सीनेट की उन्नतीसवीं बैठक का कार्यवृत्त

MINUTES OF THE 29TH MEETING OF THE SENATE

5TH MAY 2009

भारतीय प्रौद्योगिकी संस्थान रूड़की
रूड़की – 247 667 (भारत)

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

भारतीय प्रौद्योगिकी संस्थान रुड़की
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Lt Col A K Srivastava (Retd)
Registrar

No. IITR/MS/29th Senate/ 266 /
Dated: 4th June 2009

ALL MEMBERS OF THE SENATE
Indian Institute of Technology Roorkee

Subject: Minutes of the 29th Meeting of the Senate held on 5th May 2009.

Enclosed herewith please find a copy of the Minutes of the 29th Meeting of the Senate held on 5th May 2009 in the Senate Hall of the Institute, for your perusal. Your comments, if any, on the minutes may please be sent within 15 days.

Encl: As above

(A.K. Srivastava)
Lt. Col. (Retd)
Registrar & Secretary, Senate

04 JUN 2009

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

I N D E X

Minutes of the 29th Meeting of the Senate held on 5th May 2009 in the Senate Hall of the Institute.

The following were present: -

1.	Prof. S.C. Saxena	Director	-Chairman
2.	Prof. H.K. Verma	Dy. Director	
3.	Prof. S.Y. Kulkarni	(Architecture & Planning)	
4.	Prof. G.S. Randhawa	(Biotechnology)	
5.	Prof. R.P. Singh	(Biotechnology)	
6.	Prof. Shri Chand	(Chemical Engineering)	
7.	Prof. I.D. Mall	(Chemical Engineering)	
8.	Prof. G. Bhattacharjee	(Chemistry)	
9.	Prof. R.N. Goyal	(Chemistry)	
10.	Prof. Ravi Bhushan	(Chemistry)	
11.	Prof. Kamaluddin	(Chemistry)	
12.	Prof. V.K. Gupta	(Chemistry)	
13.	Prof. Anil Kumar	(Chemistry)	
14.	Prof. (Mrs.) Mala Nath	(Chemistry)	
15.	Prof. U.P. Singh	(Chemistry)	
16.	Prof. M.R. Maurya	(Chemistry)	
17.	Prof. G.L. Asawa	(Civil Engineering)	
18.	Prof. G. Ramasamy	(Civil Engineering)	
19.	Prof. A.K. Jain	(Civil Engineering)	
20.	Prof. V.K. Gupta	(Civil Engineering)	
21.	Prof. Deepak Kashyap	(Civil Engineering)	
22.	Prof. (Mrs) Renu Bhargava	(Civil Engineering)	
23.	Prof. U.C. Kothyari	(Civil Engineering)	
24.	Prof. P.K. Garg	(Civil Engineering)	
25.	Prof. Pradeep Bhargava	(Civil Engineering)	
26.	Prof. S.K. Ghosh	(Civil Engineering)	
27.	Prof. Mahendra Singh	(Civil Engineering)	
28.	Prof. Manoj K. Arora	(Civil Engineering)	
29.	Prof. Manoranjan Parida	(Civil Engineering)	
30.	Prof. N.K. Samadhiya	(Civil Engineering)	
31.	Prof. D.K. Paul	(Earthquake Engineering)	
32.	Prof. Ashwini Kumar	(Earthquake Engineering)	
33.	Prof. H. Sinvhal	(Earth Sciences)	
34.	Prof. V.N. Singh	(Earth Sciences)	
35.	Prof. A.K. Awasthi	(Earth Sciences)	
36.	Prof. H.O. Gupta	(Electrical Engineering)	
37.	Prof. Vinod Kumar	(Electrical Engineering)	
38.	Prof. Pramod Agarwal	(Electrical Engineering)	
39.	Prof. D.K. Mehra	(Electronics & Computer Engg	
40.	Prof. S.N. Sinha	(Electronics & Computer Engg.)	
41.	Prof. N.K. Goel	(Hydrology)	
42.	Prof. Himanshu Joshi	(Hydrology)	
43.	Prof. Pashupati Jha	(Humanities & Social Sciences)	
44.	Prof. Sukh Pal Singh	(Humanities & Social Sciences)	
45.	Prof. J.S. Upadhyay	(Paper Technology)	

46.	Prof. V.K. Nangia	(Management Studies)
47.	Prof. G.S. Srivastava	(Mathematics)
48.	Prof. S.P. Sharna	(Mathematics)
49.	Prof. T.R. Gulati	(Mathematics)
50.	Prof. (Mrs) Rama Bhargava	(Mathematics)
51.	Prof. R.C. Mittal	(Mathematics)
52.	Prof. Satish C. Sharma	(Mechanical & Industrial Engg.)
53.	Prof. Dinesh Kumar	(Mechanical & Industrial Engg.)
54.	Prof. P.K. Jain	(Mechanical & Industrial Engg.)
55.	Prof. B.K. Gandhi	(Mechanical & Industrial Engg.)
56.	Prof. P.S. Mishra	(Metallurgical & Materials Engg.)
57.	Prof. Satya Prakash	(Metallurgical & Materials Engg.)
58.	Prof. R.D. Agarwal	(Metallurgical & Materials Engg.)
59.	Prof. P.K. Ghosh	(Metallurgical & Materials Engg.)
60.	Prof. (Mrs) Vijaya Agarwala	(Metallurgical & Materials Engg.)
61.	Prof. S.K. Nath	(Metallurgical & Materials Engg.)
62.	Prof. R.C. Agarwala	(Metallurgical & Materials Engg.)
63.	Prof. B.D. Indu	(Physics)
64.	Prof. Ravindra Nath	(Physics)
65.	Prof. A.K. Jain	(Physics)
66.	Prof. Rajesh Srivastava	(Physics)
67.	Prof. Vir Singh	(Physics)
68.	Prof. D. Das	(Water Resource Dev. & Management)
69.	Prof. U.C. Chaube	(Water Resource Dev. & Management)
70.	Prof. Ram Pal Singh	(Water Resource Dev. & Management)
71.	Prof. M.L. Kansal	(Water Resource Dev. & Management)
72.	Prof. Prem K.Kalra	IIT Kanpur
73.	Prof. Karmeshu	JNU, New Delhi
74.	Dr. Arun Kumar	Head, AHEC
75.	Mr. Yogendra Singh	Librarian, Central Library
76.	Dr. (Ms) Bina Gupta	Chief Warden, Kasturba Bhawan
77.	Dr. Ankush Mittal	Associate Professor, E & CE Deptt.
78.	Dr. Sandeep Singh	Associate Professor, Earth Sciences
79.	Dr. A.K. Sen	Associate Professor, Earth Sciences
80.	Lt.Col. (Retd.) A.K. Srivastava	Registrar - Secretary

The Chairman (Director) welcomed the members to the 29th Meeting of the Senate especially Prof. Prem K. Kalra, IIT Kanpur, who was attending a meeting of the Senate for the first time, and Prof. Karmeshu, JNU, New Delhi.

Before taking up the agenda, the Senate thanked the under-mentioned outgoing member and recorded its appreciation for his valuable contribution in the meetings of the Senate.

Dr. G.S. Agarwal, Associate Professor
Department of Mathematics & Ex-Chief Warden, Govind Bhawan

The Senate also welcomed the under- mentioned new member and hoped for her valuable contribution and active participation in its functioning:

Dr. (Ms.) Bina Gupta, Chief Warden, Kasturba Bhawan & Associate Professor, Department of Chemistry.

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

1. Prof. Sushil, I IT Delhi
2. Prof. S.P. Gupta, Department of Electrical Engineering
3. Prof. S.S. Jain, Department of Civil Engineering
4. Prof. A.K. Saraf, Department of Earth Sciences
5. Prof. R.P. Maheshwari, Department of Electrical Engineering

The Agenda was then taken up:

Item No.29.1.1: To confirm the minutes of the 28th meeting of the Senate held on 2nd March 2009.

The minutes of the 28th meeting of the Senate held on 2nd March 2009 were confirmed.

Item No.29.1.2: To receive a report on the actions taken to implement the decisions taken by the Senate in its 28th meeting held on 2nd March 2009.

The Senate noted that the required actions have been taken on the decisions taken by the Senate in its 28th meeting held on 2nd March 2009.

Item No.29.2.1: To consider the syllabi of Integrated M.Sc. Physics Courses of III year onwards.

As considered and recommended by the Board of Studies, the Senate, after minor modifications, approved the syllabi of Integrated M.Sc. Physics Courses of III year onwards. The detailed syllabi of the courses are appended at **Appendix 'A'.**

Item No.29.2.2: To consider the syllabi of B.Arch. I year courses of the structure applicable from 2009-10 session.

As considered and recommended by the Board of Studies, the Senate, after minor modifications, approved the syllabi of the following courses of B.Arch. I year for the structure applicable from 2009-10 sessions:

1.	AR-101	Basic Design and Model Making
2.	AR-103	Architectural Graphics-I
3.	AR-102	Architectural Design-I
4.	AR-104	Architectural Graphics-II
5.	AR-106	Introduction to Building Materials and Construction-I
6.	AR-108	Principles of Architectural
7.	AR-110	Colour Fundamentals and its Applications

The syllabi of the above courses are appended at **Appendix 'B'.**

Item No.29.2.3: To consider the syllabus of a new Departmental Elective proposed by the Department of Mathematics.

As considered and recommended by the Board of Studies, the Senate decided that the Departmental Elective MA-905: Evolutionary Algorithms, as appended at **Appendix 'C'** be approved.

Item No.29.2.4: To consider the syllabus of a new Institute Elective proposed by the Department of Metallurgical and Materials Engineering.

As considered and recommended by the Board of Studies, the Senate decided that the Institute Elective IMT-01: Non Destructive Testing, as appended at **Appendix 'D'** be approved.

Item No.29.2.5: To consider the minimum CGPA required for OBC category students to be eligible for a change of branch.

As considered and recommended by the Board of Studies, the Senate decided that a minimum CGPA of 7.0 will be required for OBC category students for a change of their branch.

Item No.29.2.6: To consider the syllabi of III and IV year of B.Tech. (Metallurgical & Materials Engineering) programme.

As considered and recommended by the Board of Studies, the Senate, after minor modifications, approved the syllabi of III and IV year of B.Tech. (Metallurgical & Materials Engineering) Programme. The syllabi of all these courses are appended at **Appendix 'E'.**

Item No.29.2.7: To consider the Grievance Redressal System for Students.

As considered and recommended by the Board of Studies, the Senate decided that the under-mentioned Standing Committee be constituted to address the grievances of any student.

1. Dean, Academic Studies — Chairman
2. Coordinator, I year
3. Associate Dean, Discipline
4. One Senate Nominee
5. Chairman, DAC (Concerned Department)

Item No.29.2.8: To consider the syllabi of new Institute Electives proposed by the Department of Electronics & Computer Engineering.

The Senate decided that the new institute Electives proposed by the Department of Electronics & Computer Engineering be referred in to the Department for consideration and placed in the next meeting of the Senate.

Item No.29.2.9: To consider the syllabi of new Institute Electives proposed by the Alternate Hydro Energy Centre.

As considered and recommended by the Board of Studies, the Senate decided that the syllabi of the following new Institute Electives be approved:

IAH-01: Small Hydropower Development

IAH-02: Renewable Energy Sources Development Technology

The syllabi of these Institute Electives are appended at **Appendix 'F'.**

Item No.29.2.10: To consider the Academic Calendar for the Autumn Semester 2009-2010 Session.

The Senate decided that the Academic Calendar for the Autumn Semester 2009-2010 Session as appended at **Appendix 'G'** be approved.

Item No.29.2.11: To consider the panel of Senate's Nominees on the Selection Committee for academic positions.

After due deliberation and certain some modifications, the Senate decided that the panel of the Senate's Nominees on the Selection Committees of the academic positions in respect of each of the following Departments/ Centres be approved **(Appendix 'H')**:

1. Alternate Hydro Energy Centre
2. Architecture & Planning
3. Biotechnology
4. Chemical Engineering
5. Chemistry
6. Civil Engineering
7. Paper Technology
8. Earth Sciences
9. Earthquake Engineering
10. Electrical Engineering
11. Electronics & Computer Engg.
12. Humanities & Social Sciences
13. Hydrology
14. Management Studies
15. Mathematics
16. Mechanical & Industrial Engineering
17. Metallurgical & Materials Engg.
18. Physics
19. Water Resources Development & Management

ItemNo.29.2.12: To consider the issue related to the curriculum structure of Post B.Sc. programmes.

The Senate decided that the recommendations of the committee in respect of curriculum structure of Post B.Sc. Programme as appended at **Appendix 'I'** be approved.

Item No. 29.3.1: To report that the Director has approved the acceptance of a proposal for institution of the "Dwarka Dass Balwant Kaur Thapar Cash Prize" of Rs.5,000/- p.a. for student of M.Tech. II year (AHES), having second highest CGPA, admitted on self finance basis.

Senate noted that the Director, on behalf of the Senate has approved the proposal of Prof. O.D. Thapar for institution of the "Dwarka Dass Balwant Kaur Thapar Cash Prize" of Rs.5,000/- . The donors have contributed a sum of Rs.1,25,000/- for this purpose.

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

PROGRAM CODE 30 Integrated M.Sc. (Physics)
DEPARTMENT PH Physics Department
YEAR III

AUTUMN SEMESTER

S. NO.	SUBJECT CODE	COURSE TITLE	SUBJECT AREA	Teaching Scheme (Hrs./Week) CREDITS	L	T	P	Exam. Duration (Hrs.) Theory	Practical	Relative Weightage (%) CWS	PRS	MTE	ETE	PRE
1.	PH-301	Plasma Physics	DCC	3	3	0	0	3	0	15	-	35	50	-
2.	PH-303	Quantum Physics	DCC	4	3	1	0	3	-	25	-	25	50	-
3.	PH-305	Properties of Matter and Acoustics	DCC	4	3	1	0	3	-	25	-	25	50	-
4.	PH-307	Atomic Physics	DCC	4	3	1	0	3	-	25	-	25	50	-
5.	PH-IE1	Institute Elective I	HSS MC	3	2	1	0	2	-	25	-	25	50	-
		Sub Total		18	14	4	0							

SPRING SEMESTER

1.	PH-302	Laboratory – I	DC	3	0	0	6	-	6	-	50	-	-	50
2.	PH-304	Elements of Condensed Matter Physics	DC	4	3	1	0	3	-	25	-	25	50	-
3.	PH-306	Elements of Classical Mechanics	DC	4	3	1	0	3	-	25	-	25	50	-
4.	PH-308	Nuclear Physics and its Applications	DC	4	3	1	0	3	-	25	-	25	50	-
5.	PH-IE2	Institute Elective II	HSS MC	3	2	1	0	2	-	25	-	25	50	-
		Sub Total		18	11	4	6							

PROGRAM CODE 30 Integrated M.Sc. (Physics)
DEPARTMENT PH Physics Department
YEAR IV

AUTUMN SEMESTER

S. NO.	SUBJECT CODE	COURSE TITLE	SUBJECT AREA	Teaching Scheme (Hrs./Week) CREDITS	L	T	P	Exam. Duration (Hrs.) Theory	Practical	Relative Weightage (%) CWS	PRS	MTE	ETE	PRE
1.	PH-501	Semiconductor Devices	DCC	3	3	0	0	3	0	15	0	35	50	0
2.	PH-503	Quantum Mechanics – I	DCC	4	3	1	0	3	0	15	0	35	50	0
3.	PH-505	Mathematical Physics	DCC	3	3	0	0	3	0	15	0	35	50	0
4.	PH-507	Classical Electrodynamics	DCC	4	3	1	0	3	0	25	0	25	50	0
5.	PH-509	Classical Mechanics	DCC	3	3	0	0	3	0	15	0	35	50	0
6.	PH-511	Computational Physics	DCC	3	1	0	4	0	2	15	15	30	0	40
		Sub Total		20	16	0	4							

SPRING SEMESTER

1.	PH-502	Laboratory - II	DCC	3	0	0	6	0	4	0	50	0	0	50
2.	PH-504	Condensed Matter Physics	DCC	3	3	0	0	3	0	15	0	35	50	0
3.	PH-506	Statistical Mechanics	DCC	3	3	0	0	3	0	15	0	35	50	0
4.	PH-508	Quantum Mechanics - II	DCC	3	3	0	0	3	0	15	0	35	50	0
5.	PH-510	Nuclear and Particle Physics	DCC	2	2	0	0	2	0	15	0	35	50	0
6.	PH-512	Physics of Earth's Atmosphere	DCC	2	2	0	0	2	0	15	0	35	50	0
7.	PH-514	Molecular Spectroscopy and Lasers	DCC	2	2	0	0	2	0	15	0	35	50	0
		Sub Total		18	15	0	6							

PROGRAM CODE 30 Integrated M.Sc. (Physics)
DEPARTMENT PH Physics Department
YEAR V

AUTUMN SEMESTER

S. NO.	SUBJECT CODE	COURSE TITLE	SUBJECT AREA	Teaching Scheme (Hrs./Week) CREDITS	L	T	P	Exam. Duration (Hrs.) Theory	Practical	Relative Weightage (%) CWS	PRS	MTE	ETE	PRE
1.	PH-ELE1	Departmental Elective – Group A	DEC	4	3	1	0	3	0	25	0	25	50	0
2.	PH-ELE2	Departmental Elective – Group B	DEC	3	0	0	6	0	3	0	50	0	0	50
3.	PH-ELE3	Departmental Elective – Group C	DEC	3	3	0	0	3	0	15	0	35	50	0
4.	PH-ELE4	Departmental Elective – Group C	DEC	3	3	0	0	3	0	15	0	35	50	0
5.	PH-ELE5	Departmental Elective – Group C	DEC	3	3	0	0	3	0	15	0	35	50	0
6.	PH-IE3	Institute Elective - III	ESEC	4	3	1	0	3	0	25	0	25	50	0
		Sub Total		**20**	15	2	6							

SPRING SEMESTER

1.	PH- ELE6	Departmental Elective – Group D	DEC	4	3	1	0	3	0	25	0	25	50	0
2.	PH-608	Seminar	DCC	4	0	0	0	0	0	0	0	0	0	0
3.	PH-610	Dissertation	DCC	14	0	0	0	0	0	0	0	0	0	0
		Sub Total		**22**	3	1	0							

Group A

PH-601	Advanced Condensed Matter Physics
PH-603	Advanced Atmospheric Physics
PH-605	Advanced Laser Physics
PH-607	Advanced Nuclear Physics

Group B

PH- 609	Experiments in Condensed Matter Physics
PH- 611	Experiments in Atmospheric Physics
PH- 613	Experiments in Laser Physics
PH- 615	Experiments in Nuclear Physics

Group C

PH- 617	Advanced Characterization Techniques
PH- 619	Introduction to Quantum Field Theory
PH- 621	Fiber and Nonlinear Optics
PH- 623	General Relativity
PH- 625	Particle Physics
PH- 627	Quantum Theory of Solids
PH- 629	Weather Forecasting

Group D

PH- 602	Nuclear Astrophysics
PH- 604	Physics of Nanosystems
PH- 606	Superfluidity and Superconductivity

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-301** Course Title: **Plasma Physics**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-202M**

9. Objective: **To familiarize students with the basic principles of plasma physics with application to other areas.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction to Plasma Physics:** Plasma definition; Debye shielding; Plasma parameters; Criteria for Plasma	6
2.	**Motion of Particles in the Presence of Electric and Magnetic Fields:** Motion of charge particle in uniform and non-uniform E and B fields; Time varying E and B fields.	6
3.	**Plasma as Fluids:** Relation of Plasma Physics with ordinary Electromagnetics; The Fluid Equation of Motion; Fluid drifts perpendicular and parallel to B; The Plasma Approximation	8
4.	**Waves in Plasma:** Representation of waves; Plasma oscillations; Electron plasma waves, ion waves; Validity of plasma approximation; Comparison of ion and electron waves, Electrostatic electron oscillations perpendicular to E and B; Electrostatic ion waves perpendicular to B	10
5.	**Diffusion and Resistivity**: Diffusion and mobility in weakly ionized gases; Decay of a Plasma by Diffusion; Steady state solution, recombination; Diffusion across a magnetic field; Collision in a fully ionized plasma; The single fluid MHD equation; Diffusion in fully ionized plasma	12
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Chen F F, "Introduction to Plasma Physics", Plenum Press New York	1990
2.	Davidson R C, "Physics of Non-Neutral Plasmas", Allied Publishers Pvt. Ltd	2001
3.	Eliezer S and Eliger Y, "The Fourth State of Matter: An Introduction to Plasma Science", CRC Press	2001
4.	Paul M. B., "Fundamentals of Plasma Physics", Cambridge University Press	2004

