	0	15	25	20	40	-
4.	MIN-214	Engineering Economy	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MIN-216	Theory of Production Processes - I	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC*	3	3	2	1	0	3	0	25	-	25	50
		Total		**23/20**										

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

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	MIN-391	Technical Communication	DCC	2	0	2	0	-	-	100	-	-	-	-
2.	MIN-309	Theory of Production Processes - II	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-311	Operations Research	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MIN-313	Work System Design	DCC	4	3	0	2/2	3	0	20	20	20	40	-
5.	MIN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/	3	3	2	1	0	2	0	25	-	25	50
		Total		**21**										
(Spring)														
1.	MIN-300	Industry Oriented Problem/Case Study/ Lab based project/ Practical Problem	DCC	4	0	0	6	-	-	100	-	-	-	-
2.	MIN-310	Quality Management	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-312	Operations Management	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MIN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC 1	Minor Specialization Course – I/ Departmental Honours Course – I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
					3	1	0	3	0	25	-	25	50	-
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
7.	MIN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**19/23**										

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

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **IV**

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.	MIN-511A	Modeling and Simulation	PCC	4	3	1	2/2	3	--	20	20	20	40	--
2.	MIN-520	Advanced Thermodynamics	PCC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-521	Advanced Fluid Mechanics	PCC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-522	Advanced Heat Transfer	PCC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-527	Computational Fluid Dynamics & Heat Transfer	PCC	4	3	1	0	3	--	25	--	25	50	--
6.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		22	15	5	1							
Semester-II (Spring)														
1.		Program Elective-I	PEC	4	-	-	-	-	-	-	-	-	-	-
2.		Program Elective-II	PEC	4	-	-	-	-	-	-	-	-	-	-
3.		Program Elective-III	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Program Elective-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
5.	MIN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
		Total		18										

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M. Tech. (Thermal Engineering)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **V**

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.	MIN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MIN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (Thermal Engineering)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MIN-523	Gas Turbines & Compressors	PEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-524	Two Phase Flow & Heat Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-525	Solar Energy	PEC	4	3	1	2/2	3	--	20	20	20	40	--
4.	MIN-526	Advanced Gas Dynamics	PEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-528	Boundary Layer Theory	PEC	4	3	1	2/2	3	--	20	20	20	40	--
6.	MIN-529	Turbulent Flow	PEC	4	3	1	2/2	3	--	20	20	20	40	--
7.	MIN-530	Cold Preservation of Food	PEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-531	Hydro-dynamic Machines	PEC	4	3	1	2/2	3	--	20	20	20	40	--
9.	MIN-532	Renewable Energy Systems	PEC	4	3	1	2/2	3	--	20	20	20	40	--
10.	MIN-533	Refrigeration & Air-Conditioning System Design	PEC	4	3	1	2/2	3	--	20	20	20	40	--
11.	MIN-534	Air Conditioning and Ventilation	PEC	4	3	1	2/2	3	--	20	20	20	40	--
12.	MIN-535	Cryogenic Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-536	Convective Heat and Mass Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--

14.	MIN-537	I. C. Engines	PEC	4	3	1	2/2	3	--	20	20	20	40	--
15.	MIN-538	I. C. Engine Combustion Processes Modeling	PEC	4	3	1	2/2	3	--	20	20	20	40	--
16.	MIN-539	Micro and Nano Scale Thermal Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-540	Combustion	PEC	4	3	1	2/2	3	--	20	20	20	40	--
18.	MIN-541	Bio-Fluid Mechanics	PEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-542	Energy Management	PEC	4	3	1	2/2	3	--	20	20	20	40	--
20.	MIN-543	Fluid Power Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-544	Design of Heat Exchangers	PEC	4	3	1	0	3	--	25	--	25	50	--
22.	MIN-545	Fuel Cells	PEC	4	3	1	2/2	3	--	20	20	20	40	--
23.	MIN-500	Instrumentation and Experimental Methods	PEC	4	3	1	2/2	3	--	20	20	20	40	--
24.	MIN-603	Finite Element Method for Thermal Engineering	PEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-604	Fire Dynamics	PEC	4	3	1	2/2	3	--	20	20	20	40	--

Department Elective Courses (MI-ELE1/ ELE2/ ELE3/ ELE4)

Teaching Scheme					Contact Hrs Per Week			Exam Duration (Hrs)		Relative Weightage (%)				
S No.	Course No.	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1.	MIN-320	Automobile Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-321	Vibration and Noise	DEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-322	Principles of Lubrication Technology	DEC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-323	Design of Pressure Vessels & Piping	DEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-324	FEM applications in Mechanical Engg.	DEC	4	3	1	0	3	--	25	--	25	50	--
6.	MIN-325	Numerical Methods in Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
7.	MIN-326	Value Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-327	Reverse Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
9.	MIN-328	Manufacturing System Analysis	DEC	4	3	1	0	3	--	25	--	25	50	--
10.	MIN-329	Computer Integrated Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
11.	MIN-330	Ergonomics	DEC	4	3	1	0	3	--	25	--	25	50	--
12.	MIN-331	Total Quality Management	DEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-332	Industrial Hazards and Safety	DEC	4	3	1	0	3	--	25	--	25	50	--

14.	MIN-333	Industrial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
15.	MIN-334	Facilities Design	DEC	4	3	1	0	3	--	25	--	25	50	--
16.	MIN-335	Concurrent Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-336	Financial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
18.	MIN-337	Processing of Non-Metals	DEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-338	Measurement and Instrumentation	DEC	4	3	1	2/2	3	--	20	20	20	40	--
20.	MIN-339	Design of Heat Exchangers	DEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-340	Refrigeration and Air-Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
22.	MIN-341	Thermal Systems Design	DEC	4	3	1	0	3	--	25	--	25	50	--
23.	MIN-342	Environmental Pollution and Control	DEC	4	3	1	0	3	--	25	--	25	50	--
24.	MIN-343	Power Plants	DEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-344	Industrial Combustion	DEC	4	3	1	0	3	--	25	--	25	50	--
26.	MIN-345	Compressible Flow	DEC	4	3	1	0	3	--	25	--	25	50	--
27.	MIN-346	Waste Heat recovery Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
28.	MIN-347	Fluid Power Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
29.	MIN-348	Energy Management	DEC	4	3	1	2/2	3	--	20	20	20	40	--

30.	MIN-349	Fire Dynamics	DEC	4	3	1	0	3	--	25	--	25	50	--
31.	MIN-350	Industrial Ventilation and Air Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
32.	MIN-351	Gas Turbines	DEC	4	3	1	0	3	--	25	--	25	50	--
33.	MIN-352	Experimental Methods in Thermal Engineering	DEC	4	3	1	2/2	3	--	20	20	20	40	--
34.	MIN-354	Automatic Control	DEC	4	3	1	2/2	3	--	20	20	20	40	--

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial Engineering**
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-001	Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MIN-101A	Introduction to Mechanical Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	MIN-103	Programming and Data Structure	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**06**							
(Spring)														
1.	MAN-004	Numerical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-008	Electromagnetic Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-104	Manufacturing Technology-I	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-106	Engineering Thermodynamics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-108	Mechanical Engineering Drawing	DCC	4	2	0	4	3	0	-	25	25	50	-
6.	MTN-106	Material Science	ESC	4	3	1	0	3	0	25	-	25	50	-
		Total		**24**										

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	CEN-102	Solid Mechanics	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MIN-201	Kinematics of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-203	Manufacturing Technology-II	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-205	Fluid Mechanics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-291	Engineering Analysis and Design	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	2	1	0	3	0	50	-	-	50
		Total		**20-23**										
(Spring)														
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-204	Machine Drawing	DCC	4	2	0	4	4	0	-	25	25	50	-
3.	MIN-206	Mechanics of Materials	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-208	Theory of Production Processes	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-210	Energy Conversion	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC	3	3	2	1	0	3	0	50	-	-	50
		Total		**23-20**										

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

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	MIN-301	Dynamics of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-303	Principles of Industrial Engineering	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-305	Heat and Mass Transfer	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
6.	MIN-391	Technical Communication	DCC	2	0	2	0	-	-	-	-	-	100	-
		Total		**21**										
(Spring)														
1.	MIN-300	Industry Oriented Problem/Case Study/ Lab based project/ Practical Problem	DCC	4	0	0	6	-	-	100	-	-	-	-
2.	MIN-302	Machine Design	DCC	6	4	0	4	4	-	20	20	20	40	-
3.	MIN-304	Fluid Machinery	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MIN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC 1	Minor Specialization Course- I Departmental Honours Course-I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
					3	1	0	3	0	25	-	25	50	-
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
7.	MIN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**21/25**										

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

Program Code : 2XX - B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)
Department : Department of Mechanical and Industrial Engineering
Year : IV