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

1. Subject Code: **PH-303** Course Title: **Quantum 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: **DCC**

8. Pre-requisite: **PH-101**

9. Objective: **To familiarize students with the basic principles of quantum mechanics and applying these to single-particle systems.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Wave Packets and Uncertainty Principle:** Plane waves; Superposition of plane waves; Wave packets; Fourier analysis; Group velocity; Propagation of wave packets; Wave packet broadening; Gaussian wave packet.	8
2.	**Schrödinger Equation:** The wave equation and the interpretation of ψ; Operators and expectation values of dynamical variables; Commutators and operator algebra; Stationery states; Dirac notations.	10
3.	**Problems in One-dimension:** Potential step, rectangular potential barrier, symmetries and invariance properties, reflection and transmission coefficients, potential well, Kroning-Penny Model.	12
4.	**Harmonic Oscillator:** Energy eigen values and eigen functions of a 1-D harmonic oscillator; Matrix formulation of oscillator problem, N-Harmonic oscillators in contact with a heat bath of temperature T; Boltzmann factor, average energy of a harmonic oscillator at temperature T; Bose-Einstein and Fermi-Dirac distribution.	12
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Gariorowicz S, "Quantum Physics", 3rd Ed, John Wiley & Sons	2006
2.	Mathews P.M and Venkatesan K., "A Text Book of Quantum Mechanics", Tata McGraw Hill	2000
3.	Beiser A, "Concepts of Modern Physics", McGraw Hill International	2004
4.	Ghatak A and Lokanathan S, "Quantum Mechanics", Mcmillan India Ltd.	2004

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

1. Subject Code: **PH-305** Course Title: **Properties of Matter and Acoustics**

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: **DCC**

8. Pre-requisite: **PH-101**

9. Objective: **To familiarize students with fundamentals of properties of matter, waves and acoustics.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Elasticity:** Hooke's Law Stress; Strain Diagram; Elastic moduli; Relation between elastic constants; Poisson's Ratio; Work done in stretching and twisting a wire; Twisting couple on a cylinder; Rigidity modulus by static torsion; Torsional pendulum; Rigidity modulus and moment of inertia.	8
2.	**Bending of Beams**: Cantilever; Cantilever oscillations; Expression for time period; Experiments to find Young's modulus; Non uniform bending.	6
3.	**Fluids**: Surface Tension; Excess of pressure over curved surfaces - Application to spherical and cylindrical drops and bubbles - Variation of Surface tension with temperature - Jaegar's method.	6
4.	**Viscosity**: Co-efficient of viscosity; Rate of flow of liquid through a capillary tube; Poiseuilles' formula; Experiment to determine co-efficient of viscosity of a liquid; Variation of viscosity of a liquid with temperature; Applications of viscosity.	6
5.	**Waves and Oscillations**: Simple harmonic motion; Free, Damped; Forced vibrations and Resonance; Fourier's Theorem - Application to saw tooth wave and square wave, Intensity & loudness of sound; Decibels - Intensity levels; Noise pollution.	8
6.	**Ultrasonics**: Production of ultrasonic waves; Piezoelectric crystal method; Magnetostriction, Application of ultrasonics to science, industry and medicine.	8
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Feynman R P, Leighton R B and Sands M, "The Feynman Lectures on Physics", Vols. I, Narosa	2005
2.	Chakrabarthy P K, "Mechanics and General Properties of Matter", Allied Publishers Pvt. Ltd	2001
3.	Flowers B H and Mendoza E, "Properties of Matter", Wiley Publisher	1991
4.	Bajaj N K, "The Physics of Waves and Oscillations", Tata MC Graw Hill	1988
5.	Ingard K U, "Fundamentals of Waves and Oscillations", Cambridge Univ. Press	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-307** Course Title: **Atomic 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: **DCC**

8. Pre-requisite: **PH-101**

9. Objective: **To introduce basic principles of spectroscopy to the students**

10. Details of Course:

Sl.No	Contents	Contact Hour
1.	Basic Principles of Spectroscopy; The Optical Spectrum of the Hydrogen Atom; Bohr's Postulates; Motion of the Nucleus; Spectra of Hydrogen-like Atom; Excitation of Quantum Jumps by Collisions; Sommerfeld's model; Lifting of Orbital Degeneracy by the Relativistic Mass Change.	9
2.	Magnetic Moment of the Orbital Motion; Precession and Orientation in a Magnetic Field; Stern and Gerlach experiment; Calculation of Spin-Orbit Splitting in the Bohr Model; Level Scheme of the Alkali Atoms; Fine Structure in the Hydrogen Atoms; The Lamb Shift.	9
3.	Directional Quantisation in a Magnetic Field; Electron Spin Resonance; The Zeeman Effect Experiments; Explanation of the Zeeman Effect from the Standpoint of Classical Electron Theory; Description of the Ordinary Zeeman Effect by the Vector Model; The Anomalous Zeeman Effect; Magnetic Moments with Spin-Orbit Coupling; The Paschen-Back Effect.	8
4.	The Spectrum of the Helium Atoms; Electron Repulsion and the Pauli Principle; Angular Momentum Coupling, Coupling Mechanism; *LS* Coupling (Russell-Saunders Coupling); *jj* Coupling, Magnetic Moments of Many-Electron Atoms; Multiple Excitations.	8
5.	X-Radiation from Outer Shells; X-Ray Bremsstrahlung Spectra; Emission Line Spectra: Characteristic Radiation; Absorption Spectra; The Auger Effect; Nuclear Spin; Hyperfine Structure	8
	Total	42

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Hanken H and Wolf H C, "The Physics of Atoms and Quanta", 6th Ed., Springer	2007
2.	Laud B B, "Non-linear Optics", Wiley Eastern Ltd.	1992
3.	Beiser A, "Concept of Modern Physics", 6th Ed., Tata McGraw Hill	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-302** Course Title: **Laboratory -I**

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: **DCC**

8. Pre-requisite: **PH-101**

9. Objective: **To familiarize students with the basic experiments in properties of matter and acoustics.**

10. Details of Course:

S. No.	Particulars	Contact Hours
1.	To determine the Young's modulus of steel, aluminum and brass by method of flexure	14 x 6
2.	Determination of shear modulus of steel, copper and brass	
3.	Determination of surface tension of olive oil at different temperatures	
4.	To measure the dynamic viscosity of water and methanol at different temperatures	
5.	To study free oscillations and forced oscillations under damped ands un-damped conditions	
6.	Determination of wavelength and frequency of sound wave by Quincke's method	
7.	Determination of phase and group velocity of ultrasonic wave in different liquids	

8.	Study of stationary ultrasonic wave and determination of its wavelength	
9.	Study of interference of ultrasonic wave with Michelson's interferometer	
10.	Determination of the value of g (acceleration due to gravity) using Kater's type compound pendulum	
11.	Coefficient of viscosity of water b rotating disc/cylinder method	
12.	Determination of surface tension of a liquid at different temperatures by Jaeger's method	
13.	Coefficient of viscosity of water by Poiseuilles's method	
14.	Determination of modulus of elasticity of different materials	
	Total	**84**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Chattopadhayay D and Rakshit P.C., "An advanced course in Practical Physics" 7th Ed., New Central Book agency (P) Ltd.	2005
2.	G. L. Squires " Practical Physics" 4th Ed., Cambridge University Press	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-304** Course Title: **Elements of 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: **Spring** 7. Subject Area: **DCC**

8. Pre-requisite: **PH-202M**

9. Objective: **To familiarize students with bonding, mechanical properties, crystal structure, lattice vibrations, defects in solids and theory of ferromagnetism.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Bonding and Mechanical Properties:** Covalent bonding, ionic bonding, metallic bonding, hydrogen bonding and Van der waals bonding. Elastic constants and elastic waves.	6
2.	**Crystal Structure:** Point symmetry, translational symmetry, two- and three- dimensional lattices, simple crystal structures, Miller indices, diffraction from periodic structures, reciprocal lattice, Brillouin zones.	9
3.	**Lattice Vibrations:** One dimensional lattices (monoatomic and diatomic), quantization of elastic waves, phonon momentum, density of modes.	7
4.	**Electrons in Solids:** Free electron gas in metals, periodic potential and Bloch's theorem and Kronig-Penney model.	8
5.	**Defects in Solids:** Lattice vacancies, diffusion, colour centers and elementary idea of dislocation.	4
6.	**Magnetism:** Langevin theory of dia- and para- magnetism, quantum theory of dia- and para- magnetism, magnetic ordering, Weiss molecular field theory of ferromagnetism and Neel theory of anti-ferromagnetism.	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", 8th Ed., Wiley Eastern Ltd	2004
2.	Ashcroft N W and Mermin N D, "Solid State Physics", 2nd Ed. Holt-Saunders	2000
3.	Hook J R and Hall H E, "Solid State Physics", John Wiley	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-306** Course Title: **Elements of Classical Mechanics**

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: **DCC**

8. Pre-requisite: **None**

9. Objective: **To familiarize students with the basics of classical mechanics**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Central Force**: Equations of motion, equivalent one body problem, orbits, Virial theorem, Kepler's problem, scattering theory, centre of mass and laboratory frames of reference	10
2.	**Rigid Body Motion**: Orthogonal transformation, transformation matrix, Euler angles, Cayley-Klein parameters, Euler's theorem, Finite & infinitesimal rotations; Rotating frames of reference, Coriolis' force; Angular momentum and kinetic energy, dyadic & tensors; Moment of inertia, principal axis transformation, Euler equation of motion and its solutions, tops, precession, satellite orbits.	15
3.	**Small Oscillations**: Eigenvalue problem, normal coordinates, frequencies of vibrations, forced vibrations, examples.	4
4.	**Introduction to Constrained Motions**: Principle of virtual work, generalized coordinates, introduction to Lagrange's equation of motion, generalized momenta, cyclic coordinates, Legendre's dual transformation, Hamilton's function and Hamilton's equation of motion; Configuration space, phase space and state space.	13
	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 N.C. and Joag P.S, "Classical Mechanics", Tata McGraw Hill	1994
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: **PH-308** Course Title: **Nuclear Physics and its Applications**

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: **DCC**

8. Pre-requisite: **None**

9. Objective: **To familiarize students with the basic concepts of nuclear physics and its industrial, analytical, medicinal and energy applications.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Nuclear shape, size, radii, matter/charge distributions; Nuclear force; Concept of isospin; Charge independence of nuclear forces in the light of isospin. Mass defect and binding energy; Liquid drop model; Semi empirical mass formula; Evidence of shell structure; Shell model with harmonic oscillator and spin-orbit potential and its predictions.	9
2.	α-decay, its properties, range, range-energy relationship, Geiger-Nuttal law, theory of α-decay, β-decay and its classifications (only basics), γ-decay: range, properties, pair production, energy spectra and nuclear energy levels.	8
3.	Nuclear reaction, Kinematics, Direct nuclear reaction, Compound nuclear reaction, Nuclear fission and fusion.	7
4.	Gas, Scintillation and Semiconductor detectors. Neutron detectors, Accelerators: Cyclotron and Linac.	9
5.	Industrial, analytical and medicinal applications; Power from fission, Nuclear reactors; Source of stellar energy	9
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Lilley J S, "Nuclear Physics", John Wiley & Sons	2001
2.	Ghoshal S.N., "Nuclear Physics", S. Chand & Comp. Ltd	2000
3.	Povh B, Rith K, Scholz C and Zetsch F, " Particles and Nuclei", 2nd Ed. Springer	1999
4.	Heyde K, " From Nucleons to the Atomic Nucleus", Springer	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-501** Course Title: **Semiconductor Devices**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **EC-102 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**

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-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: **DCC**

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **MA-101 or equivalent, MA-202M or equivalent**

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: **PH-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: **DCC**

8. Pre-requisite: **PH-202M 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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-306 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: **PH-511** Course Title: **Computational Physics**

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

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

4. Relative Weightage: **CWS** 10 **PRS** 15 **MTE** 15 **ETE** 30 **PRE** 30

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

8. Pre-requisite: **MA-202M or equivalent**

9. Objective: **To provide the knowledge of computation with a suitable mathematical software and its applications to solve the problems of Physics.**

10. Details of Course:

S. No.	Particulars	Contact Hours
1.	**Introduction to mathematical software:** Need and advantages of numerical computation in physics, programming in a suitable mathematical software (Matlab/Mathematica/Scilab/ Octave), input/output, interactive input, loading and saving data, loops branches and control flow. Matrices and Vectors, Matrix and array operations, eigenvalues and eigen vectors.	8
2.	**Sub programs:** Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules.	3
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, Monte-Carlo simulation, ordinary differential equation, first order and second order ODEs, event location.	13
	Total	28

List of Experiments	
1. Black body radiation (computation and graphical representation) 2. Reflection and transmission of an electromagnetic wave 3. Statistical distributions at different temperatures 4. Binding energy curve for nuclei using liquid drop model 5. Eigen-value problem: 1-D square potential well 6. Eigen-values and wave-functions of a simple harmonic oscillator 7. Monte-Carlo simulation 8. Linear/Projectile motion (simulation and solutions)	
Total	**28**

11. Suggested Books:

S.No.	Name of Authors / Books / Publisher	Year of Publication/ Reprint
1.	Pratap R, "**Getting started with MATLAB 7**", Oxford Univ. Press	**2006**
2.	Gilat A, "**Matlab: An introduction with applications**", Wiley	**2008**
3.	Eaton J W, Batchman D and Hauberg S "**GNU Octave Manual Version 3**", Network Theory Ltd.	**2008**
4.	Campbell S, Chancelier J P and Nikoukhah R, "**Modeling and simulation in Scilab**", Springer	**2005**
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**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-502** Course Title: **Laboratory-II**

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

3. Examination Duration (Hrs.): **Theory** 0 **Practical** 4

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

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

8. Pre-requisite: **PH-304, PH-308 or equivalent**

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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

9. Objective: **To introduce various time-independent and time-dependent perturbation methods and relativistic quantum mechanics.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Time-independent Perturbation Theory:** Non-degenerates 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, spontaneous and stimulated emission cross-section.	10
3.	**Identical Particles:** Indistinguishability, permutation symmetry, two-particle system; Helium atoms, simple idea of Hartee self-consistent field, Hartee-Fock theory.	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.	Merzbacher E, "Quantum Mechanics", 2nd Ed., John Wiley & Sons	1997
3.	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: **PH-510** Course Title: **Nuclear and Particle Physics**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-308 or equivalent**

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

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Binding Energy and Mass Formula; Nature of nuclear force; Two nucleon problem: Ground state of deuteron, its magnetic moment and quadrupole moment; Tensor nature of nuclear force; Gamma decay selection rules; Rotational spectra in deformed nuclei; Nuclear reaction mechanisms; Compound nuclear reaction	8
2.	Concept of isospin, Charge independence of nuclear force in the light of isospin; mirror nuclei; estimate of decay rates from isospin conservation.	4
3.	Strangeness, Lepton and other quantum numbers, conservation of these quantum numbers related to strong and weak reactions, Strong interaction, salient features of Quantum chromodynamics, structure of nucleon, quark model, concept of colour.	5
4.	SU(2) and SU(3) of isospin symmetry and its generators, preliminary idea of Lie algebra, SU(3) flavour symmetry and construction of meson octet, Baryon octet & decuplet and their wave functions.	5
5.	β-decay and its classifications, neutrino hypothesis, energy spectrum of β-decay, Fermi theory of β-decay, concept of parity, helicity, non-conservation of parity in β-decay and its experimental verifications, Standard model of particle physics.	6
	Total	28

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Perkins, D.H., "Introduction to High Energy Physics", Addison-Wesley Publishing company.	2004
2.	Griffith D, "Introduction of Elementary Particles", John Wiley	2005
3.	Burcham W E and Jobes M, "Nuclear & Particle Physics", Addison-Wesley	2002
4.	Ghoshal, S.N., "Nuclear Physics", S. Chand and Company	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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: **PH-514** Course Title: **Molecular Spectroscopy and Lasers**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-307 or equivalent**

9. Objective: **To introduce molecular spectroscopy and the basics of lasers.**

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Types of molecular energy states and molecular spectra, pure rotational spectra; Vibration-Rotational spectra, Raman Spectra; Electronic spectra,	7
2.	Frank-Condon principle; Isotope effect on electronic spectra; Fluorescence and Phosphorecence; Classification of molecular electronic states. Idea of Line broadening mechanisms	7
3.	Lasers-Physical principles; Threshold condition; Generation of population Inversion; Optical Resonator; Gaussian beam; Single mode lasers; He-Ne, CO_2 and Semiconductor Lasers.	7
4.	Laser absorption Spectroscopy; Saturated absorption spectroscopy; Doppler-free two photon spectroscopy; Level crossing spectroscopy. Laser cooling and trapping of atoms	7
	Total	28

11. Suggested Books:

S.No.	Name of Authors/ Books/Publishers	Year of Publication /Reprint
1.	Hanken H and Wolf H C, "The Physics of Atoms and Quanta", (6th edition), Springer	2007
2.	Herzberg G, "Molecular Spectra and Molecular Structure of Diatomic Molecules", Van Nostrand Reinhold	1989
3.	Bransden B H, Joachain C J, "Physics of Atoms and Molecules"(2nd Edition) Pearson Education	2003
4.	Metcalf H J, "Laser Cooling and Trapping", Peter van der Straten, Springer	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-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: **DEC**

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	8

	transition and Isotropic-mematic transition.	
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: **PH-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: **DEC**

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, atmospheric waves	12
2.	**Cloud Physics:** Aerosols, CCN, IN, cloud formation, cloud electrification, lightning, sprites, global electric circuits.	10
3.	**Ionosphere:** Formation of Ionosphere, ionospheric exploration, langmuir probe, temperature measurements, airglow and aurora, radio wave propagation in the ionosphere.	10
4.	**Magnetosphere:** Solar wind and its interaction with the magnetosphere, frozen-in magnetic field radio wave propagation through the magnetosphere, whistlers, 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-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: **DEC**

8. Pre-requisite: **PH-514**

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: **PH-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: **DEC**

8. Pre-requisite: **PH 510 or equivalent**

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. Subj ect Code: **PH-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: **DEC**

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: **PH-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: **DEC**

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-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: **DEC**

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: **PH-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: **DEC**

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. 9. 10.	To study Rutherford Scattering of alpha particles from thin gold foil and Al foil. To determine Half-Lives of Radioactive sources prepared by neutron activation – In and Ag isotopes 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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-201M , PH-202M or equivalent**

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)	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: **PH-619** Course Title: **Introduction to Quantum Field Theory**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-503, PH-508**

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
4.	**Spin-1 (Gauge Field Theory):** Covariant formulation of Maxwell's equations, (transverse) canonical quantization of the gauge field (in the Coulomb gauge),	5
1.	**Scattering**: LSZ reduction (for bosons and fermions), Wick's theorem, S-matrix, cross sections.	6

2.	**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**

1. Subject Code: **PH-621** 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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **Nil**

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.	**Optical Waveguides:** 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:** (a)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. (b) 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.	10 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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

8. Pre-requisite: **PH-510**

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; (ii) **QCD** (quantization of non-abelian gauge theories with fermions): Yang-Mills theory, Parton model revisited, Feynman rules, Asymptotic freedom.	8
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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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: **PH-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** 15 **PRS** 0 **MTE** 35 **ETE** 50 **PRE** 0

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

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: **PH-602** Course Title: **Nuclear Astrophysics**

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: **DEC**

8. Pre-requisite: **PH-510**

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/Reprint
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: PH-604 Course Title: **Physics of Nanosystems**

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: DEC

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

9. Objective: **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: **PH-606** Course Title: **Superfluidity and Superconductivity**

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: **DEC**

8. Pre-requisite: **PH-404**

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

Department Core (DCC)

B. ARCH. I YEAR

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-101** Course Title: **Basic Design and Model Making**

2. Contact Hours: **L: 1** **T: 0** **P: 6**

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

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

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

8. Pre-requisite: **Nil**

9. Objective:

To enable students to develop an understanding of basic design elements and forms as basis for architectural design and to gain basic skills needed for model making and carpentry .

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Relationship between basic design and architectural design, comprehensive understanding of space, form, order and design.	2
2.	Study of space, its scale, proportions and form, conception and space breaking through compositions and models.	2
3.	Study of elementary two dimensional shapes and three dimensional form.	2
4.	Ordering combination principles and their application in building through exercises in design of murals, screens and voids in walls.	2
5.	Block and detailed building models.	2
6.	Cutting, fine joints and joinery in cardboard and wood/ plastic.	2
7.	Model making in paper, wood and plastics and demonstration in metal work.	2
	Total	14

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Parmar, V.S., "Design Fundamentals in Architecture", Somoiya Publications.	1973
2.	Morgan, C.L., "Jean Nouvel – The Elements of Architecture", Thames and Hudson.	1998
3.	Ching, F.D.K., "Architecture: Form, Space and Order", 3rd Ed., John Wiley & Sons.	2007
4.	Kieran, S. and Timberlake, J., "Elements of a New Architecture", Princeton Architectural.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-103** Course Title: **Architectural Graphics -I**

2. Contact Hours: **L: 1** **T: 0** **P: 6**

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

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

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

8. **Pre-requisite: Nil**

9. Objective:

To introduce the fundamentals of architectural drawing through the study of architectural graphic symbols, orthographic projections, section of solids and sciography and to impart an understanding of architectural plans, elevations and sections.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Architectural Graphic Fundamentals:** Lines, lettering and dimensioning, reduction and enlargement of drawings on different scales, representation of materials and architectural elements through architectural graphic symbols, introduction to architectural plans, elevations and sections.	5
2.	**Orthographic Projections**: Principles and projection methods of orthographic projection (third angle projection), straight lines, planes, solids and development of surfaces, section of solids	7
3.	**Sciography**: Study of shades and shadows cast by simple architectural forms on plain surfaces.	2
	Total	**14**

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Bhatt, N.D. and Panchal, V.M., "Engineering Drawing – Plane and Solid Geometry", 48th Ed., Charotar Publishing House.	1996
2.	Griffin, A.W. and Brunicardi, V.A., "Introduction to Architectural Presentation Graphics", Prentice Hall.	1998
3.	Ching, F.D.K., "Architectural Graphics", 4th Ed., John Wiley.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-102** Course Title: **Architectural Design-I**

2. Contact Hours: **L: 1** **T: 0** **P: 6**

3. Examination Duration (Hrs): **Theory** 0 **Practical** 7

4. Relative Weightage: **CWS** 0 **PRS** 60 **MTE** 20 **ETE** **PRE** 20

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

8. Pre-requisite: **Nil**

9. Objective:

To introduce architectural design process to the students and to lead them to understand the fundamentals of space through the design of simple buildings.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Study of anthropometrics and their relationship with the dimensions of objects of daily use.	3
2.	Determining spaces for activities such as living, dining, sleeping and conveniences.	3
3.	Measured drawing of a small building such as, a small house or office.	2
4.	Simple circulation/flow diagrams for small building projects	2
5.	Three dimensional organization of a variety of forms to create built forms, importance of shades and shadows in the entire composition, layout of repetitive units within a site to create interesting and functional compositions.	4
	Total	**14**

Design Exercises:

Very small building structures, such as a compound wall, gate, milk booth, vendor stall, guard room, cycle stand, bus stop etc.