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.	MIN-511B	Modeling and Simulation	PCC	4	3	1	2/2	3	--	20	20	20	40	--
2.	MIN-559	Computer Aided Design	PCC	4	3	1	2/2	3	--	20	20	20	40	--
3.	MIN-502	Robotics and Control	PCC	4	3	1	2/2	3	--	20	20	20	40	--
4.	MIN-554	Computer Aided Mechanism Design	PCC	4	3	1	2/2	3	--	20	20	20	40	--
5.		Program Elective – I	PEC	4	-	-	-	-	-	-	-	-	-	-
6.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		22	12	4	4							
Semester-II (Spring)														
1.	MIN-501	Computer Aided Manufacturing	PCC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-700	Seminar		2	-	-	-	-	-	-	-	100	-	-
3.		Program Elective – II	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Program Elective – III	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Program Elective – IV	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		18	3	1	0							

Program Code : **2XX - B.Tech. (Mechanical Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **V**

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.	MIN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MIN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (CAD, CAM and Robotics)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1	MIN-500	Instrumentation and Experimental Methods	PEC	4	3	1	2/2	3	--	20	20	20	40	--
2	MIN-508	Advanced Automatic Control	PEC	4	3	1	0	3	--	25	--	25	50	--
3	MIN-515	Manufacturing System Analysis	PEC	4	3	1	0	3	--	25	--	25	50	--
4	MIN-516	Artificial Intelligence	PEC	4	3	1	0	3	--	25	--	25	50	--
5	MIN-517	Automated Materials Handling Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
6	MIN-527	Computational Fluid Dynamics & Heat Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--
7	MIN-550	Advanced Machine Design	PEC	4	3	1	0	3	--	25	--	25	50	--
8	MIN-551	Dynamics of Mechanical Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
9	MIN-557	Finite Element Methods	PEC	4	3	1	0	3	--	25	--	25	50	--
10	MIN-561	Advanced Mechanical Vibrations	PEC	4	3	1	2/2	3	--	20	20	20	40	--
11	MIN-563	Mechatronics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
12	MIN-565	Smart Materials, Structures, and Devices	PEC	4	3	1	0	3	--	25	--	25	50	--
13	MIN-566	Computer Aided Analysis of Mechanical Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
14	MIN-567	Computer Graphics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
15	MIN-568	Advanced Robotics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
16	MIN-569	Expert System Design	PEC	4	3	1	0	3	--	25	--	25	50	--

17	MIN-575	Product Design and Development	PEC	4	3	1	0	3	--	25	--	25	50	--
18	MIN-576	Machine Tool Design and Numerical Control	PEC	4	3	1	0	3	--	25	--	25	50	--
19	MIN-577	Industrial Automation	PEC	4	3	1	0	3	--	25	--	25	50	--
20	MIN-578	Computer Aided Process Planning	PEC	4	3	1	0	3	--	25	--	25	50	--
21	MIN-579	Information Systems and Data Management	PEC	4	3	1	0	3	--	25	--	25	50	--
22	MIN-582	Flexible Manufacturing Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
23	MIN-584	Operations Research	PEC	4	3	1	0	3	--	25	--	25	50	--
24	MIN-602	Bond Graph Modelling of Engineering Systems	PEC	4	3	1	2/2	3	--	20	20	20	40	--
25	MIN-608	Product and Process Optimization	PEC	4	3	1	0	3	--	25	--	25	50	--

Department Elective Courses (MI-ELE1/ ELE2/ ELE3/ ELE4)

Teaching Scheme					Contact Hrs Per Week			Exam Duration (Hrs)		Relative Weightage (%)				
S No.	Course No.	Course Title	Subject Area	Credits	L	T	P	T	P	CWS	PRS	MTE	ETE	PRE
1.	MIN-320	Automobile Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-321	Vibration and Noise	DEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-322	Principles of Lubrication Technology	DEC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-323	Design of Pressure Vessels & Piping	DEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-324	FEM applications in Mechanical Engg.	DEC	4	3	1	0	3	--	25	--	25	50	--

6.	MIN-325	Numerical Methods in Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
7.	MIN-326	Value Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-327	Reverse Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
9.	MIN-328	Manufacturing System Analysis	DEC	4	3	1	0	3	--	25	--	25	50	--
10.	MIN-329	Computer Integrated Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
11.	MIN-330	Ergonomics	DEC	4	3	1	0	3	--	25	--	25	50	--
12.	MIN-331	Total Quality Management	DEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-332	Industrial Hazards and Safety	DEC	4	3	1	0	3	--	25	--	25	50	--
14.	MIN-333	Industrial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
15.	MIN-334	Facilities Design	DEC	4	3	1	0	3	--	25	--	25	50	--
16.	MIN-335	Concurrent Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-336	Financial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
18.	MIN-337	Processing of Non-Metals	DEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-338	Measurement and Instrumentation	DEC	4	3	1	2/2	3	--	20	20	20	40	--
20.	MIN-339	Design of Heat Exchangers	DEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-340	Refrigeration and Air-Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--

22.	MIN-341	Thermal Systems Design	DEC	4	3	1	0	3	--	25	--	25	50	--
23.	MIN-342	Environmental Pollution and Control	DEC	4	3	1	0	3	--	25	--	25	50	--
24.	MIN-343	Power Plants	DEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-344	Industrial Combustion	DEC	4	3	1	0	3	--	25	--	25	50	--
26.	MIN-345	Compressible Flow	DEC	4	3	1	0	3	--	25	--	25	50	--
27.	MIN-346	Waste Heat recovery Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
28.	MIN-347	Fluid Power Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
29.	MIN-348	Energy Management	DEC	4	3	1	2/2	3	--	20	20	20	40	--
30.	MIN-349	Fire Dynamics	DEC	4	3	1	0	3	--	25	--	25	50	--
31.	MIN-350	Industrial Ventilation and Air Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
32.	MIN-351	Gas Turbines	DEC	4	3	1	0	3	--	25	--	25	50	--
33.	MIN-352	Experimental Methods in Thermal Engineering	DEC	4	3	1	2/2	3	--	20	20	20	40	--
34.	MIN-354	Automatic Control	DEC	4	3	1	2/2	3	--	20	20	20	40	--

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial Engineering**
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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-001	Mechanics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MIN-101B	Introduction to Production and Industrial Engineering	DCC	2	2	0	0	2	0	-	-	-	100	-
7.	MIN-103	Programming and Data Structure	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**06**							
			(Spring)											
1.	MAN-006	Probability and Statistics	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-008	Electromagnetic Theory	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-104	Manufacturing Technology-I	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-108	Engineering Drawing	DCC	4	2	0	4	3	0	-	25	25	50	-
5.	MIN-110	Fluid Mechanics	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	MTN-106	Material Science	ESC	4										
		Total		**24**										

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial 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
			(Autumn)											
1.	CEN-102	Solid Mechanics	ESC	4	3	1	0	3	0	25	-	25	50	-
2.	MIN-203	Manufacturing Technology-II	DCC	4	2	0	4	3	0	-	25	25	50	-
4.	MIN-209	Thermal Engineering	DCC	4	3	1	2/2	3	0	20	20	20	40	-
5.	MIN-211	Theory of Machines	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-291	Engineering Analysis and Design	DCC	4	-	-	-	-	-	-	-	-	-	-
6.	HS- ELE	HSS Elective Course*	HSSMEC*	3	3	2	1	0	3	-	25	-	25	50
		Total		**20/23**										
			(Spring)											
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MIN-210	Production Planning and Control	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-212	Machine Design	DCC	4	2	0	4	3	0	15	25	20	40	-
4.	MIN-214	Engineering Economy	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MIN-216	Theory of Production Processes - I	DCC	4	3	1	2/2	3	0	20	20	20	40	-
6.	HS-ELE	HSS Elective Course*	HSSMEC*	3	3	2	1	0	3	0	25	-	25	50
		Total		**23/20**										

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

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial 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
(Autumn)														
1.	MIN-391	Technical Communication	DCC	2	0	2	0	-	-	100	-	-	-	-
2.	MIN-309	Theory of Production Processes - II	DCC	4	3	1	2/2	3	0	20	20	20	40	-
3.	MIN-311	Operations Research	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MIN-313	Work System Design	DCC	4	3	0	2/2	3	0	20	20	20	40	-
5.	MIN-ELE1	Departmental Elective Course-I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/	3	3	2	1	0	2	0	25	-	25	50
		Total		**21**										
(Spring)														
1.	MIN-300	Industry Oriented Problem/Case Study/ Lab based project/ Practical Problem	DCC	4	0	0	6	-	-	100	-	-	-	-
2.	MIN-310	Quality Management	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MIN-312	Operations Management	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MIN-ELE2	Departmental Elective Course-II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC 1	Minor Specialization Course – I/ Departmental Honours Course – I	MSC/DHC	4	3	1	0	3	0	25	-	25	50	-
					3	1	0	3	0	25	-	25	50	-
6.	BMN-ELE/OEC	Management Studies /Open Elective Course*	OEC/ HSSMEC	3	3	2	1	0	2	0	25	-	25	50
7.	MIN-399	Educational Tour	DCC	0	-	-	-	-	-	-	-	-	-	-
		Total		**19/23**										

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

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **IV**

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.	MIN-511B	Modeling and Simulation	PCC	4	3	1	2/2	3	--	20	20	20	40	--
2.	MIN-559	Computer Aided Design	PCC	4	3	1	2/2	3	--	20	20	20	40	--
3.	MIN-502	Robotics and Control	PCC	4	3	1	2/2	3	--	20	20	20	40	--
4.	MIN-554	Computer Aided Mechanism Design	PCC	4	3	1	2/2	3	--	20	20	20	40	--
5.		Program Elective – I	PEC	4	-	-	-	-	-	-	-	-	-	-
6.	MIN-499	Training Seminar	DCC	2	0	2	0	-	-	100	-	-	-	-
		Total		20	12	4	4							
Semester-II (Spring)														
1.	MIN-501	Computer Aided Manufacturing	PCC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-700	Seminar		2	-	-	-	-	-	-	-	100	-	-
3.		Program Elective – II	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Program Elective – III	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Program Elective – IV	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		18	3	1	0							

Program Code : **2XX - B.Tech. (Production and Industrial Engineering) and M.Tech. (CAD, CAM and Robotics)**
Department : **Department of Mechanical and Industrial Engineering**
Year : **V**

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.	MIN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MIN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester				
Semester-wise Total Credits				
Total Credits				

Program Elective Courses (CAD, CAM and Robotics)

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
	MIN-500	Instrumentation and Experimental Methods	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-508	Advanced Automatic Control	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-515	Manufacturing System Analysis	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-516	Artificial Intelligence	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-517	Automated Materials Handling Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-527	Computational Fluid Dynamics & Heat Transfer	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-550	Advanced Machine Design	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-551	Dynamics of Mechanical Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-557	Finite Element Methods	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-561	Advanced Mechanical Vibrations	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-563	Mechatronics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-565	Smart Materials, Structures, and Devices	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-566	Computer Aided Analysis of Mechanical Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-567	Computer Graphics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-568	Advanced Robotics	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-569	Expert System Design	PEC	4	3	1	0	3	--	25	--	25	50	--

	MIN-575	Product Design and Development	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-576	Machine Tool Design and Numerical Control	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-577	Industrial Automation	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-578	Computer Aided Process Planning	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-579	Information Systems and Data Management	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-582	Flexible Manufacturing Systems	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-584	Operations Research	PEC	4	3	1	0	3	--	25	--	25	50	--
	MIN-602	Bond Graph Modelling of Engineering Systems	PEC	4	3	1	2/2	3	--	20	20	20	40	--
	MIN-608	Product and Process Optimization	PEC	4	3	1	0	3	--	25	--	25	50	--

Department Elective Courses (MI-ELE1/ ELE2/ ELE3/ ELE4)

Teaching Scheme					Contact Hrs Per Week			Exam Duration (Hrs)		Relative Weightage (%)				
S.No.	**Course No.**	**Course Title**	**Subject Area**	**Credits**	**L**	**T**	**P**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1.	MIN-320	Automobile Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
2.	MIN-321	Vibration and Noise	DEC	4	3	1	0	3	--	25	--	25	50	--
3.	MIN-322	Principles of Lubrication Technology	DEC	4	3	1	0	3	--	25	--	25	50	--
4.	MIN-323	Design of Pressure Vessels & Piping	DEC	4	3	1	0	3	--	25	--	25	50	--
5.	MIN-324	FEM applications in Mechanical Engg.	DEC	4	3	1	0	3	--	25	--	25	50	--
6.	MIN-325	Numerical Methods in Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--

7.	MIN-326	Value Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
8.	MIN-327	Reverse Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
9.	MIN-328	Manufacturing System Analysis	DEC	4	3	1	0	3	--	25	--	25	50	--
10.	MIN-329	Computer Integrated Manufacturing	DEC	4	3	1	0	3	--	25	--	25	50	--
11.	MIN-330	Ergonomics	DEC	4	3	1	0	3	--	25	--	25	50	--
12.	MIN-331	Total Quality Management	DEC	4	3	1	0	3	--	25	--	25	50	--
13.	MIN-332	Industrial Hazards and Safety	DEC	4	3	1	0	3	--	25	--	25	50	--
14.	MIN-333	Industrial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
15.	MIN-334	Facilities Design	DEC	4	3	1	0	3	--	25	--	25	50	--
16.	MIN-335	Concurrent Engineering	DEC	4	3	1	0	3	--	25	--	25	50	--
17.	MIN-336	Financial Management	DEC	4	3	1	0	3	--	25	--	25	50	--
18.	MIN-337	Processing of Non-Metals	DEC	4	3	1	0	3	--	25	--	25	50	--
19.	MIN-338	Measurement and Instrumentation	DEC	4	3	1	2/2	3	--	20	20	20	40	--
20.	MIN-339	Design of Heat Exchangers	DEC	4	3	1	0	3	--	25	--	25	50	--
21.	MIN-340	Refrigeration and Air-Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
22.	MIN-341	Thermal Systems Design	DEC	4	3	1	0	3	--	25	--	25	50	--

23.	MIN-342	Environmental Pollution and Control	DEC	4	3	1	0	3	--	25	--	25	50	--
24.	MIN-343	Power Plants	DEC	4	3	1	0	3	--	25	--	25	50	--
25.	MIN-344	Industrial Combustion	DEC	4	3	1	0	3	--	25	--	25	50	--
26.	MIN-345	Compressible Flow	DEC	4	3	1	0	3	--	25	--	25	50	--
27.	MIN-346	Waste Heat recovery Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
28.	MIN-347	Fluid Power Systems	DEC	4	3	1	0	3	--	25	--	25	50	--
29.	MIN-348	Energy Management	DEC	4	3	1	2/2	3	--	20	20	20	40	--
30.	MIN-349	Fire Dynamics	DEC	4	3	1	0	3	--	25	--	25	50	--
31.	MIN-350	Industrial Ventilation and Air Conditioning	DEC	4	3	1	0	3	--	25	--	25	50	--
32.	MIN-351	Gas Turbines	DEC	4	3	1	0	3	--	25	--	25	50	--
33.	MIN-352	Experimental Methods in Thermal Engineering	DEC	4	3	1	2/2	3	--	20	20	20	40	--
34.	MIN-354	Automatic Control	DEC	4	3	1	2/2	3	--	20	20	20	40	--

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

Department : Department of Metallurgical and Materials Engineering

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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-007	Modern Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MTN-101	Introduction to Metallurgical and Materials Engineering	DCC	2	2	0	0	2	-	-	-	-	100	-
7.	MTN-103	Computer Programming	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**6**							
(Spring)														
1.	CYN-006	General Chemistry-II	BSC	4	3	0	2	3	0	15	25	20	40	-
2.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-102	Metallurgical Thermodynamics and Kinetics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MTN-104	Structural Metallurgy	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-110	Metallography Lab	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	MIN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	3	0	-	25	25	50	-
		Total		**22**	**14**	**3**	**9**							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

Department : Department of Metallurgical and Materials 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
(Autumn)														
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MTN-201	Transport Phenomena	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-203	Phase Transformation and Heat Treatment	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MTN-205	Mechanical Behaviour of Materials	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-207	Electrical and Electronic Materials	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	HSN-ELE	HSS Elective course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**5**	**2**							
(Spring)														
1.	ECN-102	Fundamentals of Electronics	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MTN-204	Metal Casting and Joining	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	MTN-206	Non-ferrous Metallurgy	DCC	4	3	1	0	0	0	25	-	25	50	-
4.	MTN-208	Engineering Polymers and Composites	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-292	Engineering Analysis and Design	DCC	4	3	0	2	3	0	25	-	25	50	-
6.	HSN-ELE	HSS Elective course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**3**	**5**							

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

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

Department : Department of Metallurgical and Materials 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
(Autumn)														
1.	MTN-301	Mechanical Working of Metals	DCC	4	3	0	2	3	0	15	25	20	40	-
2.	MTN-303	Iron and Steel Making	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-305	Materials Testing Lab	DCC	2	0	0	3	0	3	-	50	-	-	50
4.	MTN-307	Materials Characterization	DCC	4	3	0	2	3	0	15	25	20	40	-
5.	MTN-ELE1	Departmental Elective Course – I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	BM-ELE/OEC	Management Studies / Open Elective Course	HSSMEC/ OEC	3	3	0	0	3	0	25	-	25	50	-
7.	MTN-391	Technical Communication	DCC	2	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**2**	**7**							
(Spring)														
1.	MTN-300	Industry Oriented Problem/ Case Study/ Lab based project/ Practical Problem	DCC	4										
2.	MTN-302	Environmental Degradation of Materials	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	MTN-304	Ceramics and Metal Powder Processing	DCC	4	3	0	2/2	3	0	20	20	20	40	-
4.	MTN-ELE2	Departmental Elective Course – II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC1	Minor Specialization Course – I/ Departmental Honours Course - I	MSC/ DHC	4	3	1	0	3	0	25	-	25	50	-
					3	1	0	3	0	25	-	25	50	-
6.	BM-ELE/OEC	Management Studies / Open Elective Course	HSSMEC/ OEC	3	3	0	0	3	0	25	-	25	50	-
7.	MTN-399	Educational Tour	DCC	0	0	0	0	0	0	-	-	-	-	-
		Total		**19/23**	**9/ 15**	**1/2**	**3**							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

Department : Department of Metallurgical and Materials Engineering

Year : IV

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.	MTN-501	Structure of Materials	PCC	4	3	1	0	3	0	25	-	25	50	-
2.	MTN-503	Characterization of Materials	PCC	4	3	0	2	3	0	15	25	20	40	-
3.		Program Elective-I	PEC	4	3	1	0	3	0	25	-	25	50	-
4.		Program Elective-II	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Training and Seminar	DCC	2	0									
		Total		18	12	3	2							
Semester-II (Spring)														
1.	MTN-502	Modelling, Simulation and Computer Applications	PCC	4	3	0	2	3	0	15	25	20	40	-
2.	MTN-504	Phase Transformation	PCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
4.		Program Elective-III	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Program Elective-IV	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	6	1	2							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

Department : Department of Metallurgical and Materials Engineering

Year : V

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.	MTN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MTN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary										
Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**22**	**23**	**21**	**24**	**16**	**18**	**18**	**12**	**18**
Total Credits	**193**									

Program Elective Courses Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Industial Engg.)