Visits to architectural sites.

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Ching, F.D.K., "Design Drawing", Van Nostrand Reinhold.	1998
2.	Neufert, P., "Architects' Data", 3rd Ed., Blackwell Science.	2000
3.	Watson, D. (Editor), "Time-saver Standards for Architectural Design: Technical Data for Professional Practice", 8th Ed., McGraw-Hill.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-104** Course Title: **Architectural Graphics -II**

2. Contact Hours: **L: 1** **T: 0** **P: 6**

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

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

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

8. **Pre-requisite: AR-103**

12. Objective:

To impart knowledge of isometric views, axonometric views and perspectives.

13. Details of Course:

S. No.	Contents	Contact Hours
1.	**Isometric and Axonometric Views**: Solids, compositions and buildings	6
2.	**Perspective Drawing**: Definition of perspective technique and their role in drawing perspectives, one point, two point and three point perspectives of geometrical shapes leading to perspectives of built forms, exercises in parallel, angular and bird's eye views, shades and shadows cast by simple forms on plain surfaces	8
	Total	14

14. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Bhatt, N.D. and Panchal, V.M., "Engineering Drawing – Plane and Solid Geometry", 48th Ed., Charotar Publishing House.	1996
2.	Griffin, A.W. and Brunicardi, V.A., "Introduction to Architectural	1998

	Presentation Graphics", Prentice Hall.	
3.	Ciriello, M., "Architectural Design Graphics", McGraw-Hill.	**2002**
4.	Ching, F.D.K., "Architectural Graphics", 4th Ed., John Wiley.	**2003**
5.	Carpo, M., "Perspective, Projections and Design: Technologies of Architectural Representation", Routledge.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-106** Course Title: **Introduction to Building Materials and Construction - I**

2. Contact Hours: **L: 1** **T: 0** **P: 4**

3. Examination Duration (Hrs): **Theory** 4 **Practical** 0

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

5. Credits 3 6. Semester: **Spring** 8. Subject Area: **DCC**

7. Pre-requisite: **Nil**

9. Objective:

To introduce the students to building materials, their properties and application in building construction, alongwith the construction of some basic components of a building.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Mud**: Stabilisation and use for walling and terracing.	1
2.	**Bricks**: Constituents and properties of brick earth, manufacturing of various types of bricks, decorative brick work and jail work Stone: Properties, varieties and their characteristics, stone masonry.	2
3.	**Timber**: Varieties of Indian timbers, their characteristics and suitability for different uses, defects and decay, seasoning and preservation; manufactured timber products and their applications as insulation materials and decorative materials etc.	2
4.	**Surface Finishes**: Various types of plaster and their application, guniting and its application; pointing, glazing and gluing.	2
5.	**Lime and Cement**: Sources, classification, properties and method of manufacturing, testing, mixing and uses.	1
6.	**Concrete**: Composition, properties and uses, light weight and no	1

	fines concrete and its uses.	
7.	**Various Construction Components of Buildings** **Foundations:** Definition, safe bearing capacity of soils and methods of improving foundations, causes of failure and remedies, types of footings. **Temporary work:** Excavation and timbering of trenches, shoring, underpinning and scaffolding. **Basement**: Damproofing, construction details of walls, floors, foundations etc. **Walls**: Masonry walls, hollow and panel walls, practical considerations during construction, hollow concrete and glass block construction **Arches:** Different forms and centering.	5
	Total	**14**

Practicals: Construction of simple brick walls, stone masonry and brick arches.

Site Visits: Visits to construction sites,

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Kumar, S.K., "Building Construction", 19th Ed., Standard Publishers Distributors.	2001
2.	Allen, E. and Iano, J., "Fundamentals of Building Construction: Materials and Methods", Wiley.	2004
3.	Mehta, M., Scarborough, W. and Armpriest, Diane, "Building Construction: Principles, Materials and Systems", Pearson Prentice Hall.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-108** Course Title: **Principles of Architecture**

2. Contact Hours: **L: 2** **T: 1** **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 [3] 6. Semester: **Spring** 7. Subject Area: **DCC**

8. Pre-requisite: **Nil**

9. Objective:

To introduce the students to the theory of architectural design and the principles pertaining to visual and aesthetic aspects of architecture.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Understanding of relevant terms – architecture, design art, fine art, visual art, architectural design and other types of design; comparisons of aesthetics in art and architecture.	3
2.	Principles of two dimensional design elements, such as, point, line, direction, shape, size, colour and texture; Three dimensional design profiles of geometric forms and their arrangements in different compositions.	3
3.	Harmony and contrast in 2-D and 3-D design; interplay of light and shade on building blocks and their effect.	5
4.	Scale and proportion in architecture; Le Modular and other concepts.	5
5.	Style, rhythm, balance, unity and order.	6
6.	Form and function in architecture; use of building materials, construction techniques and engineering services for different functions.	6
	Total	28

11. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Ching. F.D.K., "A Visual Dictionery of Architecture", Van Nostrand Reinhold.	1997
2.	Ching. F.D.K., "Architecture Theoretician', Wiley.	2007
3.	Fisher, T., "Architectural Design and Ethics: Tools for Survival", Architectural Press.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Architecture and Planning Department**

1. Subject Code: **AR-110** Course Title: **Colour Fundamentals and Its Application**

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

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

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

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

8. Pre-requisite: **Nil**

12. Objective:

To study colour theory, classification of colours and psychological factors which govern the choice of colour schemes in buildings.

13. Details of Course:

S. No.	Contents	Contact Hours
1.	Physiology of colour, colour mixtures, colour systems, colour organisation	7
2.	Psychological factors governing colour schemes, application of colour schemes	5
3.	National and International standards on colours	2
	Total	**14**

14. Suggested Books:

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Toy, Maggie (Ed.), "Colour in Architecture", Academy Editions.	1996
2.	Yanes, M.D. and Dominguez, E.R., "Freehand Drawing for Architects and Interior Designers", Norton.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE.: DEPARTMENT OF MATHEMATICS

1. Subject Code: **MA-905** Course Title: **Evolutionary Algorithms**

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: 3 6. Semester: Both 7. Subject Area: **DEC**

8. Pre-requisite: M.Sc./M.Tech/MCA with sufficient background in Optimization Techniques and Computer Programming

9. Objective:

To acquaint the students with recent advances in Evolutionary Algorithms and their use in solving discrete and continuous optimization problems in Engineering, Science and Industry.

10. Details of Course:

S.No.	Contents	Contact Hours
1	**Genetic Algorithms**: GA concepts – encoding, fitness function, population size, selection, crossover and mutation operators, along with the methodologies of applying these operators. Binary GA and their operators, Real Coded GA and their operators.	10
2	**Particle Swarm Optimization:** PSO Model, global best, Local best, velocity update equations, position update equations, velocity clamping, inertia weight, constriction coefficients, synchronous and asynchronous updates, Binary PSO.	10
3	**Memetic Algorithms:** Concepts of memes, Incorporating local search as memes, single and multi memes, hybridization with GA and PSO, Generation Gaps, Performance metrics.	5
4	**Discrete Optimization:** Use of Evolutionary Computations to solve Traveling Salesman Problem, Time Table Problem, Vehicle Routing Problem.	5
5	**Constrained Optimization:** Methods based on rejection strategies, repair strategies, specialized operators and penalty functions.	5
6	**Multi-Objective Optimization:** Linear and nonlinear multi-objective problems, convex and non – convex problems, dominance – concepts and properties, Pareto – optimality. Use of Evolutionary Computations to solve multi objective optimization, bi level optimization. Theoretical Foundations.	7
	TOTAL	42

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1	Hart W.E., Krasnogor N., Smith J.E., "Recent Advances in Memetic Algorithms", Springer Berlin Heidelberg	2005
2	Deb K., "Multi-Objective Optimization using Evolutionary Algorithms", John Wiley and Sons.	2002
3	Coello C.A., Van Veldhuizen D.A. and Lamont G.B., "Evolutionary Algorithms for solving Multi Objective Problems", Kluwer.	2002
4	Deb K., "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India	1998
5	Gen M. and Cheng R., "Genetic Algorithms and Engineering Design", Wiley.	1997
6	Michalewicz Z., "Genetic Algorithms + Data Structures = Evolution Programs", Springer-Verlag, 3rd Ed.	1992

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Metallurgical & Materials Engineering

1. Subject Code: IMT-01 Course Title: Non Destructive Testing

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

3. Examination Duration (Hrs): Theory: 03 Practical: 00

4. Relative Weightage: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits: 04 6 Semester: Autumn [ ] Spring [ ] Both [√]

7. Pre-requisite: Nil 8. Subject Area: ESEC

9. Objective

To make students aware of the importance of quality control & quality assurance and role of non destructive testing..

10. Details of the Course:

S. No	Particulars	Contact Hours
1.	Non destructive testing and its comparison with destructive testing. Role of NDT in quality control	3
2.	Liquid penetrant inspection its, principles, advantages, limitations & applications.	6
3.	Magnetic particle inspection	6
4.	Ultrasonic inspection	6
5.	Eddy current inspection	6
6.	Radiography,	6
7.	Organizing for quality, fitness for use concept. Quality control: Statistical quality control, control charts, control chart attribute & variables and acceptance sampling	5
8.	Quality assurance & ISO 9000:2000	4
	Total	42

11. Suggested Books:

Sl No	Name of Authors/Books/Publisher	Year of Publication
1.	Metals Hand Book Ninth edition volume 17, Non Destructive Evaluation & Quality Control ASM Hand book committee ASM International Metals Park, Ohio,	1989
2.	K.C. Srivastava, Handbook of magnetic particle testing American Book Centre, Delhi.	1998
3.	K.C. Srivastava, Handbook of liquid penetrant testing, American Book Centre, Delhi.	1997
4.	K.C. Srivastava, Handbook of ultrasonic testing, International Inspection Services, Delhi	2001
5.	Engene. L. Grant and Richard. S. Larenwork: Statistical quality control Tata McGraw-hill Publishing Co. Ltd., New Delhi, India	2000
6.	Non destructive evaluation science and technology for quality improvement: 658.562 W83NDDC, Indian National Academy of Engineering:	1999

DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY

TEACHING & EXAMINATION SCHEME FOR METALLURGICAL AND MATERIALS ENGINEERING PROGRAMME
First Year

Appendix - 1

Structure-A

S. No.	Subject Code	Course Title	Subject Area	Credits	Contact Hours/Week L	T	P	Exam Duration Theory	Practical	Relative Weightage (%) CWS	PRS	MTE	ETE	PRE
					Semester – I (Autumn)									
1.	MA-101	Mathematics-I	BSC	4	3	1	0	3	-	25	-	25	50	-
2.	PH-101	Physics-I	BSC	5	3	1	2	3	3	15	15	15	40	15
3.	EE-101	Electrical Science	ESC	4	3	1	2/2	3	-	15	15	30	40	-
4.	EC-101A	Computer System & programming	ESC	4	3	0	2	3	-	15	15	30	40	-
	EC-101B	Fundamentals of Object oriented Programming		4	3	0	2	3	-	15	15	30	40	-
5.	MI-102	Manufacturing Techniques	ESC	3	2	0	2	2	-	15	15	30	40	-
6.	BT-101	Fundamentals of Biotechnology	GSC	2	2	0	0	2	-	15	-	35	50	-
7.	HS-101	Technical Communication	HSSMC	2	1	0	2	2	-	25	-	25	50	-
		Total		24	17	3	9							
					Semester – II (Spring)									
1.	MA-102	Mathematics-II	BSC	4	3	1	0	3	-	25	-	25	50	-
2	CY-101	Chemistry	BSC	5	3	1	2	3	3	15	15	15	40	15
3.	EC-102	Fundamentals of Electronics	ESC	4	3	1	2/2	3	--	15	15	30	40	-
4.	CE-101	Engineering Graphics	ESC	4	2	0	4	3	--	-	25	25	50	-
5.	MI-103	Thermodynamics	ESC	3	2	1	0	2	--	25	-	25	50	-
6.	CE-102	Environmental Studies	GSC	2	2	0	0	2	-	15	-	35	50	-
7.	HS-102	Behavioural Science	HSSMC	2	2	0	0	2	-	15	-	35	50	-
		Total		24	17	5	7							

TEACHING & EXAMINATION SCHEME FOR METALLURGICAL AND MATERIALS ENGINEERING PROGRAMME

Second Year

Appendix - 1

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weightage (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
Semester – III (Autumn)														
1.	CE-201	Computer Aided Graphics	ESC	2	1	0	2	2	-	-	25	25	50	-
2.	HS-201	Economics	HSSMC	3	2	1	0	2	-	25	-	25	50	-
3.	MI-201A	Solid Mechanics	ESC	4	3	1	0	3	-	25	-	25	50	-
4.	MT-203	Metallurgical Thermodynamics and Kinetics	DCC	3	3	0	0	3	-	15	-	35	50	-
5.	MT-205	Physical Metallurgy	DCC	4	3	0	2	3	-	15	15	30	40	-
6.	MT-207	Transport Phenomena in Metallurgy	DCC	3	2	1	0	2	-	25	-	25	50	-
7.	MT-209	Particulate Processing	DCC	3	2	0	2	2	-	15	15	30	40	-
		Total		22	16	3	6							
Semester – IV (Spring)														
1.	PH-201	Physics-II	BSC	3	3	0	0	3	-	15	-	35	50	-
2.	BM-201	Managements concepts and practices	HSSMC	3	2	1	0	2	-	25	-	25	50	-
3.	CH-201	Energy Resources and Conversion	GSC	2	2	0	0	2	-	25	-	25	50	-
4.	MT-202	Electrical and Electronic materials	DCC	3	2	1	0	2	-	25	-	25	50	-
5.	MT-204	Metal Extraction Principles	DCC	3	2	0	2	2	-	15	15	30	40	-
6.	MT-206	Fuels, Furnaces and Refractories	DCC	3	2	0	2	2	-	15	15	30	40	-
7.	MT-208	Metallurgical and Instrumental Analysis lab.	DCC	2	0	0	4	-	3	-	25	25	-	50
8.	IE	Institute Elective-I (BSC)	BGSEC	3	2	1	0	2	-	25	-	25	50	-
		Total		22	15	3	8							

TEACHING & EXAMINATION SCHEME FOR METALLURGICAL AND MATERIALS ENGINEERING PROGRAMME
Third Year

Appendix - I

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weightage (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practi-cal	CWS	PRS	MTE	ETE	PRE
Semester – V (Autumn)														
1.	MT-301	Ceramics and Metal Powder Processing	DCC	3	3	0	2/2	3	-	15	15	30	40	-
2.	MT-303	Mechanical Behaviour of Materials	DCC	4	3	1	2/2	3	-	15	15	30	40	-
3.	MT-305	Modelling and Simulation of Metallurgical Processes	DCC	3	2	0	2	2	-	15	15	30	40	-
4.	MT-307	Metal Processing	DCC	4	3	0	2	3	-	15	15	30	40	-
5.	MT	Departmental Elective-I	DEC	3	3	0	0	3	-	15	-	35	50	-
6.	IE	Institute Elective-II (HSSMC)	IE	3	3	0	0	3	-	15	-	35	50	-
		Total		20	17	0	07							
Semester VI (Spring)														
1.	MT-302	Corrosion Science and Technology	DCC	3	2	0	2	2	-	15	15	30	40	-
2.	MT-306	Phase Transformation and Heat Treatment	DCC	4	3	0	2	3	3	15	15	15	40	15
3.	MT-304	Iron Making	DCC	4	3	1	0	3	-	25	-	25	50	-
4.	MT-308	Communication Skills	DCC	2	0	0	2	-	-	100	-	-	-	-
5.	MT-	Departmental Elective-II	DEC	3	3	0	0	3	-	15	-	35	50	-
6.	IE	Institute Elective-III (BSC)	IE	3	3	0	0	3	-	15	-	35	50	-
7.	IE	Institute Elective-IV (HSSMC)	IE	3	3	0	0	3	-	15	-	35	50	-
		Total		22	17	1	6							

TEACHING & EXAMINATION SCHEME FOR METALLURGICAL AND MATERIALS ENGINEERING PROGRAMME

Fourth Year

Appendix - 1

S. No.	Subject Code	Course Title	Teaching Scheme: Subject Area	Credits	Contact Hours/Week: L	T	P	Exam Duration: Theory	Practical	Relative Weightage (%): CWS	PRS	MTE	ETE	PRE
Semester – VII (Autumn)														
1.	MT-401	Composites and Polymers	DCC	4	3	1	0	3	-	25	-	25	50	-
2.	MT-403	Steel Making	DCC	4	3	1	0	3	-	25	-	25	50	-
3.	MT-405	Non-ferrous Technology	DCC	4	3	1	0	3	-	25	-	25	50	-
4.	MT-491	Minor Project	DCC	2	0	0	4	-	-	-	100	-	-	-
5.	MT-492	Major Project	DCC	-	0	0	3	-	-	-	-	-	-	-
6.	MT-	Departmental Elective-III	DEC	3	3	0	0	3	-	15	-	35	50	-
7.	MT-	Departmental Elective-IV	DEC	3	3	0	0	3	-	15	-	35	50	-
8.	IE	Institute Elective-V (ESC)	IE	4	3	1	0	3	-	25	-	25	50	-
		Total		24	18	4	07							
Semester – VIII (Spring)														
1.	MT-402	Mechanical working of metals	DCC	4	3	0	2	3	-	15	15	30	40	-
2.	MT-490	Practical/Field Training	DCC	2	0	0	2	-	-	-	100	-	-	-
3.	MT-492	Major Project	DCC	8	0	0	12	-	-	-	-	-	-	100
4.	MT-	Departmental Elective-V	DEC	3	3	0	0	3	-	15	-	35	50	-
5.	IE	Institute Elective VI (ESC)	IE	4	3	1	0	3	-	25	-	25	50	-
		Total		21	09	1	16							

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-301 **Course Title:** Ceramics and Metal Powder Processing

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 1 5 **MTE:** 3 0 **ETE:** 4 0 **PRE:** 0 0

5. Credits: 0 3 **6 Semester:** Autumn

7. Pre-requisite: MT-209 **8. Subject Area:** DCC

9. **Objective:** This course aims at imparting knowledge on principles of ceramic and metal powder processing and technologies for making ceramic and metal powder based engineering products.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	**Introductory Overview:** General characteristics of ceramics, ceramic microstructures, introduction to ceramic crystal structures.	2
2	**Ceramic Powder Production and Consolidation** : Synthesis by mechanical methods and chemical methods; Powder characterizations : physical characterization relating particles types, shapes, size, size distribution, their measurements, surface area, porosity; chemical compositions, phase composition and surface characterization; Dry and semidry pressing methods: die compaction, isostatic pressing; Casting methods: slip casting, pressure casting, tape casting; Additives in forming process, plastic forming methods: extrusion and injection moulding.	8
3	**Colloidal Processing**: Colloid types, electrostatic stabilization, polymeric stabilization, rheology of colloidal suspension.	3
4	**Sintering of Ceramics:** Defects and defect chemistry; solid state sintering, atomic mechanisms, coarsening, densification, sintering kinetics: sintering stages – initial stage sintering, intermediate sintering, coarsening and grain growth growth kinetics; Liquid phase sintering : introduction, the different stages, controlling kinetics and thermodynamic factors.	7
5	**Ceramic Phase Diagrams**: Binary systems: complete solid solubility, eutectic diagrams with partials solid solubility and no intermediate compounds, partial solid solubility with formation of intermediate compounds; Ternary systems.	3

6	**Glasses** : Processing of glasses and glass-ceramics	3
	Metal Powders-Characteristics and Testing: Introduction to powder metallurgical applications, pressing properties, properties of sintered compacts.	3
7	**Powder Production, Characterization, Compaction and Sintering:** Mechanical processes, physico chemicals and chemical processes; Pressure-less shaping, cold pressure shaping and pressure shaping technique; tooling system, Sintering furnaces and their classifications; sintering atmosphere; vacuum sintering.	10
8	**Powder Products and Selected Applications**: Classifications; Friction materials; tool materials.	3
	Total	**42**

List of Practicals:

1. Determination of ceramic oxide powder densities using pycnometric method.
2. Powder processing and preparation of green compacts using uniaxial pressing.
3. Study of solid state sintering behaviour of the samples at different temperature and soaking time periods and study their densification characteristics.
4. Estimation of the particle size of the powder from X-ray diffraction line broadening technique.
5. Determination of average grain size by linear interception method.
6. Study of voltage vs. current (V-I) characteristics of ceramic varistors and determination of their nonlinear exponent.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Reed, J. S., "Introduction to the Principles of Ceramic Processing", A Wiley-Interscience Publication.	1988
2	Rahaman, M. N., "Ceramic Processing and Sintering", Marcel Dekker Inc.	1995
3	Richerson, David W., "Modern Ceramic Engineering – Properties, Processing and use in Design", Marcel Dekker, Inc.	1992
4	German, R.M., "AZ of Powder Metallurgy", MPIF	2005
5	Hirschhorn, J.S., "Introduction to Powder Metallurgy", APMI, USA	1975
6	Masuda, H., "Powder Technology Handbook", Taylor and Francis	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-302 **Course Title:** Corrosion Science and Technology

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

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

4. Relative Weightage: CWS: 1 5 PRS: 1 5 MTE: 3 0 ETE: 4 0 PRE: 0 0

5. Credits: 0 3 **6. Semester:** Spring

7. Pre-requisite: CY-101 **8. Subject Area:** DCC

9. Objective: To familiarise the students with the basic knowledge of corrosion behaviour of metals and their protection.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1	**Thermodynamics of Corrosion**: Free energy change, EMF, Galvanic, Pourbaix diagram.	4
2	**Electrochemical Theory:** Corrosion rates; Activation polarization, concentration polarization, anodic, cathodic, mixed control. Passivation, Tafel equation.	6
3	**Types of Corrosion**: Different forms of corrosions-uniform, Galvanic, crevice, pitting, intergranular, erosion-corrosion, scc, hydrogen cracking, corrosion fatigue, fretting corrosion. Effect of metallurgical variables and environments on different forms of corrosion.	6
4	**Corrosion Protection:** Corrosion prevention method-anodic protection, cathodic protection, inhibitors.	4
5	**Corrosion Testing**: Electrochemical techniques-potentiostat, galvanostat, impedence. Thermogravimetric technique.	4
6	**Hot Corrosion:** High temperature oxidation of metals and alloys, laws governing oxidation, molten salt corrosion, liquid metal corrosion.	4
	Total	**28**

List of Practicals:

1. Corrosion rate measurements by potentiostat/Galvanostat.
2. Effect of alloying elements on passivity.
3. To study the effect of cathodic protection on given couple of metallic samples.
4. To study the effect of intergranular corrosion on microstructure of given metallic samples.
5. To study the Effect of various inhibitors on corrosion protection.
6. To study the effect of various atmospheric conditions on degradation of coatings.
7. To study the macro/micro structure of crevice corroded metallic samples.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Fontana, M.G., and Greene, N.D., "Corrosion Engineering", McGraw Hill.	2005
2	Uhling, H.H. and Revie, R.W., "Corrosion and Corrosion Control", 3rd Ed., John Wiley & Sons,	1985
3	"Corrosion", Metals Handbook, Vol.13 A&B, 9th Ed., ASM	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-303 **Course Title**: Mechanical Behaviour of Materials

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

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

4. Relative Weightage: CWS: 1 5 PRS: 1 5 MTE: 3 0 ETE: 4 0 PRE: 0 0

5. Credits: 0 4 **6 Semester:** Autumn

7. Pre-requisite: MT-205 **8. Subject Area:** DCC

9. Objective

The course is aimed at developing an understanding of the response of engineering materials (metals, ceramics, polymers and composites) to mechanical loading.

10. Details of the Course:

S.No.	Contents	Contact Hours
1	Introduction, Stress and strain relations, mechanical testing, elastic behavior, and viscoelasticity.	5
2	Elements of plasticity, the flow curve, Strain hardening, Strain rate and temperature dependence of flow stress.	4
3	Plastic deformation, slip in crystals, dislocations, and dislocation motion.	5
4	Twins, strengthening mechanisms, grain boundaries, solid solution strengthening, strengthening from fine particles and strain hardening.	5
5	Fracture, types of fracture, brittle fracture, Griffith theory of brittle fracture of material, ductile fracture, notch effects, and fracture mechanics.	6
6	Fatigue, the S-N curve, low cycle fatigue, structural features, surface effects, and metallurgical variables.	5
7	Creep, the creep curve, stress rupture test, structural changes, creep mechanisms, DMM (deformation mechanism maps), and superplasticity	6
8	Embrittlement, residual stresses, mechanical behavior of Ceramics, glasses, polymeric materials, and composite materials.	6
	Total	**42**

List of Practicals:

1. To determine the hardness of given metallic sample by Brinnel Hardness Testing Machine.
2. To determine the hardness of given metallic sample by Vickers Hardness Testing Machine.
3. To determine the hardness of given metallic sample by Rockwell Hardness Testing Machine.
4. To determine the tensile properties of given steel and cast iron samples.
5. To determine the impact strength of low, medium, high carbon steel and cast iron by Izod and Charpy method.
6. To study the deep draw-ability of given metallic sheet samples by Ericson method.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Dieter, G. E., "Mechanical Metallurgy", 3rd Ed., McGraw Hill.	1988
2	Courtney, T.H., "Mechanical Behavior of Materials", 2nd Ed., McGraw Hill.	1990
3	Meyers, M.A. and Chawla, K.K., "Mechanical Behavior of Materials", Prentice Hall.	1999
4	Hull, D. and Bacon, D.J., "Introduction to Dislocations", 4th Ed., Butterworth-Heinemann.	2001
5	Honeycombe, R.W.K., "The Plastic Deformation of Metals", Edward Arnold.	1977

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-304 **Course Title:** Iron Making

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

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

4. Relative Weightage: CWS: 2 5 PRS: 0 0 MTE: 2 5 ETE: 5 0 PRE: 0 0

5. Credits: 0 4 **6 Semester:** Spring

7. Pre-requisite: MT-204 **8. Subject Area:** DCC

9. Objective : To provide knowledge about iron making from iron ore through blast furnace route and an elementary idea about alternative methods of iron production.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	Resources, characteristics and functions of Indian iron Ores, metallurgical coal and limestone; factors governing values of iron ore, coal, and lime stone for use in blast-furnace.	5
2	Significance of agglomeration, processes of agglomeration; Principles and mechanism of production of sinters and pellets from iron ore fines; Self-fluxing and super-fluxing agglomerates.	7
3	Basic principles and design aspect of blast furnace (BF), Cowper hot stove; design and working of BF gas cleaning system; Conditions prevailing in different zones of B.F. and refractories required.	7
4	Physico-chemical principles of production of iron in BF: C-O, Fe-C-O, and Fe-H-O equilibria; Direct and indirect reduction reactions; comparison of CO and H2 as reducing agents on BF performance; Change in the composition of BF gas at different levels of BF; Stages of slag formation in blast-furnace and effects of Al_2O_3, MgO and CaO on slag behaviour; Physical chemistry of desulphurization; External desulphurization and its importance; Combustion race-way and effects of its shape and size on BF performance.	12
5	Irregularities in B.F. and their remedies: Hanging, scaffolding, break-out, channeling, and pillaring.	5
6	Auxiliary fuel injection, lime-injection, high-top pressure operation, humidification of blast; their effects on BF performance.	3
7	Elementary idea of alternative methods of iron making; Brief outline of direct reduction methods, their scope and limitations with reference to Indian conditions.	3
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Basforth, G. R., "The Manufacture of Iron and Steel", Vol I,II and III, Chapman and Hall Ltd.	1965
2	Tupkare, R.H., "Introduction to Modern Iron Making", Khanna Publishers.	2004
3	Biswas, A.K., "Principles of Blast-furnace Iron Making", S.B.A. Publications.	2005
4	Ward, R.G., "Physical Chemistry of Iron and Steel Making", ELBS, Edward Arnold Publishers	1999
5	Bodsworth, C., "Physical Chemistry of Iron and Steel Making", ELBS, Edward Arnold publishers.	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-305 **Course Title:** Modelling and Simulation of Metallurgical Processes

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

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

4. Relative Weightage: CWS: 1 5 PRS: 1 5 MTE: 3 0 ETE: 4 0 PRE: 0 0

5. Credits: 0 3 **6 Semester:** Autumn

7. Pre-requisite: MA-101 and MA-102 **8. Subject Area:** DCC

9. Objective: To familiarize the students about the fundamentals of process modeling and simulation of metallurgical interest.

10. Details of the Course:

S.No.	Contents	Contact Hours
1	**Introduction:** Classification, functions, physical modeling: Similarity criteria, materials for modeling, measurement techniques,	8
2	**Mathematical Modeling:** Transport equations, applications for the metallurgical processes like- Continuous casting, hot rolling, powder rolling, powder pressing, and melt spinning.	8
3	**Mathematical Modeling of Plants**: Nominal model, calibration model, building models and model complexity, state space models, linear and nonlinear models, linearization, linear continuous time models, Laplace transformation, transfer functions, poles, zeroes, and time responses essentials of SISO control loop, stability and polynomical analysis. PD, PI and PID control.	6
4	**Neural Network:** Neural architecture, knowledge representation, learning process-error correction, and back propagation learning algorithm.	3
5	**Fuzzy Logic Modeling**: Fuzzy concepts and fuzzy variables, fuzzy sets, membership functions, controllers and relationship with PI, PD and PID control, Developing fuzzy models, and template based fuzzy system modeling.	3
	Total	**28**

List of Practicals:

1. Software development to determine temperature variation in a metal droplet moving in a gas stream.
2. Software development to determine temperature variation in a slab/strip during hot rolling.
3. Software development to determine porosity in powder metallurgy compact using neural network.
4. Software development for continuous casting of steel using neural network/fuzzy logic/genetic algorithm/conventional techniques.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Goodwin, G.C. and Graebe, S.F. and Salgado, M.E., "Control System Design", Prentice Hall of India.	2002
2	Yager, R. R. and Filer, D.P., "Essentials of Fuzzy Modeling and Control", John Wiley and Sons.	2002
3	Haykin, S., "Neural Networks- A Comprehensive Foundation", Pearson Education.	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-306 **Course Title:** Phase Transformation and Heat Treatment

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

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

4. **Relative Weightage:** **CWS:** 1 5 **PRS:** 1 5 **MTE:** 1 5 **ETE:** 4 0 **PRE:** 1 5

5. **Credits:** 0 4 **6. Semester:** Autumn

7. **Pre-requisite:** MT-205 **8. Subject Area:** DCC

9. **Objective :** To develop understanding of phase transformations in metals and alloys by using concepts of thermodynamics and diffusion kinetics and to give insight into the microstructural changes occurred due to different heat treatments.

10. **Details of the Course:**

Sl.No.	Contents	Contact Hours
1	**Thermodynamics and Phase Diagram:** Equilibrium, binary solutions, equilibrium in heterogeneous systems, kinetics of phase transformations	4
2	**Diffusion**: Atomic mechanism, interstitial and substitutional diffusion, atomic mobility, tracer diffusion in binary alloys, and diffusion in multiphase binary systems.	4
3	**Crystal Interfaces and Microstructure**: Interfacial energy, solid/vapour interfaces, boundaries in single phase solids, interphase interfaces in solids, and interface migration.	6
4	**Diffusional Transformation**: Homogeneous nucleation in solids, heterogeneous nucleation, precipitate growth, overall transformation kinetics – TTT diagram, precipitation in age-hardening alloys, the precipitation of ferrite from austenite, eutectoid transformation, pearlite and Bainite transformation in steel, continuous cooling diagrams, massive transformations, and order-disorder transformation.	10
5	**Diffusionless Transformations**: Characteristics of diffusionless transformation, martensite crystallography, theory of martensite nucleation, martensite growth, and pre-martensite phenomena.	4
6	**Hardenability of Steels:** Concept of critical diameter, joining-end-quench test, effect of parameters viz: alloying elements, carbon content,	4

	austenic grain size, section size and quenching media.	
7	**Heat Treatment Processes:** Various methods of heat treatments, surface hardening treatments, heat treatment of non-ferrous alloys, heat treatment schedules/case studies of some important steels and special types of treatments viz. martempering, austempering and thermo-mechanical treatments and intercritical treatments.	10
	Total	**42**

List of Practicals:

1. Metallographic examination and hardness determination of as received steel samples (low, medium and high carbon steels)
2. To study the effect of various heat treatments viz annealing, normalizing, quenching and tempering on low, medium and high carbon steel samples.
3. To study the effect of case carburizing on microstructure and hardness of steel samples.
4. To determine the hardenability of given steel by Jominey-End-Quench test method.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Porter, D.A. and Easterling, K.E., "Phase Transformations in Metals and Alloys", Chapman and Hall.	1997
2	Reed-Hill, R.E. and Abbaschian, R., "Physical Metallurgy Principles", The PWS-KENT Series in Engg.	1992
3	Lakhtin, Y., "Physical Metallurgy", Mir Publisher.	1975
4	"Heat Treatment", Metals Handbook, Vol.4, 9th Ed., ASM	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-307 **Course Title:** Metal Processing

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

3. **Examination Duration (Hrs):** **Theory:** 03 **Practical:** 00

4. **Relative Weight age:** CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. **Credits:** 04 **6 Semester:** Autumn

7. **Pre-requisite:** MI-102 **8. Subject Area:** DCC

9. **Objective:** To familiarise the students with fundamentals of metal casting principles and metal joining processes and their applications.

10. **Details of the Course:**

Sl.No.	Contents	Contact Hours
1	**Introduction:** Application and advantages of metal casting processes and classification of foundries. Types of patterns, patterns materials patterns allowances, and color codification.	5
2	**Mould and Core Making:** Ingredients: sand, clay, binders, and moisture, characterization of moulding sand, general requirement, and sand conditioning.Classification of moulding methods on the basis of technique used viz., green sand, dry sand, CO_2 process, shell moulding etc. and machine moulding, floor and pit moulding.	6
3	**Gating and Risering:** Various component of gating system, types of gates, principle and practice of gating and risering for various metals and alloys, methods for directional solidification, plane front vs denderitic solidification, and concept of constitutional supercooling.	5
4	**Special Casting Processes:** Die casting, centrifugal casting, squeeze casting and reocasting etc.	2
5	**Casting Defects Causes and Remedies:** Defects arise due pattern, moulding sand and due to improper designing of gating system viz lap, scab, rattail, pipe, and porosity.	3
6	**Melting furnaces and melting practice:** Various types of furnaces used in foundry technique, melting practice of cast iron, steel, Al and its alloys and Cu and its alloys.	4
7	**Welding :** Scope, welding Processes: Gas, arc, resistance and plasma welding, welding consumables: flux, gas, electrode, fillet weld, butt weld, weld thermal cycle, weld testing, microstructure, and weld properties. Scope of micro-joining, resistance-spot, laser welding, ultrasonic welding, micro-plasma welding, and properties. Mechanisms of soldering and brazing, brazing materials, and properties.	8

8	**The Use of Adhesives for Making Structural Joints**: Scope and applications, bonding between adhesive and substrate, polymers, the properties of adhesive polymers, bonding procedures, joints design and applications.	3
9	**Similar and Dissimilar Joining of Ceramics:** Scope of applications, properties of ceramics, ceramic-ceramic joining, ceramic-metal joining, brazing materials, mechanical and materials aspects,	2
10	**Mechanical Joining :** Riveting, bolting, fastening, designing of joints, and properties	2
11	**Application Oriented Comparison of Joining Processes :** Properties of different joints, efficiency of joints, merits and demerits, maintenance, life and reliability	2
	Total	**42**

List of Practicals:

1. Preparation of green sand mould.
2. To estimate AFS grain fineness number for dry silica sand.
3. To estimate the clay content in the sand.
4. To estimate the moisture content in the green sand.
5. To estimate the permeability of the green sand.
6. To estimate hardness, compressive, shear and tensile strength for core sand.
7. To estimate refractoriness of the sand.
8. To study the effect of gas and arc welding processes on microstructure and hardness of given steel samples
9. To study the effect of various parameters of soldering and brazing processes on strength of joint.
10. To study the effect of TIG and MIG welding processes on microstructure and hardness of given metallic samples.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Heine, R.W., Loper C.R. and Rosenthal, P.C. "Principles of Metal Casting", Tata McGraw-Hill	2002
2	Mukhrjee, P.C., "Fundamentals of Metal Casting Technology", Oxford and IBH Publishing Company	1996
3	"Welding and Brazing", Metals Handbook, Vol. 6, ASM	1996
4	Parmar, R.S., "Welding Engineering and Technology", Khanna Publishers.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-401 **Course Title: Composites and Polymers**

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

3. **Examination Duration (Hrs):** **Theory:** 03 **Practical:** 00

4. **Relative Weightage:** **CWS:** 25 **PRS:** 00 **MTE:** 25 **ETE:** 50 **PRE:** 00

5. **Credits:** 04 **6. Semester:** Autumn

7. **Pre-requisite:** MT-205 and MT-303 **8. Subject Area:** DCC

9. **Objective:** To impart basic knowledge about the preparation, characterisation, application and reliability of the composites and engineering polymers.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Introduction:** Definition of composite material, constituents of composites, interfaces and interphases; Distribution of constituents and their synergy; Classification of composite – continuously and discontinuously reinforced composites, metal, ceramic and polymer based composites.	3
2	**Fabrication of Composites:** (a) Metal matrix composites – solid state and solidification processing routes; Powder metallurgy route. (b) Ceramic matrix composites - vapour deposition; liquid phase method; hot pressing or ceramic method. (c) Polymer matrix composites and (d) Nano-composites.	6
3	**Characterisation of Composites:** Control of particle distribution and defects, particle segregation ; microstructure ; particle-matrix interfacial reactions ; Mechanical properties ; Composite models ; Fibre strengthening ; Fracture behaviour of fibre reinforced composite.	5
4	**Joining of Composites :** Induction heating, fusion bonding, ultrasonic welding, gas tungsten arc welding, gas metal arc welding, resistance spot and seam welding, resistance brazing, resistance spot joining, resistant spot brazing, resistance welding of thermoplastic- composite, weld bonding, brazing of MMC	4

5	**Application of Composite Materials :** Civil constructions of structures/pannels, aerospace industries, automobile and other surface transport industries, packaging industries, house hold and sports components.	2
6	**Fracture mechanics and safety of composite:** Griffith theory of brittle fracture and modification for structural materials, basic fracture mechanics of composite (fracture toughness, COD and J-integral approaches, fatigue crack growth rate).	5
7	**Introduction and classification and synthesis of polymers**: Basic definitions and nomenclature, molar mass and degree of polymerization, synthesis, glass transition temperature and crystallinity in polymers, structure and its relation to thermal, chemical, electrical and optical properties.	6
8	**Mechanical and thermomechanical characteristics**: General characteristics, viscoelasicity, deformation behaviour of elastomers, deformation mechanisms, fractures, and toughened polymers.	5
9	**Polymer processing, characterisation and applications:** Introduction, plastics, elastomerics and fibres, compounding and processing techniques, practical aspects of polymer blending, standards and engineering applications of polymers.	6
	Total:	**42**

11. Suggested Books :

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Chawala, K.K., "Ceramic Matrix Composites", Chapman & Hall, London	1993
2	"Composites", Metals Handbook ,Vol. 21, 9th Ed., ASM.	1989
3	Rudin, A., "The Elements of Polymer Science and Engineering", Academic Press.	1999
4	Young, R.L. and Lovell, P.A., "Introduction to Polymers", Stanley Thornes Publishers Ltd.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-402 **Course Title:** Mechanical Working of Metals

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

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

4. **Relative Weightage:** **CWS:** 1 5 **PRS:** 1 5 **MTE:** 3 0 **ETE:** 4 0 **PRE:** 0 0

5. **Credits:** 0 4 **6 Semester:** Spring

7. **Pre-requisite:** MT-303 **8. Subject Area:** DCC

9. **Objective:** To introduce various metal forming processes, mechanics involved and effect of these on structure and properties of metals.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Fundamental of Working:** Yield criteria, Levi-Mises equation, classification of forming processes, mechanics of metal working, temperature in metal working hot working vs. cold working, strain rate effects, sliding and sticking friction, recovery and recrystallization, preferred orientation.	6
2	**Forging:** General aspects, closed-die and open-die forging, spread law, different types of drop and press forging equipment, forging loads, forging defects, case studies.	5
3	**Rolling:** Terminology of rolled products, different kinds of rolling mills, forces and geometrical relationship in rolling, draft Ekelund's expression for no-slip angle, forward slip, rolling variables, problem and defects in rolled products, roll pass sequences used in rolling of blooms to billets and various structural shapes, billets to bars or rods, roll pass	8
4	**Extrusion:** Direct and indirect extrusion, impact extrusion and Hooker process, hydrostatic extrusion, equipment, extrusion variables, derivation of extrusion pressure, deformation, lubrication and defects in extrusion, production of seamless tubes by extrusion process.	6
5	**Rod, Wire and Tube Drawing:** Processes and equipments, hydrodynamic lubrication, maximum possible reduction in a pass under ideal condition, draw stress with friction and back tension, effect of diameter, angle and mode of flow on drawing stress, shaving defects.	6

6	**Other Conventional Processes**: Piercing, punching and blanking, stretch forming spinning, embossing and coining, powder performs forging.	5
7	**High Energy Rate Forming Processes**: Brief description of explosive forming, electrical discharge forming and electro magnetic forming.	6
	Total	42

List of Practicals:

1. To study the various equipments used for mechanical working metals.
2. To study the effect of type of loading viz hammer forging and press forging on microstructure and hardness of given metallic sample.
3. To study the effect of amount of deformation by rolling on microstructure and hardness of given metallic sample.
4. To study the effect of wire drawing on microstructure and hardness of given metallic samples.