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
Electives I-II (Autumn)														
1.	MTN-505	Non Destructive testing	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	MTN-507	Casting and Solidification	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-512	Joining of Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	MTN-518	Theory of Metal Forming	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-522	Composite Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
Electives III-IV (Spring)														
6.	MTN-514	Powder Metallurgy	PEC	4	3	1	0	3	0	25	-	25	50	-
7.	MTN-516	Principles of Materials Selection	PEC	4	3	1	0	3	0	25	-	25	50	-
8.	MTN-526	Failure Analysis	PEC	4	3	1	0	3	0	25	-	25	50	-
9.	MTN-528	Tribology of Engineering Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
10.	MTN-532	Corrosion Protection Methods	PEC	4	3	1	0	3	0	25	-	25	50	-

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

Department : Department of Metallurgical and Materials Engineering

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-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2.	PHN-007	Modern Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3.	CEN-105	Introduction to Environmental Studies	GSC	3	3	0	0	3	0	25	-	25	50	-
4.	HSN-001A HSN-001B	Communication Skills (Basic) Communication Skills (Advance)	HSSC	2	1	0	2	2	0	25	-	25	50	-
5.	HSN-002	Ethics and Self Awareness	HSSC	2	1	1	0	2	0	25	-	25	50	-
6.	MTN-101	Introduction to Metallurgical and Materials Engineering	DCC	2	2	0	0	2	-	-	-	-	100	-
7.	MTN-103	Computer Programming	ESC	4	3	0	2	3	0	15	25	20	40	-
		Total		**21**	**16**	**02**	**6**							
(Spring)														
1.	CYN-006	General Chemistry-II	BSC	4	3	0	2	3	0	15	25	20	40	-
2.	MAN-002	Mathematical Methods	BSC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-102	Metallurgical Thermodynamics and Kinetics	DCC	4	3	1	0	3	0	25	-	25	50	-
4.	MTN-104	Structural Metallurgy	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-110	Metallography Lab	DCC	2	0	0	3	0	3	-	50	-	-	50
6.	MIN-108	Mechanical Engineering Drawing	ESC	4	2	0	4	3	0	-	25	25	50	-
		Total		**22**	**14**	**3**	**9**							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

Department : Department of Metallurgical and Materials 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
(Autumn)														
1.	EEN-112	Electrical Science	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MTN-201	Transport Phenomena	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-203	Phase Transformation and Heat Treatment	DCC	4	3	1	2/2	3	0	20	20	20	40	-
4.	MTN-205	Mechanical Behaviour of Materials	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-207	Electrical and Electronic Materials	DCC	4	3	1	0	3	0	25	-	25	50	-
6.	HSN-ELE	HSS Elective course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**5**	**2**							
(Spring)														
1.	ECN-102	Fundamentals of Electronics	ESC	4	3	1	2/2	3	0	20	20	20	40	-
2.	MTN-204	Metal Casting and Joining	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	MTN-206	Non-ferrous Metallurgy	DCC	4	3	1	0	0	0	25	-	25	50	-
4.	MTN-208	Engineering Polymers and Composites	DCC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-292	Engineering Analysis and Design	DCC	4	3	0	2	3	0	25	-	25	50	-
6.	HSN-ELE	HSS Elective course*	HSSMEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**3**	**5**							

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

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

Department : Department of Metallurgical and Materials 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
(Autumn)														
1.	MTN-301	Mechanical Working of Metals	DCC	4	3	0	2	3	0	15	25	20	40	-
2.	MTN-303	Iron and Steel Making	DCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-305	Materials Testing Lab	DCC	2	0	0	3	0	3	-	50	-	-	50
4.	MTN-307	Materials Characterization	DCC	4	3	0	2	3	0	15	25	20	40	-
5.	MTN-ELE1	Departmental Elective Course – I	DEC	4	3	1	0	3	0	25	-	25	50	-
6.	BM-ELE/OEC	Management Studies / Open Elective Course	HSSMEC/ OEC	3	3	0	0	3	0	25	-	25	50	-
7.	MTN-391	Technical Communication	DCC	2	3	0	0	3	0	25	-	25	50	-
		Total		**20/23**	**18**	**2**	7							
(Spring)														
1.	MTN-300	Industry Oriented Problem/ Case Study/ Lab based project/ Practical Problem	DCC	4										
2.	MTN-302	Environmental Degradation of Materials	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	MTN-304	Ceramics and Metal Powder Processing	DCC	4	3	0	2/2	3	0	20	20	20	40	-
4.	MTN-ELE2	Departmental Elective Course – II	DEC	4	3	1	0	3	0	25	-	25	50	-
5.	MSC1/DHC1	Minor Specialization Course – I/ Departmental Honours Course - I	MSC/ DHC	4	3	1	0	3	0	25	-	25	50	-
					3	1	0	3	0	25	-	25	50	-
6.	BM-ELE/OEC	Management Studies / Open Elective Course	HSSMEC/ OEC	3	3	0	0	3	0	25	-	25	50	-
7.	MTN-399	Educational Tour	DCC	0	0	0	0	0	0	-	-	-	-	-
		Total		**19/23**	**9/ 15**	**1/2**	**3**							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

Department : Department of Metallurgical and Materials Engineering

Year : IV

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.	MTN-501	Structure of Materials	PCC	4	3	1	0	3	0	25	-	25	50	-
2.	MTN-503	Characterization of Materials	PCC	4	3	0	2	3	0	15	25	20	40	-
3.		Program Elective-I	PEC	4	3	1	0	3	0	25	-	25	50	-
4.		Program Elective-II	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Training and Seminar	DCC	2	0									
		Total		18	12	3	2							
Semester-II (Spring)														
1.	MTN-502	Modelling, Simulation and Computer Applications	PCC	4	3	0	2	3	0	15	25	20	40	-
2.	MTN-504	Phase Transformation	PCC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
4.		Program Elective-III	PEC	4	3	1	0	3	0	25	-	25	50	-
5.		Program Elective-IV	PEC	4	3	1	0	3	0	25	-	25	50	-
		Total		18	6	1	2							

Program Code : 2XX – Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

Department : Department of Metallurgical and Materials Engineering

Year : V

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.	MTN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	MTN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary

Semester	1	2	3	4	5	6	7	8	9	10
Semester-wise Total Credits	**21**	**22**	**23**	**21**	**24**	**16**	**18**	**18**	**12**	**18**
Total Credits	**193**									

Program Elective Courses Integrated Dual Degree: B.Tech. (Metallurgical and Materials Engg.) and M.Tech (Materials Engg.)

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
Electives I-II (Autumn)														
1.	MTN-513	Engineering Ceramics	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	MTN-522	Composite Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-511	Thin Film Technology	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	MTN-531	Electronic Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-517	High Temperature Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
Electives III-IV (Spring)														
1.	MTN-542	Biomaterials	PEC	4	3	1	0	3	0	25	-	25	50	-
2.	MTN-516	Principles of Materials Selection	PEC	4	3	1	0	3	0	25	-	25	50	-
3.	MTN-530	Nanomaterials and Applications	PEC	4	3	1	0	3	0	25	-	25	50	-
4.	MTN-528	Tribology of Engineering Materials	PEC	4	3	1	0	3	0	25	-	25	50	-
5.	MTN-558	Energy Storage Materials	PEC	4	3	1	0	3	0	25	-	25	50	-

Appendix 'J'
Item No. Senate/58.18

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Mechanical & Industrial Engineering

1. Subject Code: MI-216 Course Title: Theory of Production Processes – I

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

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

4. Relative Weightage :CWS 15 PRS 15 MTE 30 ETE 40 PRE - -

5. Credits: 4 6. Semester : x Autumn √ Spring x Both

7. Pre –requisite: NIL 8. Subject Area: DCC

9. **Objectives of Course:** This course is intended to impart fundamentals of the theory of machining, advanced machining, finishing processes besides tooling design and metrology.

10. **Details of Course:**

S. No.	Contents	Contact Hours
1.	**Theory of Machining:** Single point and multi-point machining, chip formation: mechanism, chip types, chip control, tool geometry: single point, specifications in different systems, selection of tool angles, orthogonal and oblique machining, cutting tool geometry, mechanics of single point orthogonal machining: Merchant's circle, force, velocity, shear angle, and power consumption relations, cutting tool wear and tool life: wear mechanisms, wear criterion, Taylor's tool life equation, facing test, variables affecting tool life; Machinability and its measures, economics of machining.	10
2.	**Advanced Manufacturing Processes:** Process principle, equipment, analysis and applications of advanced machining processes such as Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, Electro Chemical Machining, Chemical Machining, Electro-Discharge Machining, Wire Electro Discharge Machining, Electron Beam Machining, and Laser Beam Machining, rapid prototyping and rapid tooling: introduction of solid-based (FDM, LOM), liquid-based (SLA, SGC), powder-based (3DP, BPM)	10

	RP processes.	
3.	**Finishing and Superfinishing Processes:** Principles and applications of honing, superfinishing, lapping, polishing, buffing, peening, and burnishing	4
4.	**Metrology:** Introduction, inspection types and principles, radius and taper measurement, measurement of screw threads and gears. Limits, fits, and dimensional and geometrical or form tolerances, computer vision system based measurement, coordinate measuring machines, measurement of form tolerances, measurement of surface roughness: surface roughness terminology, different methods of surface roughness measurement	8
5.	**Jigs and Fixtures:** Usefulness of Jigs and Fixtures, Design principles of jigs and fixtures, Principles of location and clamping, Types locating and clamping devices, Few simple design of Jigs and Fixtures : lathe, milling, boring, shaping, broaching, grinding, assembly and welding fixtures, Economics of Jigs and Fixtures..	6
6.	**Gear Manufacturing:** Gear generation and forming techniques, gear rolling, gear finishing	4
	Total	42

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	DeGarmo, E.P., Black, J.T., Kohser, R.A., "Materials and Processes in Manufacturing", Prentice Hall of India	1997
2.	Ghosh, A., and Mallik, A.K., "Manufacturing Science" Affiliated East-West press Pvt. Ltd.	1985
3.	Lal, G.K., "Introduction to Machining Science" New Age International Publishers	1996
4.	Chua, C.K., and Leong, L.F., "Rapid Prototyping: Principles and Applications in Manufacturing" John Wiley & Sons Ltd.	1997
5.	Gupta, I.C., "Text Book of Engineering Metrology" DhanpatRai Publishing Co.	2003

DEPARTMENT OF MATHEMATICS
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
(To be implemented from 2015-2016 academic session)

Program Code : XXX M.Sc. (Mathematics)
Department : MA Mathematics
Year : I

S.No.	Subject Code	Course Title	Subject Area	Credits	Contact Hours/Week L	T	P	Exam. Duration Theory		Practical	Relative Weight (%) CWS	PRS	MTE	ETE	PRE
Semester-I (Autumn)															
1.	MAN-501	Theory of Ordinary Differential Equations	PCC	3	3	0	0	3	0		25	-	25	50	-
2.	MAN-503*	Real Analysis	PCC	4	3	1	0	3	0		25	-	25	50	-
3.	MAN-505	Topology	PCC	3	3	0	0	3	0		25	-	25	50	-
4.	MAN-507*	Abstract Algebra	PCC	4	3	1	0	3	0		25	-	25	50	-
5.	MAN-509*	Computer Programming	PCC	4	3	0	2	3	0		15	25	20	40	-
6.	MAN-511	Technical Communication	PCC	2	2	0	0	2	0		25	-	25	50	-
		Total		20	17	2	2	-	-		-	-	-	-	-
Semester-II (Spring)															
1.	MAN-502*	Numerical Analysis	PCC	4	3	1	0	3	0		25	-	25	50	-
2.	MAN-504*	Linear Algebra	PCC	4	3	1	0	3	0		25	-	25	50	-
3.	MAN-506*	Probability & Statistics	PCC	4	3	1	0	3	0		25	-	25	50	-
4.	MAN-508	Theory of Partial Differential Equations	PCC	3	3	0	0	3	0		25	-	25	50	-
5.	MAN-510*	Complex Analysis	PCC	4	3	1	0	3	0		25	-	25	50	-
6.	-	Departmental Elective-I	PEC	3	-	-	-	-	-		-	-	-	-	-
		Total		22	15	4	0								

*These are the new courses recommended by the IAPC for consideration of Senate. Rest of the courses have already been approved by the Senate.

279

DEPARTMENT OF MATHEMATICS
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code : XXX M.Sc. (Mathematics)
Department : MA Mathematics
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-III (Autumn)														
1.	MAN-605	Functional Analysis	PCC	3	3	0	0	3	0	25	-	25	50	-
2.	MAN-607*	Operations Research	PCC	4	3	1	0	3	0	25	-	25	50	-
3.	MAN-611	Seminar	PCC	2	-	-	-	-	-	-	-	-	100	-
4.		Departmental Elective-II	PEC	3	-	-	-	-	-	-	-	-	-	-
5.		Departmental Elective-III	PEC	3	-	-	-	-	-	-	-	-	-	-
6.		Departmental Elective-IV	PEC	3	-	-	-	-	-	-	-	-	-	-
		Total		18	6	1	0							
Semester-IV (Spring)														
1.	MAN -650	Project	PCC	8	-	-	-	-	-	-	-	-	100	-
2.		Departmental Elective-V	PEC	3	-	-	-	-	-	-	-	-	-	-
3.		Departmental Elective-VI	PEC	3	-	-	-	-	-	-	-	-	-	-
4.		Departmental Elective-VII	PEC	3	-	-	-	-	-	-	-	-	-	-
		Total		17										

DEPARTMENT OF MATHEMATICS
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
List of Departmental Electives (M.Sc. Mathematics)

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 I														
1.	MAN-520*	Graph Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
2.	MAN-522	Fuzzy Sets and Fuzzy Logic	PE C	3	3	0	0	3	0	25	-	25	50	-
3.	MAN-524*	Mechanics	PEC	3	3	0	0	3	0	25	-	25	50	-
4.	MAN-526	Integral Equations and Calculus of Variations	PEC	3	3	0	0	3	0	25	-	25	50	-
Elective II-VII														
5.	MAN-619*	Measure Theory	PCC	3	3	0	0	3	0	25	-	25	50	-
6.	MAN-523	Control Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
7.	MAN-627	Dynamical Systems	PEC	3	3	0	0	3	0	25	-	25	50	-
8.	MAN-529	Combinatorial Mathematics	PEC	3	3	0	0	3	0	25	-	25	50	-
9.	MAN-527	Stochastic Processes	PEC	3	3	0	0	3	0	25	-	25	50	-
10.	MAN-624	Approximation Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
11.	MAN-635	Wavelet Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
12.	MAN-531	Fluid Dynamics	PEC	3	3	0	0	3	0	25	-	25	50	-
13.	MAN-629	Financial Mathematics	PEC	3	3	0	0	3	0	25	-	25	50	-
14.	MAN-623	Algebraic Topology	PEC	3	3	0	0	3	0	25	-	25	50	-
15.	MAN-631*	Number Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
16.	MAN-625	Coding Theory	PEC	3	3	0	0	3	0	25	-	25	50	-
17.	MAN-632*	Advanced Numerical Analysis	PEC	3	3	0	0	3	0	25	-	25	50	-
18.	MAN-526	Numerical Optimization	PEC	3	3	0	0	3	0	25	-	25	50	-
19.	MAN-621	Abstract Harmonic Analysis	PEC	3	3	0	0	3	0	25	-	25	50	-
20.	MAN-637	Orthogonal Polynomials and Special Functions	PEC	3	3	0	0	3	0	25	-	25	50	-

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-503** Course Title: **Real Analysis**
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** 7. Subject Area: **PCC**
8. Pre-requisite: Nil
9. Objective: To impart the knowledge of advanced topics in theory of real functions and metric space properties
10. Details of Course

S. No.	Contents	Contact Hours
1.	**Riemann Integrals:** Existence and properties of the integrals, Fundamental theorem of calculus, first and second mean value theorems.	**10**
2.	**Metric Spaces:** Review of complete metric spaces, compact metric spaces, compactness and uniform continuity and connected metric spaces.	**12**
3.	**Measures:** Introduction to the properties of general measure and measurable spaces, Borel Algebras, complete measure.	**5**
4.	**Lebesgue Measures:** Measurable sets and their properties, translation invariance and completeness of Lebesgue measure Lebesgue integral of a simple function, comparison of Lebesgue and Riemann integrals.	**15**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Aliprantis, C.D. and Burkinshaw, W., Principles of Real Analysis, Elsevier	2011
2.	Apostol, T. M., Mathematical Analysis, Narosa Publishing House.	2002
3.	Barra, G. D., Measure theory and Integration, Woodhead Publishing.	2003
4.	Royden, H.L., Real Analysis, The Mcmillion company	2010
5.	Rana, I. K. , An Introduction to Measure and Integration, Narosa Publishing House.	2007
6.	Rudin, W., Principles of Mathematical Analysis, McGraw-Hill Book Company.	1976