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Dieter, G.E., "Mechanical Metallurgy", Tata-McGraw Hill	1988
2	Rowe, R., "Principles of Metal Working," Edward Arnold Publications Ltd.	1965
3	Wilson, F.W., "High Velocity Forming of Metals", Prentice-Hall.	1980
4	"Metal Working", Metals Handbook, Vol.14 A&B, 9th Ed., ASM.	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-403 **Course Title:** Steel Making

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

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

4. Relative Weightage: **CWS:** 2 5 **PRS:** 0 0 **MTE:** 2 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 4 **6. Semester:** Autumn

7. Pre-requisite: MT- 204 and MT-304 **8. Subject Area:** DCC

9. Objective: To familiarize the students to the basic fundamentals and physico-chemical principles and practice of steel production.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	**Principle of Steel Making**: Thermodynamics and physico-chemical aspect of C, S, P, Si and Mn removal reactions of hot metal, mechanism and kinetics of C-O reactions, deoxidation of steel.	10
2	**Conventional and Modified Methods**: Bessemer Process; Open-hearth process: design, construction and working of acid and basic furnaces; Electric steel making: types of electric steel making furnaces, their construction, refractory lining and working.	10
3	**Modified Methods and Recent Processes**: Duplex, triplex, cupola-open hearth process; Role of oxygen in steel making, L.D., KALDO, Rotor, Ajax, LDAC, OLP; Vacuum induction melting; Suitability of the above processes under Indian conditions w.r.t. integrated steel plant and heavy foundries.	12
4	**Secondary Steel Making**: Concept of duplexing, ASEA-SKF process, VAD process, Ladle furnace process, electroslag refining, stainless steel making practice. AOD, VOD and CLU processes.	6
5	**Casting Pit Practice:** Ingot moulds, methods of teeming steel, killed, semi killed, rimming steels ingots and continuous casting of steels.	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Bashforth, G.R., "The Manufacture of Iron and Steel", Vol II, Chapman & Hall Ltd.	1965
2	Bodswarth, C., "Physical Chemistry of Iron and Steel Manufacture", ELBS, Edward Arnold Publications Ltd.	1988
3	Ward, R.G., "Physical Chemistry of Iron and Steel Making", ELBS, Edward Arnold Publications Ltd.	1999
4	Tupkari, R.H., "Introduction to Modern Steel-making", Khanna Publishers.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-405 **Course Title:** Non-Ferrous Technology

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

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

4. Relative Weightage: **CWS:** 2 5 **PRS:** 0 0 **MTE:** 2 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 4 **6 Semester:** Autumn

7. Pre-requisite: MT-204 **8. Subject Area:** DCC

9. Objective: To familiarize the students to extraction and refining of the common non-ferrous metals including their pyro-, hydro-, and electro-metallurgical aspects.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1	**Copper:** Roasting for Pyro and Hydro Metallurgical routes, Matte smelting, converting, fire-refining, electro refining, leaching and electrowinning.	9
2	**Lead:** Principles and process of roasting of concentrate; Blast furnace: design, principles and process of smelting, effects of presence of Cu and Zn on roasting and smelting practice; Refining of lead.	6
3	**Zinc:** Principles and processes of roasting for pyro-and hydro-metallurgical routes; Principles and processes of smelting; Imperial smelting; Leaching of concentrate, Jarosite precipitation, purification of leach-liquor; Electro-winning.	7
4	**Magnesium:** Sources of Mg, recovery of MgCl2 from chloride sour ces, electrowinning of Mg from Mgcl2; principles and processes of production of Mg from oxide sources, Hansgrig process, Pidgeon process and Magnetherm processes; Conversion of MgO to $MgCl_2$.	7
5	**Aluminium**: Sources of Al; Effect of mineralogical forms and chemical composition of bauxite on production of alumina; Principles and process of production of alumina by Bayer technique; principles and process of production of Al by Hall-Heroult technique, anode effect, its causes and remedial measures; factors effecting cell performance; Refining of Al.	8
6	**Titanium:** Sources of Ti, ore break-down processes, production of Ti from TiO_2; Conversion of TiO2 into $TiCl_4$; Principles and process of production of Ti from $TiCl_4$, Kroll process; Refining of Ti by Van Arkel deBoer process.	5
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books/ Publisher	Year of Publication/ Reprint
1	Dennis, W.H., "Non-ferrous Metallurgy", Sir Issac Pitman & Sons Ltd.	1980
2	Bray, J.L., "Non-ferrous Production Metallurgy", John Wiley & Sons.	1985
3	Biswas, A.K. and Davenport, W.G., "Extractive Metallurgy of Copper", Pergamon Press.	2002
4	Embey, E.F., "Principles of Magnesium Technology", Pergamon Press.	1981
5	Mantell, C.L., "Electro-chemical Engineering", Tata-McGraw Hill	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code**: MT-310 **Course Title**: Advances in Foundry Technology

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

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 **6 Semester:** Spring

7. **Pre-requisite:** MT- 307 **8. Subject Area: DEC**

9. **Objective:** To provide advances in the field of casting technology.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Introduction:** Comparison of various forming process with foundry technique, classification of foundries, scope of foundry industry in India	2
2	**Patterns:** Functions of patterns, type and applications of patterns, considerations in design of patterns for a given geometry, pattern allowances and materials.	4
3	**Moulding Materials:** Metallic materials such as cast iron, alloy steels and copper base alloys, their constitution properties and applications; Non-metallic materials such as moulding sands: General characteristics, ingredients and their effect on properties. Sources of foundty sands in India, testing of sands and sand conditioning.	6
4	**Cores:** Types of cores, core sands, special additives, preparation of cores, core baking and finishing.	2
5	**Moulding Process:** Metallic moulding, non-metallic moulding such as plaster of paris molding, ceramic moulding and sand moulding processes; depending upon the equipment used; recent moulding techniques and materials.	6
6	**Gating and Feeding of Casting:** Gating system, requirements of an ideal gating and feeding systems, types of gates; functions of risers, chvorinor's equation, types of risers; computer application for designing of gating system and risers for ferrous and non-ferrous castings.	8

7	**Melting Practice:** Melting furnace used in foundry; foundry considerations in melting non ferrous metals such as Al, Cu and Zn alloys; melting process and problems encountered during melting of steels and cast irons; familty of cast irons and their founding;	6
8	**Special Casting Processes:** Pressure die casting, centrifugal casting, investment casting and continuous casting processes.	4
9	**Casting Defects and Fettling:** Common casting defects their causes and remedies, fettling and inspection, heat treatment of castings.	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Heine, R.W., Loper, C.R. and Rosenthal, P.C., "Principles of Metal Casting", Tata McGraw-Hill.	2002
2	Mukhrjee, P.C., "Fundamentals of Metal Casting Technology" Oxford & IBH Publishing Co.	1996
3	"Casting", Metals Handbook, Vol.15, 9thEd., ASM.	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT- 311 **Course Title:** Engineering Materials

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

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 **6 Semester:** Autumn

7. **Pre-requisite:** MT-205 **8. Subject Area:** DEC

9. **Objective:** To impart knowledge of materials used for different engineering applications such as structural, electrical, magnetic and high temperature.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Introduction:** Materials selection and related factors such as design, processing and economics; case histories related to material selection.	4
2	**High Temperature Materials:** Refractory metals and alloys, creep resistant alloys, typical creep curve: effect of load, temperature and composition; super alloys: Fe-base, Ni-base and Co-base super alloys and their composition, heat treatment, properties and applications.	8
3	**Low Temperature Materials (Cryogenic Materials):** Concept of ductile to brittle transition, determination of transition temperature; Ni-base low temperature materials, 9% Ni-steel, austenitic stainless steels, their composition, heat-treatment, properties and applications.	8
4	**Structural Steels:** Plain carbon, high strength low alloys (HSLA), micro alloyed steels, and dual-phase steels their composition, heat treatment, properties and applications.	8
5	**Tool and Die Steels:** Plain carbon and alloy tool and die steels: high speed steel, high carbon-high chromium die steel, their composition heat treatment, properties and applications.	6
6	**Cu base and Al base Non Ferrous Metals and Alloys:** Brasses, bronzes, duralumin, and Al-Si alloy their composition, properties and applications.	5
7	**Engineering Polymers and Ceramics:** Thermoplastic, thermosetting polymers and elastomers; High strength engineering ceramics.	3
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Callister, W.D. Jr., "Material Science and Engineering –An Introduction", 5th Ed. John Wiley and Sons	2000
2	Askland, R.A., "The Science and Engineering of Materials", 2nd Ed., PWS-KENT Publishing Company.	1989
3	Lakhtin Y., "Engineering Physical Metallurgy", Mir Publishers	1992
4	Avner S.H., "Introduction to Physical Petallurgy", McGraw Hill Book Co.	2005
5	Raghavan, V., "Materials Science and Engineering: A First Course", 5th Ed., Prentice-Hall of India.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT- 312 **Course Title:** Advances in Metal Joining

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6 Semester:** Spring

7. Pre-requisite: MT-307 **8. Subject Area:** DEC

9. Objective: To impart the knowledge of advances in various techniques of metal joining.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	**Review of Principles** of various joining methods for metals and non-metals namely adhesive joining, welding, brazing, soldering and mechanical joining processes.	4
2	**Heat Flow in Welding:** Temperature distribution in welding, heat flow in fillet and circular welds, heat flow in resistance welding and electroslag welding.	3
3	**Solidification of Weld Pool:** Solidification structure such as dendritic, columnar and equiaxed and their effect on mechanical properties, heat affected zone (HAZ) its structure and effect on mechanical properties; Post welding heat treatment.	8
4	**Joining Methods**: Fusion welding processes, solid phase welding, gas welding, arc welding, TIG welding, MIG welding, Submerged arc welding, electro slag, welding, electron beam welding, laser welding, cold pressure welding, ultrasonic welding, friction welding and explosive welding; brazing and soldering; principles involved, process details and equipment used for above welding processes.	10
5	**Defects in Weldments:** Classification of weld defects, causes and remedies in arc welding, resistance welding, friction welding and other welding processes.	4
6	**Weld Inspection and Quality Control:** Visual inspection, destructive tests, non-destructive tests (NDT), pressure and leak testing, and NDT of adhesive joints.	5

7	**Weldability:** Weldability assessment, weldability tests, weldability of carbon steels, HSLA steels, stainless steels, high alloy steels, cast irons, nickel alloys, copper alloys, aluminium alloys, magnesium alloys and titanium alloys.	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	"Metallography and Microstructures", Metals Handbook, Vol. 9, ASM.	2000
2	"Welding Handbook", Vol. 3, Part 2, 9th Ed. The American Welding Society.	2000
3	Kalpakjian, S., Steven R.S., "Manufacturing Engineering and Technology", Prentice Hall.	2001
4	Parmar, R.S., "Welding Engineering and Technology", Khanna Publishers.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-313 **Course Title:** Tribology of Engineering Materials

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

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 **6 Semester:** Autumn

7. **Pre-requisite:** MT-205 **8. Subject Area:** DEC

9. **Objective:** To familiarize the students about the cause of friction and wear; and the methods to minimize wear in engineering components.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1.	**Surface Properties and Surfaces in Contact:** Nature of metallic surface, surface geometry, measurement of surface topography (roughness), quantifying surface roughness, contact between surfaces; friction, the laws of friction, measurement of friction, origin of friction, theories of friction adhesion: theory, extension of the adhesion theory.	8
2.	**Wear:** Types of wear, adhesive wear, Archard's law, abrasive wear, erosion wear, factors affecting wear, wear map, various wear testing methods: pin on disc, pin on drum, slurry wear, air jet and water jet erosion as per ASTM standards	9
3.	**Tribological Properties of Solid Materials:** Hardness, strength, ductility and work hardening rate, effect of crystal structure, effect of microstructure, mutual solubility of rubbing pairs and effect of temperature.	9
4.	**Surface Treatments to Reduce Wear:** Surface treatments without change of composition and with change of composition application of surface coating by welding, by flame, by spraying, by plasma spraying, by electroplating and by electroless coating, by chemical vapour absorption (CVD) and by physical vapour deposition (PVD).	9

5.	**Development of Wear Resistant Materials:** Alloy design and development of dual-phase steels, 13/4 martensitic stainless steels, Nitronic steel, their characterization and evaluation of wear resistance properties.	7
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Hutchings, I.M. "Tribology – Friction and Wear of Engineering Materials", Edward Arnold Publications Ltd.	1992
2	Arnold, R.D., Davies, P.B., Halling, J. and Whomes, T.L., "Tribology- Principles and design applications", Springer – Verlag.	1991
3	Bhusan, B., "Introduction to Tribology", John Wiley and Sons.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code**: MT- 314 **Course Title**: Powder Metallurgy

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

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 **6. Semester:** Spring

7. **Pre-requisite:** MT-209 **8. Subject Area:** DEC

9. **Objective:** To introduce the advanced concepts of powder metallurgy with special reference to recent developments.

10. **Details of the Course:**

Sl.No.	Contents	Contact Hours
1	Review of basic features of powder metallurgy (P/M), scope and limitations of P/M technique.	3
2	General characteristic of metal powders, bulk properties of metal powders: particle shape, flow, apparent density, specific surface area, particle size distribution and their determination, different methods of production of metal powders.	5
3	Compressibility and compactibility of powders, different compacting processes and their impact on the properties of green compact, continuous compacting of metal powders, powders perform forging, hot isostatic pressing.	5
4	Theory of sintering, sintering practice, furnaces and atmosphere control, activated sintering techniques, after sintering treatments; industrial sintering practice for various ferrous and non ferrous products	6
5	Classification of powder products, selected applications relating to dense structural components.	6
6	Case histories relating to applications of the products, development of technology under Indian condition.	5

7	Application of powder metallurgy in the manufacture of self-lubricating bearing, magnetic and electrical materials, tungsten carbide tool bits, bearing materials, dispersion strengthen materials for high temperature applications, and manufacture of diamond based cutting tools.	7
8	Development of friction material through P/M route for clutch plate, and break pads for aero planes.	5
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Masuda, H., "Powder Technology Handbook", Taylor & Francis.	2006
2	German, R.M., "A to Z of Powder Metallurgy", Elsevier Advanced Technology.	2005
3	Sands, R.L. and Shakespeare, C.R., "Powder Metallurgy Practice and Applications", Newness Publication.	1970
4	"Powder Metal Technologies and Applications", Metals Handbook, Vol.7, 9th Ed., ASM.	1989
5	Hirschhorn, J.S., "Introduction to Powder Metallurgy", APMI, USA	1975
6	Upadhyaya, G.S., "Powder Metallurgy Technology", Cambridge Press.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-315 **Course Title:** Introduction to Biomaterials

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

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 **6 Semester:** Autumn

7. **Pre-requisite:** MT-205 **8. Subject Area: DEC**

9. **Objective:** Materials science and Engineering concepts are integrated with biology in order to develop a good understanding of metallic implants.

10. **Details of the Course:**

Sl.No.	Contents	Contact Hours
1.	Introductory aspects and historical background.	1
2.	Metallic materials, definitions, steel, cobalt-chromium, titanium, new titanium alloys, shape memory alloys, niobium alloys, and tantalum alloys.	8
3.	Polymeric bio materials, definitions, types, structure property relations and their characterization.	3
4.	Ceramic biomaterials, definitions, types, structure and properties.	2
5.	Corrosion of metallic biomaterials, mechanism, pitting corrosion, fretting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, galvanic corrosion, fatigue and wear Corrosion, microbiological corrosion and some case studies	8

6.	Surface modification of implants, ion implantation, ion plating, plasma spraying, PVD, CVD, atomized liquid spray, dip, spin-on, sol-gel, and electrochemical techniques.	8
7.	Biocompatibility of biomaterials, cells, interactions with proteins and materials, characterization of cell-material interactions, protein structure, interaction of proteins with synthetic materials, methods for evaluating protein adsorption, inflammatory responses, acute inflammation, chronic inflammation, foreign body response, and assessment of material performance.	6
8.	Applications of biomaterials and product development, cardiovascular applications, grafts, catheters, valves, embolic agents, sterility and infection, interactions of bacteria with biomaterials, methods of sterilization, assessment of sterility; device failure, analysis of retrieved implants, development of voluntary consensus standards for biocompatibility.	6
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1.	Bhat, S.V., "Introduction to Biomaterial", Narsova Publications	2000
2.	Park, J.B., "Biomaterials", Addison-Wiley Publishing Company.	2001
3.	Ratner, B., "Biomaterials Science", Academic Press	2000
4.	Ratner, B.D., Hoffiman, A.S., Schoen, F.J. and Lemons, J.E. "An Introduction to Materials in Medicine", Academic Press.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT- 407 **Course Title:** Surface Engineering and Coating Technology

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6 Semester:** Autumn

7. Pre-requisite: MT 205 **8. Subject Area:** DEC

9. Objective: The course aims to provide an understanding of improvement in the surface properties of engineering materials for improved performance.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1.	**Review of Surface Engineering Techniques**: Carburising, nitriding, cyaniding, hot dipping, galvanizing, hard facing; Electrodeposition, anodizing, scope and application of conventional surface engineering techniques in engineering materials; advantages and limitations of conventional processes.	6
2	**Surface Dependent Engineering Properties**: Wear, friction, fatigue, and corrosion; Surface initiated engineering failures, importance and necessity of surface engineering	8
3	**Classification and Scope of Surface Engineering in Metals**: ceramics, polymers and composites, tailoring of surfaces of advanced materials. Surface modification : physical techniques, surface modification : chemical techniques, classification, methods, and technology.	8

4.	**Modern Techniques in Surface Engineering**: PVD, CVD, plasma spray coating; HVOF and detonation gun processes, ion implantation; Surface modification by directed energy beams like ion, electron and laser beams; energy transfer, compositional and microstructural aspects, and applications.	12
5.	**Characterization:** Microstructural and compositional method; Testing and evaluation of surface-properties, structure-property correlation; Evaluation of coatings for wear, erosion, and erosion-corrosion	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Bunshah R.F. (Ed.), "Handbook of Deposition Techniques for Films and Hard Coatings", 2nd Ed., Noyes Publications.	1994
2	Burakowski, T., and Wierzchon, T., "Surface Engineering of Metals: Principles, Equipment, Technologies", CRC Publishers.	1998
3	"Surface Engineering", Metals Handbook, Vol. 5, 10th Ed., ASM.	1994
4	Sudarshan, S., (Ed.) "Surface Modification Technologies-An Engineers Guide", Marcel Dekker Inc.	1989
5	Grainger S. and Blunt J., "Engineering Coatings: Design and Application", 2nd Ed., Woodhead Publishing.	1998
6	Pawlowaski L., "The Science and Engineering of Thermal Spray Coatings", John Wiley & Sons.	1995

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT- 409 **Course Title:** Characterization Techniques

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 1 5 **MTE:** 3 0 **ETE:** 4 0 **PRE:** 0 0

5. Credits: 0 3 **6 Semester:** Autumn

7. Pre-requisite: MT-306 **8. Subject Area:** DEC

9. Objective: To introduce structural characterization of materials at different scales and using different techniques to get the required information.