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-507** Course Title: **Abstract Algebra**

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** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To give an introduction to the basic concepts of Abstract Algebra.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Groups:** Groups and their homomorphisms, Normal Subgroups, Quotient Groups, Isomorphism Theorems. Group actions, Cayley's Theorem, Class Equation of a group, Cauchy's Theorem, p-groups, Sylow's Theorems and their applications.	15
2.	**Rings:** Rings, Ideals and Homomorphisms, Quotient rings, Isomorphism theorems, Prime and Maximal ideals, Rings of fractions, Integral domain, Euclidean Domains, Principal Ideal Domains and Unique Factorization Domains. Polynomial rings over UFD's, Criteria for irreducibility of polynomials over UFD's.	12
3.	**Modules:** Basic definitions and examples, Submodules and Direct sums, Quotient modules, Homomorphism and Isomorphism theorems, Cyclic modules, Free modules.	5
4.	**Fields:** Fields and their extensions, Algebraic and finitely generated field extensions, Splitting fields and normal extensions, Algebraic closures, Finite fields, Separable and inseparable extensions. Galois groups, Fundamental Theorem of Galois Theory.	10
	TOTAL	42

11. Suggested Books:

S. No.	Title/Authors/Publishers	Year of Publication
1.	Dummit D. S. and Foote R. M., "Abstract Algebra", John Wiley & Sons (3rd Edition)	2003
2.	Bhattacharya P. B., Jain S. K. and Nagpaul S. R., "Basic Abstract Algebra", Cambridge University Press (2nd Edition)	1995
3.	Herstein I. N., "Topics in Algebra", John Wiley & Sons (2nd Edition)	1999
4.	Hungerford T. W., "Algebra", Springer	1980
5.	Lang S., "Algebra", Springer (3rd Edition)	2005
6.	Jacobson N., "Basic Algebra Vol. 1" Dover Publications (2nd Edition)	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-509** Course Title: **Computer Programming**

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

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

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

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

8. Pre-requisite: Nil

9. Objective: To provide the basic knowledge of C++ programming

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Computer Fundamentals:** Introduction to computer systems; number system, integer, signed integer, fixed and floating point representations; IEEE standards, integer and floating point arithmetic; CPU organization, ALU, registers, memory, the idea of program execution at micro level.	07
2.	**Basic Programming in C++:** Input/output; Constants, variables, expressions and operators; Naming conventions and styles; Conditions and selection statements; Looping and control structures (while, for, do-while, break and continue); Arrays; File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking.	10
3.	**Programming through functional decomposition:** Design of functions, void and value returning functions, parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference, recursive functions; Function overloading and default arguments; Library functions.	08
4.	**Pointers:** Pointers; Dynamic data and pointers, dynamic arrays, use of pointers in linked structures.	05
5.	**Object Oriented Programming Concepts:** Data hiding, abstract data types, classes, access control; Class implementation, constructors, destructor	12
	operator overloading, friend functions; Object oriented design (an alternative to functional decomposition) inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.	
	Total	**42**

11. Suggested Books:

S. No.	Name of the Authors / Books / Publisher	Year of Publication/ Reprints
1.	Deitel, H. M. and Deitel, P. J., C++ How to Program. Prentice Hall, 8th Ed.	2011
2.	Eckel, B., Thinking in C++ Volume 1 & 2. Prentice Hall, 2nd Ed.	2003
3.	Schildt, H., C++: The Complete Reference, McGraw-Hill, 4th Ed.	2002
4.	Lafore, R., Object-Oriented Programming in C++. Sams Publishing, 4th Ed.	2001
5.	Lippman, S. B. and Lajoie, J. and Moo, B.E., The C++ Primer. Addison-Wesley Professional, 5th Ed.	2012
6.	Stallings, W., Computer Organization and Architecture: Designing for Performance. Prentice-Hall, 7th Ed.	2005
7.	Stroustrup, B., The C++ Programming Language. Addison-Wesley, 3rd Ed.	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-502** Course Title: **Numerical Analysis**

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: **04** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: Basic course in Numerical methods

9. Objective: To impart knowledge of numerical analysis in solving differential equations

10. Details of Course:

S.No.	Contetns	Contact Hours
1.	**Computations of Eigen Values of a Matrix:** Power method for dominant, sub-dominant and smallest eigen-values, Method of inflation, Jacobi, Givens and Householder methods for symmetric matrices, LR and QR methods.	10
2.	**Solution of ODE** : Multistep methods; Predictor-corrector Adam-Bashforth Milne's method , their error analysis and stability analysis	6
3.	**Finite Difference**: Review of finite difference operators, finite difference methods, Inverse interpolation, their developments and applications	6
4.	**Elliptic PDE**: Five point formulae for Laplacian, replacement for Dirichlet and Neumann's boundary conditions, curved boundaries, solution on a rectangular domain, block tri-diagonal form and its solution using method of Hockney, condition of convergence	5
5.	**Parabolic PDE**: Concept of compatibility, convergence and stability, Explicit, full implicit, Crank-Nicholson, du-Fort and Frankel scheme, ADI methods to solve two-dimensional equations with error analysis.	5
7.	**Hyperbolic PDE**: Solution of hyperbolic equations using FD, and Method of characteristics ,Limitations and Error analysis	5
8.	**Weighted residual methods**: Collocation, least squares, Galerkins, Rayleigh-Ritz methods and their compatibility	5
	TOTAL	42

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Gerald, C. F. and Wheatly P. O., "Applied Numerical Analysis", 6th Ed., Addison-Wesley Publishing	2002
2.	Smith, G. D., " Numerical Solution of Partial Differential Equations", Oxford University Press.	2001
3.	Jain, M. K., " Numerical Solution of Differential Equations", John Wiley.	1991
4.	Fausett, L. V., "Applied Numerical Analysis", Prentice Hall, 2nd Ed.	2007
5.	Froberg, C. E., "Introduction to Numerical Analysis", 2nd Ed., Addison Wesley.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-504** Course Title: **Linear Algebra**

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

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

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

5. Credits: **04** 6. Semester: **Spring** 7.Pre-Requisite:Nil

8.Subject Area: PCC

9. Objective of the Course: To introduce some advanced topics of linear algebra

10. Details of Course:

S. No.	Particulars	Contact Hours
1	**Vector Spaces &Linear Transformations:** Review of vector spaces, basis and dimension, examples of infinite dimensional spaces, ordered bases and coordinates, linear transformations, algebra of linear transformations, rank-nullity theorem, matrix representation of a linear transformation, change of basis, linear functional, dual spaces, reflexivity.	8
2	**Modules** Review of basic properties of modules, rank of a free module and epimorphisms, Noetherian module, Hilbert basis theorem, free module over a principal ideal domain, torsion free and free modules, primary decomposition, cyclic decomposition of a primary module, the invariant factor decomposition.	8
3	**Linear Operators :** Brief review, the module associated with a linear operator, orders and the minimal polynomial, cyclic modules and cyclic sub spaces, the decomposition of vector space V, the rational canonical form, characteristic polynomial of an operator, eigenvalues and eigenvectors of linear operators, eigen-space, minimal polynomial,Jordan canonical form, triangularizability and Schur'slemma, diagonalizable operators, projections, algebra of projections, resolution of the identity, spectral resolution, exponential of a square matrix	12
4	**Inner Product Space:** Inner product between two vectors, orthogonal and orthonormal vectors, normed space, isometries, projection theorems and best approximations, orthogonal direct-sum,Riesz representation theorems, adjoint of a linear operator, unitary diagonalizability, normal operators, special types of normal operators ,self-adjoint operators ,unitary operators and isometries, structure of normal operators, orthogonal projection, orthogonal resolution of identity, spectral theorem, positive operators. Gram-Schmidt process for orthogonalisation, projection operator, quadratic forms, positive definite forms.	14
	TOTAL	**42**

11. Suggested Books :

S. No.	Name of Books/Authors/Publishers	Year of publications
1	Roman,S., "Advanced Linear Algebra"Springer	2005
2.	Hoffman, K. and Kunze, R., "Linear Algebra", 2nd edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India	2004
3.	Leon, S.J., "Linear Algebra with Applications", 8th Edition, Pearson	2009
4.	Peter, J. Olever and Shakiban, C., "Applied Linear Algebra", 1st Edition , Prentice Hall	2005
5.	Strang, G., "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia Pvt Ltd	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1.Subject Code: **MAN-506** Course Title : **Probability & Statistics**