10 Details of the Course:

Sl.No.	Contents	Contact Hours
1.	**Quantitative Light Microscopy:** Introduction to light microscopy, concept of resolution, Airy rings, numerical aperture, magnification, depth of field, depth of focus, lens defects and their corrections, principles of phase contrast – bright-field and dark-field contrast, polarized light microscopy, Quantitative microscopy, estimation of grain size, grain boundary area, relevance of light microscopy ideas to electron microscopy.	8
2.	**X-ray Diffraction and Diffractometry:** Introduction, production of X-rays, crystal geometry, lattice directions and planes, zone axis, interplaner spacing and angle, Stereographic projection, Bragg's condition of diffraction, X-ray scattering, application of X-ray diffraction - estimation of grain size, particle size, macro texture, residual stress.	8
3.	**Transmission Electron Microscopy (TEM):** Principle, construction and operation of TEM, Interaction of electrons with specimen, camera constant, reciprocal space and lattice, Ewald sphere, diffraction from finite crystal, preparation of specimens, bright and dark field imaging, selected area diffraction, indexing of diffraction patterns, contrast from precipitates, dislocations and stacking faults.	8
4.	**Scanning Electron Microscopy (SEM):** Principle, construction and operation of SEM, microtexture (Electron Backscattered Diffraction), study of fractured surfaces, EDX, electron probe microanalysis.	4
	Total	**28**

List of Practicals:

1. Preparation of sample for metallography. Steel and Brass
2. Grain size measurement and volume fraction of alpha-beta phases in brass
3. Demo of X-ray diffraction equipment
4. Indexing of the powder pattern
5. Demo of Transmission Electron Microscope
6. Indexing of the Selected Area Diffraction (SAD) patterns
7. Demo of Scanning Electron Microscope and EDS

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1.	Goodhew, P.J., Humphreys J. and Beanland, R., "Electron Microscopy and Analysis", Taylor and Francis.	2001
2.	Gifkins, R.C., "Optical Microscopy of Metals", Sir Isaac Pitman and Sons.	1970
3.	Cullity, B.D., "Elements of X-Ray Diffraction", Addison–Wesley Publishing Company.	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-410 **Course Title:** Principles of Material Selection

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6. Semesters:** Spring

7. Pre-requisite: MT-205 **8. Subject Area:** DEC

9. Objective: The course aims to provide various criteria for selection of materials for different applications along with case studies.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1	Selection criteria, service requirement, design fabricability, functionability, structure-property relationship reappraisal of the role of microstructure; crystal structure and defect structure vis-à-vis properties; materials and their applications, compositions, codes and properties	6
2	Applications of important ferrous materials like stainless steels, maraging steels, tool and die steels, high speed steels, and alloyed cast irons: their composition, heat treatment and properties.	8
3	Applications of important non ferrous metals like Cu base, Al base, Ti base and Mg base alloys: their compositions, heat treatment, and properties.	5
4	Some important composites like metal-matrix and composite, ceramic matrix composites: their composition, preparation, properties and their applications, some important structural ceramics.	6
5	Thermoplastic, thermo setting polymers and elastomers: structures, properties and specific applications.	6
6	Important wear resistant alloys for hydro and thermal power stations; low and high temperature materials.	7
7	Case studies highlighting selection of materials for specific applications.	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Raghavan, V., "Physical Metallurgy: Principles and Practice", 2nd Ed., Prentice-Hall of India.	2007
2	Callister, W.D. Jr., "Material Science and Engineering–An Introduction", 5th Ed., John Wiley and Sons	2000
3	Askland, R.A., "The Science and Engineering of Materials", 2nd Ed., PWS-KENT Publishing Company.	1989
4	Raghavan, V., "Materials Science and Engineering: A First Course", 5th Ed., Prentice-Hall of India.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. **Subject Code:** MT-411 **Course Title:** Nanomaterials and their Applications
2. **Contact Hours:** L: 3 ; T: 0; P: 0

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

4. **Relative Weightage:** CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. **Credits:** 0 3 6. **Semester:** Autumn

7. **Pre-requisite:** MT-201 and MT-205 8. **Subject Area:** DEC

9. **Objective:** This course aims to provide various concepts of nanosized materials, their preparation, properties and applications.

10 Details of the Course:

Sl.No.	Contents	Contact Hours
1	**Historical Perspective**: An overview of natural and classical nanosystems.	2
2	**Classification and Nomenclature of Nanomaterials:** Nanosized metals and alloys, semiconductors, ceramics - a comparison with respective bulk materials; organic semiconductors, carbon nanotubes, nanorods, nanocomposites consisting of organic, inorganic and biomaterials; zero-, one-, two-, and three dimensional nanostructures – quantum dots, quantum wells, quantum rods, quantum wires, quantum rings.	5
3	**Novel Properties of Nanomaterials**: Size and shape dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, non-linear optical properties; catalytic and photocatalytic properties.	9
4	**Synthesis of Nanoparticulates**: Nucleation and growth of nanosystems; Physical methods: mechanical milling, laser ablation, sputtering, microwave plasma etc.; Metallo organic chemical vapor deposition; designing of advanced integrated nanocomposites, functional nanomaterials and nanostructured thin films.	8

5	**Theories of Nanosized Materials**: Transition metal sols, origin of plasmon band, Mie theory, influence of various factors on the plasmon absorption, quantum confinement in semiconductors – particle in a box like model for quantum dots, origin of charge on colloidal sols and its implications in making building blocks.	9
6	**Bulk Nanomaterial**: Severe plastic deformation, multiaxial forging, accumulated roll bonding, equichannel angular pressing (ECAP), Hall-Petch effect, reverse Hall-Petch effect; Deformation mechanism: grain boundary sliding, rotation and nano-twinning.	4
7	**Applications and Perspectives of Nanomaterials**: Development of nanoscale catalysts, photocatalysts, sensitizers, sensors, composites, polymers, ceramics, biomaterials, pharmaceuticals, optical, fluorescent, electronic, magnetic and photonic devices, future perspectives of nanotechnology in miniaturization of devices and fabrication of value added products.	5
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Poole, C.P., and Owens, F.J. (Eds.), "Introduction to Tanotechnology", John Wiley & Sons Inc.	2003
2	Rao, C.N.R., Müller, A., and Cheentham, A.K. (Eds.), "Chemistry of Nanomaterials", Wiley – VCH.	2004
3	Liz-Marzán, L.M., and Kamat, P.V. (Eds.), "Nanoscale Materials", Kluwer Academic Publishers.	2003
4	Rotello, V. (Ed.), "Nanoparticles - Building Block for Nanotechnology", Kluwer Academic/Plenum Publishers.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-412 **Course Title:** Special Steels and Superalloys

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6.,Semester:** Spring

7. Pre-requisite: MT-306 **8. Subject Area:** DEC

9. Objective: The course aims to provide substantial knowledge of various alloy steels and super alloys, their processing and applications.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1.	Introduction of Fe-C phase diagram, classification of alloying elements and their effect on Fe-C system.	4
2.	Phase transformation in steels effect of alloying elements, TTT diagram of plain C and alloy steels.	4
3.	Classification of stainless steels, martensite, ferrite, austenite and P-H stainless steels, their composition, heat treatment, mechanical properties, their weldability, formability and applications	6
4.	Higher strength low alloy (HSLA) steels, history of development and applications; ferrite steels, bainite steels and dual phase steels, mechanics of strengthening viz. grain refinement, solid solution strengthening, precipitation hardening, factors affecting strength, ductility and impact transition temperature.	8
5.	Ultra high strength steels, major requirements, maraging steels, TRIP steels, their types, heat treatment cycles, properties and applications.	6
6.	Tool steels, their types, alloying elements and their effects, classification, compositions, heat treatments, properties and applications.	6
7.	Super alloys, historical developments, physical metallurgy of Ni base alloys, Ni-Fe alloys, cobalt base alloys, chromium base alloys, microstructures, properties and weldability of super alloys.	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Pickering, F. B., "Physical Metallurgy and the Design of Steels", Allied Science Publishers Ltd.,	1978
2	Leslie, W.C., "The Physical Metallurgy of Steels", Tata McGraw-Hill.	1981
3	"Properties and Selection: Irons, Steels, and High Performance Alloys", Metals Handbook, Vol.1, , 9th Ed., ASM.	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-413 **Course Title:** Principles of Solidification

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6. Semester:** Autumn

7. Pre-requisite: MT-307 **8. Subject Area:** DEC

9. Objective: This course aims to provide advanced concepts of solidification in materials and their applications in real life situations.

10 Details of the Course:

Sl.No.	Contents	Contact Hours
1	The liquid phase, crystal structure of liquid; Thermodynamics of solidification processes, structure and characteristics of solid liquid interface, energies, kinetics and topography of interfaces.	8
2	Defect formation, micro- , macro-, normal, inverse and gravity segregation; constitutional supercooling, crystal growth morphology such as plane front, cellular and dendritic.	7
3	Transport processes, mathematical modeling of heat flow and fluid flow in solidification of metal ingot, continuously cast billets, splat cooling, and atomization.	7
4	Solidification of single phase alloys like Cu-Ni, Pt-Au systems, solidification of multiphase alloys like Fe-C, Cu-Zn and Cu-Sn systems; Effect of rate of cooling on the microstructure and properties of single phase and multiphase alloys; Structure of cast ingot: chilled zone, columnar zone and equiaxed zone.	10
5	Structure and properties of metals and alloys in special casting techniques such as rheocasting, compocasting and spray forming; Effect of vibration during solidification on structure and properties on metals and alloys.	10
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Heine, R.W., Loper C.R. and Rosenthal, P.C. "Principles of Metal Casting", Tata McGraw-Hill.	2002
2	Mukhrjee, P.C., "Fundamentals of Metal Casting Technology", Oxford & IBH Publishing Co.	1996
3	Kalpakjian, S., "Manufacturing Processes for Engineering Materials", 5th edition, Prentice Hall.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-414 **Course Title:** Metallurgy of Joining

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6. Semester:** Spring

7. Pre-requisite: MT-307 **8. Subject Area:** DEC

9. Objective: To introduce the advanced concepts of metal joining with special reference to recent welding techniques.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1	Review of principles of various joining methods for metals and non-metals namely adhesive joining, welding, brazing, soldering and mechanical joining processes.	4
2	Solidification of weld pool, its structure such as dendritic, columnar and equiaxed and their effect on mechanical properties; Heat affected zone (HAZ) its structure and effect on mechanical properties; Pre and post welding heat treatments.	6
3	Metallurgical effects of the weld thermal cycle; Gas-metal equilibria, gas-metal reactions in arc welding, the mechanism of gas absorption in welding, porosity, diffusion, dilution, and uniformity of the weld deposit, weld cracking.	6
4	Effect of alloying elements on microstructure; Heat treatment related processes in fusion welding: annealing, subcritical annealing, spherodisation, normalizing, quenching hardening, tempering, secondary hardening, precipitation hardening, temper Embrittlement and graphitization.	8
5	Welding of carbon and ferritic alloy steels: Weldability, metallurgy of liquid weld metal; Transformation and microstructure steel, mechanical properties of welded joints, stress, intensification, Embrittlement and cracking of fusion welds.	8

6	Welding of austenitic and high-alloy steels: Weldability, weld pool, alloy constitution, metallurgical transformations, Embrittlement and cracking; Austenitic Cr-Ni alloys for repair welding, cladding; Metallurgical problems like weld decay in austenitic stainless steels.	6
7	Weldability of non-ferrous metals: Weldability of Al and its alloys, Mg and its alloys, reactive and refractory metals and low melting metals.	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	"Metallography and Microstructures", Metals Handbook, Vol.9, ASM.	2000
2	"Welding Handbook", Vol. 3, Part 2, 9th Ed. The American Welding Society.	2000
3	Kalpakjian, S., Steven R.S., "Manufacturing Engineering and Technology", Prentice Hall.	2001
4	Parmar, R.S., "Welding Engineering and Technology", Khanna Publishers.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT- 415 **Course Title**: Failure Analysis
2. Contact Hours: L: 3 ; T: 0; P: 0

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6. Semester:** Autumn

7. Pre-requisite: MT-205 **8. Subject Area:** DEC

9. Objective: To familiarize the students how to investigate a failure component by applying basic metallurgical principles.

10 Details of the Course:

Sl.No.	Contents	Contact Hours
1	Deformation and general approach to analysis of failure; Fracture aspects: Type of fracture, ductile, brittle and mixed mode fractures, models of nucleation and growth of cracks, fractography.	6
2	Determination of chemical composition by various analytical techniques; determination of mechanical properties like tensile, hardness, bend tests of failed components, comparison with Bureau of Indian Standards, quality assurance.	7
3	Fracture mechanics: Plain strain plain stress fracture toughness, K_{IC}, elastic-plastic fracture mechanics, concept of stretched zone width, its identification and determination, ductile to brittle transition of metals and failure at low temperature.	7
4	Microstructural aspects: Critical appraisal of the role of microstructure in failure, application of quantitative metallography, role of grain size and second phase particles, grain boundary and segregation, temper and hydrogen embrittlement, macro and micro examination.	8
5	Environment assisted failures: Basis principles of aqueous corrosion and high temperature corrosion and oxidation, causes and their remedies.	7
6	Case studies: Failed components from hydropower, thermal power, oil exploration rigs and rope ways, inspection of failed components on the site.	7
	Total	42

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Raghavan, V., "Physical Metallurgy: Principles and Practice", 2nd Ed. Prentice-Hall of India.	2007
2	Callister, W.D. Jr., "Material Science and Engineering – An Introduction", 5th Ed. John Wiley and Sons	2000
3	Askland, R.A., "The Science and Engineering of Materials", 2nd Ed., PWS-KENT Publishing Company.	1989
4	Raghavan, V., "Materials Science and Engineering: A First Course", 5th Ed, Prentice-Hall of India.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-416 **Course Title**: Corrosion Protection Methods

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

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

4. Relative Weightage: **CWS:** 1 5 **PRS:** 0 0 **MTE:** 3 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 3 **6 Semester:** Spring

7. Pre-requisite: MT-302 **8. Subject Area:** DEC

9. Objective: To provide an understanding of the principles involved in corrosion and its protection of metallic materials.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1	**Introduction:** Thermodynamics of Corrosion: Free energy change, EMF, Galvanic, Pourbaix Diagram, Electrochemical Theory; Corrosion Rates, activation polarization, concentration polarization, anodic, cathodic, mixed control; Passivation, Tafel equation.	10
2	**Different Forms of Corrosions:** Uniform, Galvanic, crevice, pitting, intergranular, erosion-corrosion, SCC, hydrogen cracking, corrosion fatigue, fretting corrosion; Effect of Metallurgical variables and Environments on different forms of corrosion.	8
3	**Classification of Protection Techniques:** By changing physical, chemical, and mechanical properties of the materials. By modification of environmental parameters, Cathodic and Anodic protection.	8
4	**Coatings Technology:** Various coating techniques, thermal spray, plasma spray, sputtering, metallic and non-metallic coatings for corrosion protections; Smart coatings.	8
5	**Corrosion Resistant Alloys:** Stainless steels, brasses, bronzes, and Al and Ti base alloys.	4
6	**Corrosion Control Standards:** Standards for conducting electrochemical tests, high temperature corrosion tests, and SCC.	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1	Fontana, M.G., Greene, N.D. "Corrosion Engineering", Tata McGraw-Hill.	2005
2	Uhling, H.H., Revie, R.W., "Corrosion and Corrosion Control", John Wiley& Sons.	1984
3	Aryan, R., "An Introduction to Metallic Corrosion and its Prevention", Oxford & IBH Publisher.	1988
4	Uhlig, H.H., "The Corrosion Handbook", John Wiley & Sons.	1969

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: MT-417 **Course Title**: Inspection and Quality Control

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

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

4. Relative Weightage: CWS: 1 5 PRS: 0 0 MTE: 3 5 ETE: 5 0 PRE: 0 0

5. Credits: 0 3 **6 Semester**: Autumn

7. Pre-requisite: MT-205 **8. Subject Area:** DEC

9. Objective: To impart the importance of non-destructive testing in assuring quality control in engineering components.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1.	**Introduction:** Non destructive testing and its comparison with destructive testing, role of NDT in quality control.	4
2.	**Liquid Penetrant Inspection:** its principles, equipment, advantages, limitations and applications.	5
3.	**Magnetic Particle Inspection:** its principles, equipment, advantages, limitations and applications.	6
4.	**Ultrasonic Inspection:** its principles, equipment, advantages, limitations and applications.	6
5.	**Eddy Current Inspection:** its principles, equipment, advantages, limitations and applications.	6
6.	**X-ray Radiography:** its principles, equipment, advantages, limitations and applications.	5
7.	**Quality Control:** Statistical quality control, control charts, control chart attribute and variables and acceptance sampling	6
8.	**Quality Assurance**: Principles and ISO 9000:2000	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1.	"Non Destructive Evaluation and Quality Control". Metals Handbook, Vol. 17, 9th Ed., ASM.	1989
2.	Srivastava, K.C., "Handbook of Magnetic Particle Testing", Oscar Publications.	1998
3.	Srivastava, K.C., "Handbook of Liquid Penetrant Testing", Oscar Publications.	1997
4.	Grant, E.L. and Larenwork, R.S., "Statistical Quality Control", Tata McGraw-Hill.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT : Metallurgical and Materials Engineering

1. Subject Code: IMT-01 **Course Title:** Non Destructive Testing

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

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

4. Relative Weightage: **CWS:** 2 5 **PRS:** 0 0 **MTE:** 2 5 **ETE:** 5 0 **PRE:** 0 0

5. Credits: 0 4 **6 Semester:** Both

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

9. Objective: To impart the importance of non-destructive testing in assuring quality control in engineering components.

10. Details of the Course:

Sl.No.	Contents	Contact Hours
1.	**Introduction**: Non destructive testing and its comparison with destructive testing, role of NDT in quality control.	5
2.	**Liquid Penetrant Inspection**: Its principles, equipment, advantages, limitations and applications.	6
3.	**Magnetic Particle Inspection**: Its principles, equipment, advantages, limitations and applications.	6
4.	**Ultrasonic Inspection**: Its principles, equipment, advantages, limitations and applications.	6
5.	**Eddy Current Inspection**: Its principles, equipment, advantages, limitations and applications.	6
6.	**X-ray Radiography**: Its principles, equipment, advantages, limitations and applications.	5
7.	**Quality Control**: Statistical quality control, control charts, control chart attribute and variables and acceptance sampling; Quality assurance and ISO 9000:2000	8
	Total	**42**

11. Suggested Books:

S.No.	Name of Author/Book/ Publisher	Year of Publication/ Reprint
1.	"Non Destructive Evaluation and Quality Control". Metals Handbook, Vol. 17, 9th Ed., ASM.	1989
2.	Srivastava, K.C., "Handbook of Magnetic Particle Testing". Oscar Publications.	1998
3.	Srivastava, K.C., "Handbook of Liquid Penetrant Testing". Oscar Publications.	1997
4.	Grant, E.L. and Larenwork, R.S., "Statistical Quality Control", Tata McGraw-Hill.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Alternate Hydro Energy Centre**

1. Subject Code: **IAH-01** Course Title: **Small Hydro Power Development**

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: **Both** 7. Subject Area: **ESEC**

8. Pre-requisite: **NIL**

9. Objective:

To provide basic knowledge about Small Hydro Power Technology and SHP project designs.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Necessity and Importance of harnessing small hydro power; National policies, laws & clearances; Small hydro power scenario and type of schemes.	6
2.	Site selection and investigations; Environmental aspects; Flow duration, water power studies; Cost estimation. Economic and financial aspects.	9
3.	Diversion structures & power channels; Desilting arrangements, forebay tank and balancing reservoir. Penstock and power house building	9
4.	Types of turbines and their selection; Gates and valves; Governing system (mechanical & electrical).	8
5.	Load forecasting.	2
6.	Types of generators– synchronous and induction; Protection & controls, Power evacuation system.	8
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/ Publishers	Year of Publication / Reprint
1.	Adam Harvey, "Micro Hydro Design Manual", Intermediate Technology	1993
2.	Fritz , "Small Hydro Mini Power Systems" , McGraw Hills	1994
3.	Emil Mosonyi , "Water power development", Vol.1&2 , Nem Chand & Bros	2009
4.	Small Hydro Stations. (Publication No. 175), Central Board Of Irrigation and Power	1985
5.	Civil Engineering Guidelines for Hydroelectric Projects. (Vol.4-Small Hydro), ASCE	1989
6.	P.S. Nigam, "Hand book of Hydroelectric Engineering", Nem Chand & Bros	2001
7.	Brown G., "Hand Book Hydro-electric Engineering Practice", Vol.1, 2 &3, CBS Publication,	1984

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Alternate Hydro Energy Centre**

1. Subject Code: IAH-02 Course Title: **Renewable Energy Sources Development 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: **Both** 7. Subject Area: **ESEC**

8. Pre-requisite: **NIL**

9. Objective:

To provide the basic knowledge to students about various renewable energy resources and technologies.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Energy sources & demand in different sectors, conventional & non conventional energy sources; Importance of new and renewable energy sources in the present energy scenario and types of resources.	5
2.	Small Hydro Power potential and classification of SHP projects; Basic components of civil works; Selection of electro-mechanical equipment.	8
3.	Estimation of Biomass resources, Biomass Technologies for thermal and biological conversion; Biomass based electricity generation and application of bio fuels.	6
4.	Solar energy estimation and different routes of solar energy applications; Technologies for solar thermal power generation; Photovoltaic power generation system.	8
5.	Estimation of wind energy potential and site selection; Types of wind mills, their basic characteristics and applications; Recent technologies of wind energy conversion system (WECS), wind farms.	8
6.	Ocean energy-potential, methods of harnessing; Geothermal energy; New technologies for renewable energy; Integrated renewable energy systems.	7
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books/ Publishers	Year of Publication/ Reprint
1.	Charles Y. Wereko, "Energy: The Biomass Option", John Willey.	1991
2.	Lysen, "Introduction to Wind Energy", Georgia Institute.	1998
3.	ICIMOD, "Small Hydro Design Manuals, Vol. I to IV", AHEC Publication.	1998/2005
4.	Godfrey Boyle, "Renewable Energy Power for a Sustainable Future", Oxford University Press.	1996
5.	Sukhatme S.P., "Solar Energy Principles of Thermal Collection and Storage-II Edition", Tata McGraw Hill.	1996
6.	Clare R., "Tidal Power : Trends and Development", Thomas Telford.	1992
7.	"Key World Energy Statics", International Energy Agency.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