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

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

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

5. Credits: **04** 6. Semester: **Spring** 7.Pre-Requisite: Nil

8.Subject Area: **PCC**

9. Objective of the Course: To impart knowledge of Probability and Statistics.

10. Details of Course:

S. No.	Particulars	Contact Hours
1	**Random variable:** Distribution functions, probability mass function and probability density function, moments and moment generating functions. Chebyshev's inequality, law of large numbers, central limit theorem	07
2	**Special distributions:** Binomial, Poisson, Negative binomial, Geometric, Hypergeometric. Uniform, Exponential, Gamma, Beta, Weibull, Normal, Lognormal, Pearsons.	06
3	**Bivariate random variables:** Statistical independence, joint, marginal, conditional distribution, Product moment, correlation, regression, function of random variables and their probability distribution.	07
4	**Sampling:**Random sampling with replacement and without replacement, Sampling distribution on samples from normal population: normal, t, χ^2, F distribution.	04
5	**Theory of estimation:**Basic concepts of estimation, point estimation, methods of estimation, method of moments, method of maximum likelihood, unbiasedness, minimum variance estimation, interval estimation.	09
6.	**Testing of hypothesis:** Null and alternative hypothesis, type I and II errors power function, method of finding tests, likelihood ratio test, Neyman Pearson lemma, uniformly most powerful tests, some results based on normal population.	09
	TOTAL	42

11. Suggested Books :

S.No.	Author/Books/Publishers	Year of Publications
1.	Miller, I. and Miller, M: John E. Freund's Mathematical Statistics with Appliation, (Prentice Hall)(7^{th} edition)	2006
2.	Hogg, R. V., McKean, J. and Craig, A. : Introduction to Mathematical Statistics, (Pearson Education) (7^{th} Ed.)	2006
3.	Rohatgi, V.K and Md. Ehsanes Saleh, A.K. : An Introduction to Probability and Statistics,(John Wiley and Sons),(2^{nd} edition)	2000
4.	Casella, G., Berger, R..: Statistical Inference. 2nd edition, Duxbury Press	2002
5.	Rao, C.R. : Linear statistical Inference and its application (Wiley Eastern Ltd) (2^{nd} Ed.)	2002
6.	Lehmann, E.L. and Joseph P. Romano : Testing Statistical Hypothesis (Springer) (3^{rd} Ed.)	2005
7.	Lehmann, E.L. and Casella George : Theory of Point Estimation (Springer) (2^{nd} Ed.)	1998
8.	Papoulis, A. and Pillai, S.U. Probability, Random Variables and Stochastic Processes(Tata McGraw-Hill) (fourth edition)	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-510** Course Title: **Complex Analysis**
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**

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

8. Pre requisite: A first course on Complex Analysis

9. Objective: To provide advance topics in functions of one complex variable.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Complex Integration:** Revisit to Cauchy Integral formula, Winding Numbers , Morera's theorem, Maximum modulus principle, Schwarz Lemma, Meromorphic function, the Argument Principle , Rouche's theorem, improper integrals, evaluation of a real integral, improper integrals involving sines and cosines, integration through branch cut.	14
2.	**Conformal Mapping:** Definition, Bilinear transformation, Cross ratio, the mappings from disc to disc, disc to half plane and half plane to half plane. mapping of elementary transformations, Schwarz, Christoffel transformation and their applications.	10
3.	**Applications:** Applications of conformal mapping to steady temperature, electrostatic potential, two dimensional fluid flow, stream function, Poisson integral formula, Dirichlet problem in the unit disc, Dirichlet problem in the half plane, Neumann problem for the disc and the half plane.	12
4.	**Analytic Continuation**: Definition and uniqueness of analytic continuation, standard method of analytic continuation using power series, the principle of reflection.	6
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Ahlfors, L.V., Complex Analysis, McGraw Hill	1988
2.	Conway, J.B., Functions of one complex Variables I, Narosa Publishing House.	2000
3.	Gamelin, T.W., Complex Analysis, Springer,Verlag	2001
4.	Greene, R. and Krantz, S.G., Function Theory of One Complex Variable, 3rd Edition, GSM, Vol. 40, American Mathematical Society.	2006
5.	Lang, S., Complex Analysis, Springer , Verlag.	2003
6.	Mathews, J.H. and Howell, R.W., Complex Analysis for Mathematics and Engineering, Narosa	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-607** Course Title: **Operations Research**

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

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

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

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

8. Pre-requisite: Nil

9.Objective: To acquaint the students with the basic techniques of Operations Research.

10. Details of the course:

S. No.	Contents	Contact Hours
1	**Basics of LPP:** Different Types of OR Models, Convex Sets, Graphical Method, Simplex Method, Big –M Method, Two Phase Method, Revised Simplex Method.	11
2	**Duality Theory:** Dual Simplex Method, Sensitivity Analysis, Parametric Linear Programming .	9
3	**Integer Program:** Cutting Plane and Branch and Bound Techniques for all Integer and Mixed Integer Programming Problems .	5
4	**Transportation Problems**: Transportation Problems and Assignment Problems .	5
5	**Game Theory:** Graphical Method and Linear Programming Method for Rectangular Games, Saddle point, notion of dominance .	5
6	**Queuing Theory:** Steady -state solutions of Markovian Queuing Models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited space, M/G/1, Inventory Models.	7
	TOTAL	42

11. Suggested Books:

S. No.	Name of Books/ Authors/ Publishers	Year of Publication
1	Mohan, C. and Deep,K.: "Optimization Techniques", New Age India Pvt. Ltd, New Delhi.	2009
2	Mittal, K.V. and Mohan, C.: "Optimization Methods in System Analysis and Operations Research", New Age India Pvt. Ltd, New Delhi.	1996
3	Taha, H.A. : "Operations Research: An Introduction", MacMillan Pub Co., NY, Ninth Edition (Reprint).	2013
4	Ravindran, A., Phillips, D.T. and Solberg, J.J.: "Operations Research: Principles and Practice", John Wiley and Sons, NY, Second Edition (Reprint).	2012
5	Pant, J.C.: "Introduction to Optimization/ Operations Research", Jain Brothers, New Delhi, Second Edition.	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-520** Course Title: **Graph Theory**
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. Prerequisite: Nil
9. Objective: To introduce the basic concepts of graph theory and its applications

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Introduction to Graphs:** Definition of a graph, finite and infinite graphs, incidence of vertices and edges, types of graphs, subgraphs, walks, trails, paths, cycles, connectivity, components of a graph, Eulerian and Hamiltonian graphs, travelling salesman problem, vertex and edge connectivity, matrix representation of graphs, incidence and adjacency matrices of graphs	10
2.	**Trees and Fundamental Circuits:** Definition and properties of trees, rooted and binary trees, counting trees, spanning trees, weighted graphs, minimum spanning tree, fundamental circuit, cut set, separability, network flows	6
3.	**Vector Spaces associated with Graphs:** Galois fields, Vector spaces associated with graphs, orthogonal vectors and spaces	4
4.	**Planar graphs and graph coloring:** Planar graphs, Kuratowski's graphs, detection of planarity, Euler's formula for planar graphs, geometric and combinatorial duals of a planar graphs, coloring of graphs, chromatic numbers, chromatic polynomial, chromatic partitioning, Four color theorem.	6
5.	**Directed Graphs:** Types of digraphs, digraphs and binary relations, directed paths and connectedness, Euler digraphs, de Brujin sequences, tournaments	6
6.	**Ramsey Theory:** Introduction to Ramsey theory, Ramsey numbers, Ramsey theorem	4
7.	**Enumerations:** Types of enumerations, Polya theory of enumeration and its applications.	6
	Total	42

11. Suggested Books:

S. No.	Title/Authors/Publishers	Year of Publication
1.	Deo, N., "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall India	2004
2.	West, D. B., "Introduction to Graph Theory ", Prentice Hall India (2nd Edition)	2009
3.	Clark, J. and Holton, J. A.,"A First Look at Graph Theory", World Scientific	1991
4.	Aldous, J. M., Wilson, R. J. and Best S., "Graphs and Applications: An Introductory Approach", Springer	2003
5.	Deistel, R., "Graph Theory", Springer (4th Edition)	2010
6.	Chartrand, G. and Zhang, P., "Introduction to Graph Theory", Tata McGraw Hill	2007
7.	Bondy, J. A. and Murty, U. S. R., "Graph Theory", Springer	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1.Subject Code : **MAN-524** Course Title: **Mechanics**

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**

5. Credits: **03** 6. Semester: **Spring**

7.Pre-Requisite: Nil 8.Subject Area: **PEC**

9. Objective of the Course: To introduce basic concepts of mechanics.

10. Details of Course:

S. No.	Particulars	Contact Hours
1	**Equilibrium of forces in 3D:** Condition of equilibrium for a system of forces in 3D, finite and infinitesimal displacements of a rigid body, work, potential energy virtual work, D'Alembert's principle.	6
2	**Motion of rigid body:** General motion of a rigid body, momental ellipsoid and principal axes, kinetic energy, and angular momentum of a rigid body, principles of energy and momentum, moving frames of reference, Coriolis force.	12
3	**Lagrange's and Hamilton theory:** Generalized forces, Lagrange's equation of motion, Lagrangian function, generalized momentum, deduction of principle of energy from Lagrange's equations(conservative field), Lagrange's equations with impulsive forces, Hamilton formulation, Hamilton to Lagrangian, Ignoration of coordinate and Routh's product procedure,Hamilton principle,Lagrange's equtions by varaitional methods, derivative of Lagrange's equation from Hamilton principle.	12
4	**Small oscillations:** The general theory of small oscillation, stable equilibrium and small oscilllation, the approximate forms of T and V, normal modes, orthogonality of normal modes.	12
	TOTAL	**42**

11. Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of publications
1	Synge, J.L. and Griffith, B.A., "Principles of Mechanics", McGraw-Hill	1970
2.	Gregory, R.D., "Classical Mechanics", First South Asian Edition, Cambridge Univ. Press	2008
3.	Goldstein, H., "Classical Mechanics", Addison-Wesley Publishing Company	1970
4.	Rana, N.C and Joag, P.S,"Classical Mechanics", Tata McGraw-Hill.	1991
5.	Louis, N. Hand and Janet, D. Finch, Analytical Mechanics, Cambridge University Press.	1998
6.	Ramsey, A.S., "Dynamics Part II", Cambridge Univ. Press	1961

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-619** Course Title: **Measure Theory**
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**
5. Credits: **3** 6. Semester: **Autumn/Spring**
7. Subject Area: **PEC**
8. Pre-requisite: A first course on Real Analysis
9. Objective: To provide the knowledge of Lebesgue Measure and L^p spaces.
10. Details of Course

S. No.	Contents	Contact Hours
1.	**Measure on the real line**: Introduction, Lebesgue outer measure, Measurable sets, Borel sets, Regular Measure, Measurable functions, Borel and Lebesgue Measurable Functions.	5
2.	**Integration of Functions of a real variable**: Integration of non-negative functions, Lebesgue Integral, Fatou's Lemma, Lebesgue Monotone Convergence theorem, The General Integral, Lebesgue dominated convergence theorem, Integraion of Series , Riemann and Lebesgue Integrals.	10
3.	**Abstract Measure spaces**: Measures and Outer Measures, Extensions of Measure , Uniqueness of the Extension, Completion of a measure , Measure spaces , Integration with respect to a measure.	10
4.	**Inequalities and the L^p spaces**: L^p spaces, Convex functions, Jensen's inequality, Inequalities of Holder and Minkowski, Convergence in Measure, Almost uniform Convergence.	6
5.	**Signed Measures and their Derivatives**: Signed Measures and the Hahn Decomposition, The Jordan decomposition, The Radon Nikodym Theorem and some applications.	6
6.	**Complex Measures**: Total variation, Absolute Continuity, Consequences of Radon Nikodym Theorem, Riesz Representation Theorem.	5
		42

11.Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Barra, G.D., Measure theory and Integration. Woodhead Publishing.	2003
2.	Natanson, I.P., E. Hewitt, L.F. Boron, Theory of Functions of a Real Variable, Vol. I & II, Literary Licensing, LLC	2013
3.	Rana, I.K., An Introduction to Measure and Integration, Narosa Publishing House.	2007
4.	Rudin, W., Real and Complex Analysis, 3rd Ed., McGraw Hill	1987
5.	Royden, H.L., "Real Analysis", The Macmillan Company.	2010
6.	Munroe, M.E., Introduction to Measure and Integration, Addison Wesley, Mass.	1953

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-631** Course Title: **Number Theory**

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: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To give an introduction of basic concepts of Number Theory.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Divisibility and prime numbers:** Divisibility, Euclidean algorithm, linear Diophantine equations, prime numbers, fundamental theorem of arithmetic, discussion on the prime number theorem.	6
2.	**Congruences:** Introduction to congruences, solutions of linear congruences, Chinese Remainder Theorem, Euler's totient function, Euler-Fermat theorem, Wilson's theorem, non-linear congruences, Hensel's lemma, primitive roots and power residues.	10
3.	**Public key cryptography:** Introduction to public key cryptography, the RSA cryptosystem.	3
4.	**Quadratic residues and quadratic reciprocity:** Quadratic residues, quadratic reciprocity, the Jacobi symbols.	6
5.	**Some functions of number theory:** The greatest integer function, arithmetic functions, Mobius function and Mobius inversion formula.	6
6.	**Continued fractions:** Finite continued fractions, infinite continued fractions, approximation to irrational numbers.	5
7.	**Algebraic numbers:** Introduction to algebraic numbers, algebraic number fields, algebraic integers, quadratic fields, units in quadratic fields, primes in quadratic fields, unique factorization, primes in quadratic fields having the unique factorization property.	6
	Total	42

11. Suggested Books:

S. No.	Title/Authors/Publishers	Year of Publication
1.	Niven I., Zuckerman H. S., and Montgomery H. L., An Introduction to the Theory of Numbers, John Wiley & Sons (5th Ed.)	1991
2.	Hardy, G., H. and Wright, E. M, An Introduction to the Theory of Numbers, Oxford University Press (6th Ed.)	2008
3.	Burton D., M., Elementary Number Theory, McGraw Hill (7th Ed.)	2010
4.	Apostol T. M., Introduction to Analytic Number Theory, Springer	1998
5.	Baker A., A Comprehensive Course in Number Theory, Cambridge University Press	2012
6.	Koblitz N., A Course in Number Theory and Cryptography, Springer (2nd Ed.)	1994

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics**

1. Subject Code: **MAN-632** Course Title: **Advanced Numerical Analysis**

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: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite: Basic knowledge of numerical methods

9. Objective: To impart knowledge of finite element methods for solving ordinary and partial differential equations.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Concepts:**Introduction to finite elements methods, comparison with difference methods.	2
2.	**Weighted Residuals Method:**Collocations, least squares and Galerkin's method.	4
3.	**Ritz's Method:** Variational formulation of boundary value problems, equivalence of Galerkin and Ritz methods.	6
4.	**Application in ODE:** Application to solving simple problem of ordinary differential.	6
5.	**One Dimension Elements:** Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.	6
6.	**Two Dimensional Elements:** Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries	8
7.	**Interpolation and Integration:** Interpolation functions, numerical integration, and modeling considerations.	5
8.	**Application to PDE:**Solution of two dimension partial differential equations under different Geometric conditions.	5
	Total	42

Table-I

S.No.	PG Level Course under Old Structure	Recommended Equivalent Course from PG for IDD	Remark
B.Tech.(Electrical Engg.) and M.Tech. (Power Electronics)			
1.	EE-567 HVDC Systems	EE-564 HVDC Transmission Systems	Code and Title change
2.	EE-540 Advanced Power Electronics	EE-540 Advanced Power Electronics	No change
3.	EE-541 Power Electronic Controlled Drives	EE-640 Power Electronic Controlled Drives	Code change
4.	EE-554 FACTS Devices	EE-543 FACTS Devices	Code Change
5.	EE-543 Advanced Electric Drives	EE-542 Advanced Electric Drives	Code Change
B.Tech.(Chemical Engg.) and M.Tech. (Hydrocarbon Engg.)			
1.	CH-551 Hydrocarbon Processing & Engineering-I	-	The Department will run these courses separately for the students of IDD as being done now.
2.	CH-553 Reservoir Engineering	-	
3.	CH-552 Hydrocarbon Processing & Engineering-II	-	
4.	CH-554 Oil & Gas Transport	-	
5.	CH-556 Natural Gas Engineering	-	
6.	CH-558 Distillation Process	-	
7.	CH-562 Hydrocarbon Engineering Lab	-	
B.Tech.(Computer Science Engg.) and M.Tech. (Information Technology)			
	Program Elective-I /II/III/IV/V/VI	Program Elective-I /II/III/IV/V/VI	PG Electives from new list will be offered
B.Tech.(Electronics and Communication Engg.) and M.Tech. (Wireless Communications)			
1.	Program Elective-I /II/III/IV/V	Program Elective-I /II/III/IV/V	PG Electives from new list will be offered
B.Tech.(Civil Engg.) and M.Tech. (Structural Engg.)			
1.	CE-512 Analysis and Design for Dynamic Effects	CE-544 Structural Dynamics	Equivalent courses in new structure
2.	CE-561 Computer Applications in Structural Analysis	CE-541 Matrix Structural Analysis	
3.	CE-661 Finite Element Method	CE-545 Finite Element Analysis	
4.	CE-663 Design of Bridge Superstructure	CE-642 Analysis and Design of Bridges	
5.	CE-665 Design of Plates and Shells	CE-644 Analysis and Design of Plates and Shells	
B.Tech.(Metallurgical and Material Engg.) and M.Tech. (Materials Engg.)			
1.	MT-503 Modelling, Simulation and Computer Appl.	-	The Department will run these courses separately for the students of IDD as being done now.
2.	MT-511 Thin Films Technology	-	
3.	MT-562 Micro-fabrication Technology	-	
4.	MT-564 Micro-sensors, MEMS and Smart Devices	-	
5.	MT-410 Electronic and Magnetic Materials Lab	-	

30.3.08

Item No. Senate/58.20 Table-1