ACADEMIC CALENDAR FOR THE AUTUMN SEMESTER
SESSION 2009-2010

1.	Registration for Summer Term	May 20-22, 2009	Wed - Fri
2.	Summer Vacation	June 01-July 20, 2009	---
3.	Joint Entrance Examination Counselling for B.Tech. / B.Arch./ IDD / Integrated M.Sc. & Integrated M.Tech. Programmes	June 09-16, 2009	Tue - Tue.
4.	Submission of Progress reports by the Ph.D. students to Departments/Centres	June 12, 2009	Friday
5.	Joint Entrance Examination Architecture/Design Aptitude Test	June 12 and June 15, 2009	Friday and Monday
6.	Declaration of JEE-2009 Counselling results	June 28, 2009	Sunday
7.	Joint Entrance Examination Counselling for Preparatory Courses 2009-10	June 30, 2009,	Tuesday
8.	Last date for submission of M.Tech. / M.Arch./ MURP / M.Sc. & M.Tech.(ES)/ IDD dissertation.	June 30, 2009	Tuesday
9.	Classes for Summer Term	May 25, 2009 to July 06, 2009	-----
10.	Examinations for Summer Term Courses	July 09-11, 2009	Thursday – Saturday
11.	Declaration of Results for Summer Term Examination	July 15, 2009	Wednesday
12.	Institute Reopens for the Autumn Semester 2009-2010	July 21, 2009	Tuesday
13	Registration of all **New UG Students** including IDD/ 5 Year Integrated Courses.and **student of IIT Mandi**	July 22, 2009	Wednesday
14.	Date of Registration of all students (Other than New Entrants)	July 23, 2009	Thursday
15.	Classes begin for all students in respective Department/Centres (Other than New Entrants)	July 24, 2009	Friday
16.	Registration of all **New PG Students** including New Research Scholars	July 24, 2009	Friday
17.	Last date for Final Evaluation of MTech. Dissertation	July 24, 2009	Friday
18.	Orientation Programme for all **New Students.**	July 25, 2009	Saturday
19.	Classes begin for all New Entrants	July 27, 2009	Monday
20.	Registration/Counselling for left over seats of all UG/PG programmes	July 27, 2009	Monday
21.	Closing of admissions	July 31, 2009	Friday
22.	Selection for NSO at SCB ground	August 01, 2009 (Forenoon)	Saturday

23.	Selection for N.C.C. / N.S.S. at SCB ground	August 01, 2009 (Afternoon) & August 02, 2009	Saturday & Sunday
24.	On-line Subject Registration of all students (New Entrants)	August 02-05, 2009	Sunday to Wednesday
25.	Last date of addition/deletion of subject for other then new entrants.	August 07, 2009	Friday
26.	Academic/Research Section to send to Deptts/Centres final lists of Registered Students	August 10, 2009	Monday
27.	Last date for On-line subject registration (New entrants) with late fine.	August 11, 2009	Tuesday
28.	Display/Dispatch of final list of on-line Subject Registration by Academic Section to the Department/Centres	August 14, 2009	Friday
29.	Assignment of UG Projects	August 21, 2009	Friday
30.	Departments to send the lists of Institute Elective to Academic section to be run in **Spring Semester – 2009-10**	August 31, 2009	Monday
31.	Last date of submission of Seminar Report (PG students)	August 31, 2009	Monday
32.	**Mid Term Exam.- I** for all UG/PG/Ph.D./Preparatory Course students	September 03-05, 2009	Thur - Sat
33.	Last date for withdrawal from a course (s)	September 11, 2009	Friday
34.	Intimation to the UG Students about the Institute Electives to be run during Spring Semester 2009-10 by the Academic Section	September 11, 2009	Friday
35.	Last date of display of attendance record of students falling short of minimum attendance requirements during the middle of semester (by departments / centres)	September 16, 2009	Wednesday
36.	On-line subject registration for Institute Electives by UG Students for Spring Semester 2009-10.	September 24-27, 2009	Thur -Sun.
37.	Intimation to parents/guardians of students having "short attendance" by Academic Section.	September 25, 2009	Friday
38.	Last date of submission of remaining document(s) by all new entrants (UG/PG/PhD)	September 30, 2009	Wednesday
39.	**Semester break** (for students only)	Sept.28 – Oct 01, 2009	Mon - Thur
40.	Last date for submission of Project (PG students)	Oct. 05, 2009	Monday
41.	Issue of blank progress forms for Ph.D. students by Research Section to respective Deptts./Centres	October 16, 2009	Friday
42.	Last date for finalization of time tables of Spring Semester -2009-10 session by all departments / centres	October 16, 2009	Friday
43.	**Mid Term Exam.-II** for all UG/PG/Ph.D./Preparatory Course students	Oct. 22 – 24, 2009	Thur – Sat
44.	Jubilee Alumini Meet	Oct.24-25, 2009	Sat-Sun.
45.	Notification of seating plan Autumn Semester Exam,	October 26, 2009	Monday
46.	Notification of dates of Exam. for common subjects.	October 28, 2009	Wednesda
47.	On-line subject registration for Spring Semester for the session 2009-10 for UG /PG/ Ph.D. students	October 28-Nov 05, 2009	Wednesda -Thursday

48.	Thomso – 2009	Oct 30 -- Nov.01, 2009	Fri – Sun
49.	Filling of response forms by UG/PG students in the respective Departments /Centres	Nov. 09-11, 2009	Mon - Wed
50.	Annual Convocation	To be decided	
51.	Information regarding short attendance cases to be sent to Academic Sections. by Departments/Centres	November 11, 2009	Wednesday
52.	Display of marks of course work evaluation	November 13, 2009	Friday
53.	Display of shortage of attendance cases on the Notice Boards by Departments/Centres	November 13, 2009	Friday
54.	Last day of evaluation of M.Tech. Dissertation for 3rd Semester & sending of satisfactory/unsatisfactory report to Academic section by departments/centres	November 13, 2009	Friday
55.	Last date of Teaching for all UG/PG /Ph.D. classes	November 18, 2009	Wednesday
56.	Action by Academic Section to ascertain that the detained students do not appear in End Term Exam.	November 18, 2009	Tuesday
57.	Practical Examination, if any	Nov.19 to 21, 2009	Thu-Sat.
58.	**End Term Exam.** for all UG/PG/Ph.D. classes including Preparatory Course	Nov.23 to Dec. 03, 2009	Mon. - Thurs
59.	NCC Camp	To be decided by DOSW	
60.	J.M.E.T.-2010 Examination	December , 2009 (To be decided)	Sunday
61.	Last date to show the answer scripts of End Term Examination to the students	December 09, 2009	Wednesday
62.	Finalization of grades by the Grade Moderation Committees	December 10, 2009	Thursday
63.	Display of grades for all classes on Department Notice Board	December 10, 2009	Thursday
64.	Last date for sending of grades to Academic Section after scrutiny	December 11, 2009	Friday
65.	Submission of progress reports of the Ph.D. students by the Departments/ Centres	December 11, 2009	Friday
66.	Last date for declaration of Autumn Semester results	December 14, 2009	Monday
67.	Winter vacation for Teaching Staff	Dec. 15 - 29, 2009	Tue.- Tue.
68.	Spring Semester 2009-2010 begins	December 30, 2009	Wednesday
69.	Registration for all courses in respective Departments/Centres	December 31, 2009	Thursday
70.	Classes begin for all courses	January 01, 2010	Friday

Note: - Heads of Department are requested to please plan the functions / Seminars on Saturdays and Sundays so that the Institute is able to maintain the minimum teaching day required in a semester.

Teaching days for Autumn Semester 2009-10 (w.e.f. 24.7.2009 to 17.11.2009)

Excluding Mid-term semester break w.e.f. 28.09.2009 to 01.10.2009

Day	July	August	September	October	November	Total days
Monday	27	3,10,17,24,31	7,14	5,12,26	9,16.	13
Tuesday	28	4,11,18,25	1,8,15,22	6,13,20,27	3,10,17	16
Wednesday	29	12,19,26	2,9,16,23	7,14,21,28	4,11,18	15
Thursday	30	6,13,20,27	10,17,24	8,15,29	5,12	13
Friday	24, 31	7,21,28	11,18,25	9,16,30	6,13	13
Total	6	19	16	17	12	**70**

Details of Saturday and Sunday used in MTE & ETE

	SATURDAY	SUNDAY
MTE (I & II)	5.9.2009; 24.10.2009	----
ETE	28.11.2009	29.10.2009

APPENDIX 'H'
Item No. Senate/29.2.11

PANEL OF SENATE NOMINEES

1. Alternate Hydro Energy Centre
2. Architecture & Planning
3. Biotechnology
4. Chemical Engineering
5. Chemistry
6. Civil Engineering
7. Paper Technology
8. Earth Sciences
9. Earthquake Engineering
10. Electrical Engineering
11. Electronics & Computer Engineering
12. Humanities & Social Sciences
13. Hydrology
14. Management Studies
15. Mathematics
16. Mechanical & Industrial Engineering
17. Metallurgical & Materials Engineering
18. Physics
19. Water Resources Development & Management

SENATE NOMINEES (S1 – S13)

Department: Alternate Hydro Energy Centre

Small Hydropower (Civil, Electrical, Mechanical)/Renewable Energy/Limnology-Aquatic Ecology

SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Dr. S.N. Singh	Dr. S.N. Singh Deptt of Applied Mechanics, Indian Institute of Technology , Delhi, New Delhi -110 016 Tel(O) 011 26591180 Tel(R)011 68545519	Fluid Mechanics and Solid Liquid Flow	9818300945S Fax:011 26855227 26862037 Email:sns@am.iitd.ernet.in sidhnathsingh@hotmail.com	136, Defence Enclave Vikas Marg, Delhi-110 092
S2	Prof. D. Thukaram	Prof. D. Thukaram Deptt. Of Electrical Engg., Indian Institute of Science Banglore-560012 Tel(O)080 22932362 22933168 Tel(R) 080 23600336	Renwable energy integration	09448383392 Fax:080 -23600444 Email:dtram@ee.iisc.ernet.in dtram_2001@yahoo.com	Qtr. No. NE-102, New Housing Cology IISc Campus Bangalore-560 012
S3	Dr. R. Balsubramanian	Dr. R. Balasubramanian , Centre for energy Studies, Indian Institue of Technology, Delhi-110 016 Tel(O) 011 26591246 Tel® 011 26562182	Renewable energy	09868111541 Fax: 011 26855227, 26862037 Email:rbmanian@ces.iitd.ernet.in	House No. 6, C-Street , IIT Delhi Campus

S4	Shri D.K. Mody Executive Director	Shri D.K. Mody Bharat Heavy Electrical Limited (BHEL) Hardwar-249 403 Tel. (O) 01334 226459 Tel.(R) 01334 226461	Electrical Engineering Machines, Hydropower	9837089407 Fax:01334- 225096 Email:dkmody@bhellhwr.co.in	BHEL Campus
S5	Dr. Bhim Singh	Dr. Bhim Singh, Professor Room No. II/118, Department of Electrical Engineering, Indian Institute of Technology, Delhi Tel(O) 01126591890;011 26516223	Electrical	9811502125 Fax: 011-26581606 Email:bsingh@ee.iitd.ac.in	60, New Campus, IIT Delhi
S6	Dr. K.S. Sayann	Dr. K.S. Sayann Former Professor & Principal MANIT Bhopal Res.(O) 011 45599900 Tel(R) 011 25109242	Hydropower, Machines	09313439399 Fax:011-25136819 Email:sayannks@gmail.com	C-186, II Floor, Mansarovar Gardden, New Delhi-110 015

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S7	Dr. S. Mohan	Dr. S. Mohan Professor Deptt. Of Civil Engg. IIT Madras, Chennai-600 036 Tel(O) 044 24458296 2274261 Tel(R) 044 22300739,24459296	Hydrological, Hydropower	09444022160 Fax:044- 22350509 Email:smohan@iitm.ernet.in	1420, Sundarapuram 1st Street Teachers Colony Road Thanjavur-613006 Tamil Nadu, Ph.04362-255617
S8	Prof. (Dr.) V.K. Dadhwal	Prof. (Dr.) V.K. Dadhwal Indian Institute of Remote Sensing (National Remote Sensing Agency), deptt. Of Space, Goevt. Of India, P.B. No. 135, 4 Kalidas Road, Dehradun 248 001 Tel(O) 0135 2744583 2524101 Tel.(R) 0135 2744914	Remote sensing, planning	Fax: 0135 2741987 Emai:dean@iirs.gov.in, tso@iits.gov.in	
S9	Prof. S.A. Khaparde	Prof. S.A. Khaparde Deptt. Of Electrical Engg. Indian Institue of Technology, Bombay Tel(O) 91 22 2576-7434 Tel(R) 91 22-252576-8434	Deregulation in Power Industry	9869991285 Fax 91(0) 22-25723707 Email:sak@eeiitb.ac.in	Staff Hostel Annexe Flat No 10-IIT Bombay

S10	Dr. J.K. Nayak	Dr. J.K. Nayak Prof. & Head, Deptt. Of Energy Science and Engineering, Indian Institute of Technology Bombay, Mimbai-208 016 Tel(O) 022 2576 7881,7890 Tel(R) 022 25704166; 25728890	Renewable energy ,solar energy	09930404624 Fax: 022-2572 6875 25754890	IIT Bombay Campus
S11	Dr. P. Subramanian	Dr. P. Subramanian Tel(R) 0431 2794884	Biomass gasifier, thermal conversion	9442516013 Fax:0431-2500133 Email:psubbu44@hotmail.com	93B, Park View Road , Anna Nagar Tenur, Trichy 620 107
S12	Prof. H.R. Singh	Prof. A.S. Singh College of Fisheries Pant Agricultural University Pant Nagar, Utarakhand Tel(O) 05944 233376 233377 Tel(R) 9415340695	Aquatic Ecology, Limnology	9410035821 Email:profsinghhr@yahoo.co.in	3/33, HIG, Shradhapuri Phase I Meerut-250001
S13.	Prof. R.S. Ambasht	Prof. R.S. Ambasht Botany Department Banaras Hindu University Varanasi-221 010	Aquatic Ecology, Limnology	9451493555(M) Email:rambasht@yahoo.com Tel (O) 2307147/46 Tel (R) 0542-2277485	97, Jawaharnagar Ex. Varanasi

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SENATE NOMINEE(S1- S15)

Department: Architecture & Planning

APPLIED ART					
SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Prof. Kirti Trivedi	Industrial Design Centre, Indian Institute of Technology Bombay, Powai, Mumbai-400076 Tel.(O) 022-25767813 Tel.(R) 022-25724244	Visual Communication & Indian Design Traditions	09892918096 Fax: 022-25783480,25767803 E-mail: kirti@iitb.ac.in	
S2	Prof. (Dr.) P.S. Shinde	Sri Venkateshwar College of Architecture, Hyderabad-81 Tel.(O) Tel.(R) 040-23310059 23307134	Architecture & Planning	09866866631 E-mail: sysca_ses@yahoo.com	A-201 Satya Apt., Masaltanjk, Hyderabad-500028
S3	Prof. Ravi Poovaiah	Industrial Design Centre, Indian Institute of Technology Bombay, Powai, Mumbai-400076 Tel.(O)022-2576820 Tel.(R)022-25767801	Visual Art & Com. Design	Fax: 022-25783480,25767803 E-mail: ravi@iitb.ac.in	

S4	Prof. U.A. Athavankar	Industrial Design Centre, Indian Institute of Technology Bombay, Powai, Mumbai-400076 Tel.(O)022-25767817 Tel.(R)	Product Design , Product Semantics, Cognition & Imagery	Fax: 022-25783480/25767803 E-mail: uaa@iitb.ac.in	
B. PLANNING					
S5	Prof. Utpal Sharma	Faculty of Planning & Public Policy, CEPT University, Kasturbhai Lalbhai Campus, University Road , Navarangpura, Ahmedabad 380009 (Gujarat) Tel.(O) Tel.(R)	Urban Planning & Housing Design	09825082808 E-mail: utpalsharma@cept.ac.in	
S6	Prof. A.N. Sachithanandan	Dean, MEASI Academy of Architecture, 8T Peters Road, Royapettah, Chennai- 600014 Tel.(O) 044-28350445,28351126, 28352982 Tel.(R)	Urban Development and Housing Planning	09840324140 Fax: 044-28351050 E-mail: sivusachi@yahoo.com	

S7	Prof. S.A. Deshpande	Retd. Ex. Head of Deptt. of Architecture Tel.(O) Tel.(R)0712-2524427	Architecture & Planning	09822944064 E-mail: prosad@hotmail.com	88 West Park Road, Dhantoli, Nagpur-440012
S8	Ar. J.B. Kshirsagar	Town @ Country Planning Organization (TCPO), E-Block, Vikas Bhawan, I.P.Estate, New Delhi-110002 Tel.(O)011-23379353 Tel.(R)	Urban Planning	09968074518 Fax: 011-23379197 E-mail: cp.tcpo@yahoo.com, jbksagar@gmail.com	
S9	Prof. Shovan K. Saha	Environmental Planning, School of Planning @ Architecture , 4-Block 'B' , Indraprastha Estate, New Delhi- 110002 Tel.(O) 011-23724383 Tel.(R)	Urban and Regional Planning, Environmental Planning	09810249324 Fax: 011-23702383 E-mail: sk.saha@spa.ac.in	
C. ARCHITECTURE					
S10	Prof. Kulbhushan Jain	School of Architecture, CEPT, University Road, Navrangpur, Ahmedabad-380009 Tel.(O) Tel.(R)	Architecture & Planning	09825323381 E-mail: kbj81@hotmail.com	

S11	Prof.(Dr.) Uttam Banerjee	Deptt. of Arch. & Regional Planning, IIT Kharagpur-721302 Tel.(O)03222-283200 Tel.(R)03222-283201,277802	Architecture & Planning	09434005812 E-mail: ukb@arp.iitkgp.ernet.in, uttam61@yahoo.com	B-177, IIT Kharagpur (W.E)
S12	Prof. Nalini Thakur	Deptt. of Architectural Conservation, School of Planning & Architecture, Indraprastha Estate, New Delhi -110002 Tel.(O)011-23724383 Tel.(R)	Architectural Conservation	Fax: 011-23702383 E-mail: mm.thakur@spa.ac.in	
S13	Ar. P.R. Das	Bengal Shelter Housing Development Limited, Kanak Building (3rd Floor), 41, J.L.Nehru Road Kolkata-700071 Tel.(O) 033-22685554 Tel.(R)033-24657001	Architecture & Planning	09830489558 Fax: 033-2884679 E-mail: benalshelter@vsnl.net	Flat No. B-43, Alaka Apts. 59/2B Pratap Aditya Road, Kolkata 700026
S14	Ar. Uttam Chand Jain	408 Regent Chambers, 208 Nariman Point, Mumbai 400021 Tel.(O)022-22840284 22852033,40020658 Tel.(R)	Eminent Practicing Architect	E-mail: ucjain@uchain.com	

S15	Prof. A.L. Chhatre	Retd. Professor & Head Tel.(O)07122428189 Tel.(R)07122294215	Architecture	09370321074	Plot No. 45, Saraswati Society, Deen Dayal Nagar, Nagpur-440022

SENATE NOMINEES (S1 – S36)

Department: Biotechnology

SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
A. BIOINFORMATICS					
S1	Dr. Velurugan Professor	Department of Crystallography and Biophysics, University of Madras, Guindy Campus , Chennai-600025 India Tel(O) 044 22351367 Tel(R) 044 223300122	Bioinformatics	09841075847 Fax: 91 44 22300122 Email: d velu@yahoo.com	-
S2	Dr. K.V.R. Chary Professor	Deptt. Chemical Sciences, Tata Institue of Fundamental Research (TIFR), Homi Bhabha Road, Navy Nagar, Colaba, Mumbai Tel(O) 022 22782480 Tel(R) 022 22804860	Bioinformatics	Fax: 022 2280 4610/4682 Email: chary@tifr.res.in	1002, Bhaskara, TIFR Housing Colony Homi Bhabha Road, Navy Nagar, Mumbai, 400 005, India

S3	Dr. N. Gautham Professor	Deptt. Of Crystallography and Biophysics, University of Madras Guindy Campus, Chennai 600025 Tel(O) 9144 2235 1367 Tel(R) 9144 22300 0122	Bioinformatics	09940578240 Fax: 91 44 2235 2494 Email: gautham@unom.ac.in, n_gautham@hotmail.com	No. 1, Park Stree Kilpauk Gardens, Chennai-600 010
S4	Dr. J.K. Datta Gupta Professor	C& MB Division, Saha Institue of Nuclear Physics 1/AF, Bidhannagar, Calcutta 700 064 Tel(O) 91 2337 5345 91 33 2337 5346	Bioinformatics	Fax. 91 33 2337 4637	-
S5	Prof. B. Jayaram	Deptt. Of Chemistry, IIT Delhi, Hauz Khas, New Delhi-110016 India Tel(O) 011 2659 1505 Tel(R) 011 26510219	Bioinformatics	09911814410 Fax: 011 26581102 Email: bjayaram@chemistry iitd. ac.in	19, North Ansari Road, IIT Campus, New Delhi

B. BIOCHEMISTRY & BIOPHYSICS					
S6	Dr. G.K. Jarori	Dept. of Biological Sciences, Tat Institute of Fundamental Research (TIFR) Colaba, Navy Nagar, Mumbai-400 005 Tel(O) 022 22782228 Tel(R) 022 22804559	Biochemistry and Biophysics	Fax: 022 2245 2110	TIFR Housing Colony, Colaba, Navy Nagar, Mumbai-400 005
S7	Dr. K.L. Khanduja	Deptt. Of Biophysics, Post Graduate Institute of Medical Education & Research, Chandigarh 160 012 Tel(O) 0172 2755246 Tel(R) 0172 2710963	Biochemistry & Biophysics	099142-8246 Fax; 0172 2744401, 2745078 Email: klkhanduja@satyam.net.in	House No. 84, Sector, 24A Chandigarh 160 023
S8	Dr. M.V. Hosur Scientist 'H'	Solid State Physics Division Bhabha Atomic Research Centre Trombay, Mumbai 400085 India Tel(O) 022 25593614 Tel(R) 022 255593614	Biochemistry & Biophysics	09821988370 Fax: 91 22 25505151 Email: hosur@magnum.barc.ernet.in	2-B Udayagiri Anu Shakti Nagar, Mumbai-400 094

S9	Dr.K.V. Ramanathan Professor	Deptt. Physics & Chairman NMR Research Centre, Indian Institute of Science, Bangalore 560 012 Tel.(O) 080 2293 3299 Tel(R) 080 2341 3808	Biochemistry and Biophysics	09845927385 Fax: 080 2360-1550 Email: kvr@nrc.iisc.ernet.in	No.No.39, Sixth Main Tat Nagar, Bangalore-560 092
S10	Dr. Krishna Misra Professor	Emeritus Professor Chemistry Department Allahabad University, Allahabad, and Coordinator, Indo Russian Centre for Biotechnology IIT Allahabad Tel(O) 0532 2461377/78/79/80 Tel(R) 0532 2465 462/2467154	Biochemistry and Biophysics	09415247579 Fax: 0532 2461376/2608469 Email: kmisra@iiita.ac.in krishnamisra@hotmail.com kkmisra@yahoo.com.	187, A/1 Allen Gunj, Allahabad
C. BIOCHEMICAL ENGG.					
S11	Srivastava A.K. Professor	Deptt. Of Biochemical Engg. & Biotechnology Indian Institute of Technology , Delhi Hauz Khas New Delh-110 016 Tel(O) 91 11 2659 1010 & 1001 Tel(R) 91 11 2656 1932 & 2659 1983	Biochemical Engg.	9868551429 Fax: 91 11 2658 2282 Email: ashokks@debd.iitd.ac.in ashokiitd@hotmail.com ashokiitd@rediffmail.com ashokiitd@gmail.com	45 New Campus, India Institute of Technology , Delhi Hauz Khas, New Delhi 110 016

S12	Dr. Pratap R. Patnaik	Institute of Microbial Technology Sector 39-A, Chandigarh 160 036 Tel(O) 91 172 2690223	Biochemical Engg.	Fax: 91 (O) 172 2690132/585/632 Email: prtap@imtech.res.in; p_r patnaik!@yahoo.co.in	-
S13	Prof. U.C. Banerjee	Department of Pharmaceutical Technology, National Institute of Pharmaceutical Education & Research, Sector-67 Mohali 160 062 Tel(O) 0172 2214682-87 Ext. 2142	Biochemical Engineering	Fax. 0172 2214692 Email: ucbanerjee @niper.ac.in	-
S14	Prof. Suresh Kumar G.K.	Deptt. Of Biochemical Engg., IIT , Madras Chennai 600 036 Tel(O) 044 225741105 Tel(R) 044 22576105	Biochemical Engg.	Fax; 044 2570509 044 2579003 Email: gk.@iitm.ac.in gk@biotech.iitm.ac.in	-
S15	Dr. A.K. Suresh Professor	Deptt. Of Chemical Engg. Indian Institute of Technology, Powai, Bombay Tel(O) 022 2572 2545	Biochemical Engg.	Fax: 022 2572 3480 Email: aksuresh@che.iitb.ac.in	-

D. PLANT BIOTECHNOLOGY					
S16	Dr. P. Ananda Kuamr	Project Director NRC on Plant Biotechnology Indian Agricultural Research institute, New Delhi-110012 Tel(O) 011 25488783 Tel(R) 011 25841748	Plant Molecular Biology	Fax: 011 25843984 Email: polumentla@hotmail.com	B-17, IARI, Campus New Delhi 1110012
S17	Prof. P.C. Sharma	University School of Biotechnology, GGS Indraprastha University Kashmee Gate, Delhi 110 006 Tel(O) 91 11 23900220	Plant Biotechnology	Fax: 91 011 23865941 23900111, 23900221 Email: pcsharma@ipu.edu;deansbt@yahoo.co.in	-
S18	Dr. J.P. Khurana Professor	Professor & Coordinator (UGC-SAP), Department of Plant Molecular Biology, University of Delhi, South Campus, New Delhi-110021 Tel(O) 011 24115126 Tel.(R) 011 24119090	Plant Biotechnology	Fax: 011 241152270 Email: khurana@genomeindia.org	Provost's Residence, Geetanjali Hostel, University of Delhi, South Campus, New Delhi-110021
S19	Dr. Shyam Kumar Sharma	Director, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012 Tel(O) 011 25843697 Tel(R) 011 25841177	Plant Biotechnology, Genetics and Breeding	Fax: 011 25842495 Email: skspbg@yahoo.co.in	Pusa Campus, New Delhi 110 012

S20	Dr. Akhilesh Kumar Tyagi	Director National Institute of Plant Genome Research Tel(O) 011 26742267 Tel(R) 011 24142408	Plant Biotechnology & Genomics	Fax: 011 26741759 Email: Director @nipgr.res.in	House 4, Type VB University of Delhi, South Campus, New Delhi- 110 021
E. ANIMAL BIOTECHNOLOGY					
S21	Dr. H Krishna Prasad Professor	All India Institute of Medical Sciences, New Delhi Tel(O) 91 11 265949994	Biotechnology	Fax: 91 11 26589286 26588663 Email: hk_ Prasad@hotmail.com	-
S22	Dr. S.K. Maitra Professor	Department of Zoology, School of Life Sciences Visva Bharti Univeristy - 731 235	Animal Biotechnology	Email: dgp_skmaitra@yahoo.com	-
S23	Dr. Nanda, Amarjit Singh	Director of Research, Guru Angad Dev Veterinary and Animal Sciences University Ludhiana 141 004 Tel(O) 0161 2553346 Tel(R) 0161 2400615	Animal Biotechnology	Fax: 0161 2553340 2400822 Email: asnanda@satyam.net.in asinghnanda@gmail.com.	6/13, Punjab Agricultural University Campus, Ludhiana 141 004
S24	Dr. Anjali A Karande Professor	Deptt. Of Biochemistry , Indian Institute of Sciences, Bangalore, Bangalore-560 012 Tel(O) 080 22932473	Animal Biotechnology and Immunology	Fax: 80 23600814 Email: anjali@biochem.iisc.ernet.in	-

S25	Dr. Y.D. Sharma Professor	Deptt. Of Biotechnology All India Institute of Medical Sciences, Ansari Road, New Delhi	Biotechnology	09448465368	-
S26	Prof. Anand Kumar	Department of Reproductive Biology, All India Institute of Medical Sciences Ansari Nagar New Delhi- 100 029 Tel (O) 011 26593234	Animal Biotechnology	Fax. 011 26588663 Email: anand@aiims.ac.in anandkumarrepbiol@hotmail.com	-
F. GENETICS & MOLECULAR BIOLOGY					
~~S27~~ S27	Dr. K.R. Koundal	Joint Director Research IARI, New Delhi 110 012 Tel(O) 011 25733378 Tel(R) 011 257333043	Genetics and molecular Biology	Fax: 011 25733378 Email: jd_research @iari.res.in	IARI, Campus New Delhi 110 012
S28	Dr. Nagendra Kumar Singh	Principal Scientist, Biotechnology, National Research Centre on Platn Biotechnology, IARI New Delhi 110 012 Tel(O) 011 25860186 Tel(R) 011 28081376	Genetics and Molecular Biology	9911268915 Fax: 011 25843984 Email: nksingh@nrcpd.org	148 DDA-SFS Flats, Dwarka Sector 5, Pocket 1, New Delhi 110075

S29	Dr. Akshay Kumar Pradhan Professor	Deptt. Of Genetics University Delhi South Campus Benito Juarez Road, Dhaula Kuan, New Delhi-110021 Tel(O) 011 24112332 24115203 Tel(R) 011 26271381	Plant Genetics and Molecular Breeding	Fax: 011 24122761 Email: pradhanakshay@hotmail.com	G-1227 (2nd Floor), Chattranjan Park, New Delhi 110019
S30	Dr. Mishra Saroj Professor	Deptt. Of Biochemical Engineering & Biotechnology Indian Institute of Technology Delhi Hauz Khas New Delhi 110016 Tel(O) 11 2659 1007 & 2659 1001 Tel(R) 91 11 2658 1055 & 2659 1904	Molecular Biology and Applications of cellulases, bglucosidases, xylanases and development Yeast Expression Systems	Fax: 91 11 2658 2282 Email:saroj @dbeb.iitd.ac.in Saroj198@botmail.com	-
S31	Prof. Vijay Kumar Chaudhary	Deptt. Of Biochemistry University of Delhi, South Campus, New Delh-110021 Tel.(O) 91 11 24115883 Tel(R) 91 11 24115863	Genetics & Molecular Biology Recombinant DNA Technology, Monoclonal antibodies, etc.	09811800434 Fax: 91 1124117543 Email: vkchaudhary@south.du.ac.in vkchoudharr@vsnl.com.	1GF, Type 5, Flat University of Delhi , South Campus, New Delhi 110021

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G. MICROBIAL TECHNOLGY

S32	Prof. Anil Kumar Tripathi Professor and Co-Ordinator	School of Biotechnology Banaras Hindu University , Varanasi-221005 Tel(O) 0542 2368331 Tel(R) 0542 2575790	Microbiology, Molecular Biology	9451525811 Fax: 0542 2368693 Email:tripathianil@rediffmail.com	R-9, Hyderabad Colony Banaras Hindu University, Varanasi-221005
S33	Dr. Rakesh Kumar Jain Scientist 'G'	Institute of Microbial Technology Sector-39- A, Chandigarh 160 036 Tel(O) 91 172 2690694 Tel(R) 91 172 2690680-94,2116	Environmental Biotechnology	09417030927 Email:rkj@imtech.res.in Rakeshl 10@yahoo.com	H.No.E-15, Institute f Microbial Technology, Sector 39 A, Chandigarh 160 036
S34	Prof. V.S. Bisaria Professor	Deptt. Of Biochemical Engg. & Biotechnology India Institute of Technology Delhi Hauz Khas New Delhi-110 016 Tel(O) 011 2659 1001 (office) 011 2659 1002(Direct)	Biochemical Engineering Enzyme, Technology, Plant Cell Technology	Fax. 011 2658 2282 (Dept.) Email: vbisaria@dbeb.iitd.ac.inand vsbisaria@yahoo.com	-

S35	Dr. S.P. Singh Professor	Head, Department of Bioscience, Saurashta, University Campus, University Road, Rajkot 360 005 Tel(O) 0281 2586419 Tel(R) 0281 2562514	Microbiology	09825487556 Email: satyapsingh@yahoo.com Satyapsingh125@gmail.com	125, Prasheen Park, Near Saurashta University Road, Rajkot -360 005
S36	Dr. N.S. Punekar Professor	School of Biosciences and Bioengineering, Indian Institute of Bombay , Powai, Mumbai 400 076 Tel(O) 022 2576 7775 Tel(R) 022 2572 2545	Microbial Biochemistry and Molecular Enzyme	Fax: 022 2572 3480 Email: nsp{at}iitb.ac.in	-

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SENATE NOMINEES (S1 – S12)

Department: Chemical Engineering

SL.NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
A. DESIGN: (Design;CFD;Process Engg.;Modelling, Simulation & Control, Reactor Analysis & Deisgn ; Safety and Risk management; Design of Safety System; Fire Science & Engg.; optimization)					
S1	Dr. K. Krishnaiah	Dr. K. Krishnaiah Professor Chemical Engg. Deptt. IIT Madras Chennai Tel. (O) 044 22570840 044 22579040 Tel (R) 044 22579040 044 22579040	Chemical Reactor Analysis and Design, Fluidization	09444008040 Fax 044 22578042 044 22570509 Email: krishnak@che.iitm.ac.in	C2-II-6, 3rd Loop Road, IIT Campus Chennai
S2	Dr. S.K. Gupta	Dr. S.K. Gupta Professor Deptt. Of Chemical Engg. IIT Bombay Powai, Mumbai-76 Tel. (o) 022 25727200 Tel. (R) 022 25768256	Multi-objective optimization of industrial processes. Optimizing control of polymerization reactors Modelling of Complex Polymerization System	09930226012 Fax; 022 25726895 Email: sk.gupta@che.iitb.ac.in	C154, Hill Side, IIT Mumbai
S3	Dr. M. Chidambaram	Dr. M. Chidambaram Professor IIT Madras, Presently Director, NIT Trichi Tel. (O) 0431 2503001 Tel.(R) 0431 2504001	Process Modelling and Control Periodic Operation of Reactors	09442512370 Fax: 91 431 2500133 Email: chidam@nitt.edu	-

S4	Dr. H.S. Shankar	Dr. H.S. Shankar Professor Deptt. Of Chemical Engg. IIT Bombay Mumbai Tel (O) 022 25764219 Tel(R) 022-25726895	Bio-Systems, Environment, Reactor Engg. and Catalysis	Fax. 022 25726895 Email: hss@che.iitb.ac.in	-
S5	Dr. A.K. Suresh	Dr. A.K. Suresh Professor Deptt. Of Chemical Engg., IIT Bombay, Powai Mumabi Tel (O) 022 25767240 Tel.(R) 022 25764240/02225728729	Mass Transfer, Biochemical engg. Polymer Reaction Engg. & Catalysis	9833117240 Fax: 022 25726895 Email: aksuresh@iitb.ac.in	A8, IIT Bombay, Powai, Mumbai
S6	Dr. R.P. Chhabra	Deptt. Of Chemical Engg. IIT Kanpur-16 Tel.(O) 0512 2597393 0512 2597607	Fluid Mechanics of Multiphase Systems, Non-Newtonian Fluid-Particle Mechanics, Transport properties of molten salts and metals	9839741317 Fax; 0512 2590104 Email: rpc@che.iitk.ac.in, Chhabra@iitk.ac.in	427, IIT Campus, Kanpur

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B.	TRANSFER PROCESSES: Thermodynamics; Transport Phenomena; Transfer Process; Biochemical Engineering; energy Engg.; Hydrocarbon Engg.;Chemical Nano Manufacturing; Novel and Membrance Separation Process				
S7	Dr. K. Krishnaiah	Dr. K. Krishnaiah Professor Chemical Engg. Deptt. IIT Madras Chennai Tel. (O) 044 22570840 044 22579040 Tel (R) 044 22579040 044 22579040	Chemical Reactor Analysis and Design, Fluidization	09444008040 Fax 044 22578042 044 22570509 Email: krishnak@che.iitm.ac.in	C2-II-6, 3rd Loop Road, IIT Campus Chennai
S8	Dr. A.K. Suresh	Dr. A.K. Suresh Professor Deptt. Of Chemical Engg., IIT Bombay, Powai Mumabi Tel (O) 022 25767240 Tel.(R) 022 25764240/02225728729	Mass Transfer, Biochemical engg. Polymer Reaction Engg. & Catalysis	9833117240 Fax: 022 25726895 Email: aksuresh@iitb.ac.in	A8, IIT Bombay, Powai, Mumbai
S9	Dr. R.P. Chhabra	Deptt. Of Chemical Engg. IIT Kanpur-16 Tel.(O) 0512 2597393 0512 2597607	Fluid Mechanics of Multiphase Systems, Non-Newtonian Fluid-Particle Mechanics, Transport properties of molten salts and metals	9839741317 Fax; 0512 2590104 Email: rpc@che.iitk.ac.in, Chhabra@iitk.ac.in	427, IIT Campus, Kanpur

C. INDUSTRIAL POLLUTION ABATEMENT: Environmental Engg. And Management; Pollution Abatement (Environment Engineering)					
S10	Dr. K. Krishnaiah	Dr. K. Krishnaiah Professor Chemical Engg. Deptt. IIT Madras Chennai Tel. (O) 044 22570840 044 22579040 Tel (R) 044 22579040 044 22579040	Chemical Reactor Analysis and Design, Fluidization	09444008040 Fax 044 22578042 044 22570509 Email: krishnak@che.iitm.ac.in	C2-II-6, 3rd Loop Road, IIT Campus Chennai
S11	Dr. H.S. Shankar	Dr. H.S. Shankar Professor Deptt. Of Chemical Engg. IIT Bombay Mumbai Tel (O) 022 25764219 Tel(R) 022-25726895	Bio-Systems, Environment, Reactor Engg. and Catalysis	Fax. 022 25726895 Email: hss@che.iitb.ac.in	-
S12	Dr. A.K. Suresh	Dr. A.K. Suresh Professor Deptt. Of Chemical Engg., IIT Bombay, Powai Mumabi Tel (O) 022 25767240 Tel.(R) 022 25764240/02225728729	Mass Transfer, Biochemical engg. Polymer Reaction Engg. & Catalysis	9833117240 Fax: 022 25726895 Email: aksuresh@iitb.ac.in	A8, IIT Bombay, Powai, Mumbai

SENATE NOMINEES (S1 –S20)

Department: Chemistry

A. SPECIALIZATION: ORGANIC CHEMSITRY					
SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Dr. Anil K. Singh Professor	Department of Chemistry Indian Institute of Technology Bombay Powai, Mumbai-400 076 Tel.(O) 022 25767167 Tel.(R) 022 25768167	Organic Chemistry	09769321589 FAX: 022 25767152 Email:retinal@chem.iitb.ac.in	Bungalow#A-4, Central Area IIT Campus Indian Institue of Technology Bombay Powai, Mumbai-400 076
S2	Dr. Y.D. Vankar Professor	Department of Chemistry, Indian Institute of Technology Kanpur , Kanpur-208 016 Tel(O) 0512 2597169 Tel(R) 0512 2598493	Organic Chemistry	09935062562 FAX:0512 2597436 Email: vankar@iitk.ac.in	House No. 410, Type IV, IIT Kanpur Campus IIT Kanpur-208 016
S3	Dr. A. Basak Professor	Department of Chemistry IIT, Kharagpur- 721 302	Organic Chemistry	09434013294 FAX: 03222 282252 Email: absk@chem.iitkgp.ernet.in	A22 IIT Kharagpur 721 302

S4	Dr. A. Srikrishna	Department of Organic Chemistry Indian Institute of Science Bangalroe-560 012 Tel(O) 91 80 23942215 Tel(R) 91 80 23600550	Organic Chemistry	09449036550 FAX.91-23600683; 23600529 Email: ask@orgchem.iisc.ernet.in askiise@gmail.com	-
S5	Dr. S. Das	Dr. Suresh Das, Head Chemical Sciences and Technology Division, National Institute for Interdisciplinary Science and Technology, Trivandrum-695 019, Kerala Tel(O) 0471 2515318 Tel(R) 0471 2544309	Photochemistry and Photo physics	09249741021 FAX 91 471 2490186 Email: sureshdas55@gmail.com	Dr. Suresh Das Aishwarya, VR 19 Mannanthala Trivandrum 695015, Kerala
S6	Dr. A.T. Khan	Department of Chemistry IIT Guwahati Guwahati 781 039 Assam Tel.(O) 0361 2582305 Tel (R) 0361 2584305	Organic Chemistry	09954189496 FAX: 0361 258249 Email: atk@iitg.ernet.in	Quarter No. : F-13 IITG Residential Campus Guwahati-781 039

B.	INORGANIC CHEMISTRY				
S7	Dr. H.B. Singh	Department of Chemistry , IIT Bombay Powai, Mumbai 400076 Tel.(O) 22 257671990 Tel (R) 22 257706770675	Inorganic Chemistry	09323840676 FAX: 22 25723480 Email:chhbsia@chem. iitb.ac.in	B-305, Blue Nile, Pacific Enclave, Near Hiranandani Hospital, Powai Mumbai 400076
S8	Dr. T. Pal	Department of Chemistry IIT, Kharagpur Kharagpur-721 302 Tel(O) 03222 283320 Tel(R) 03222 283321	Inorganic Chemistry	09434342349 FAX: 03222 292252 Email:tpal@chem.iitkgp.ernet.in	B-180, IIT, KGP Campus IIT, Kharagpur Kharagpur-721302
S9	Dr. C.P. Rao	Deptt. Of Chemistry Indian Institute of Technology Bombay Powai, Mumbai-400 076 Tel(O) 022 25767162 Tel(R) 022 25768162	Inorganic & Coordination Chemistry & Inorganic Chemistry at the Interface of Biology	09969022554 FAX: 022 25723480 Email:cprao@iitb.ac.in & cprao@chem.iitb.ac.in	B-144, Cenral Area, IIT Campus Powai Mumbai-400 076

S10	Dr. V. Chandrasekhar	Deptt. Of Chemistry Indian Institute of Technology Kanpur Kanpur-208 106 Tel(O) 0512 2597259 Tel (R) 0512 2598549	Inorganic Chemistry	941513221 FAX : 0512 259 7436	House No. 647 IIT Kanpur Kanpur 208106
S11	Dr. S. Sarkar	Chemistry Department IIT Kanpur Kanpur 208016 Tel(O) 259 7265 Tel(R) 259 8623, 259 1211	Inorganic, Analytical,Nano-Bio-Chemistry Sectroscopy, DFT	98399062156 FAX: 2597265/259-7436 Email:abya@iitk.ac.in protozyme@gmail.com	656 IIT, Campus Kanpur 208 016
C.	**PHYSICAL CHEMISTRY**				
S12	Dr. A.Q. Contractor	Department of Chemistry , IIT Bombay, Powai, Mumbai400076 Tel)O) 022 25767170 Tel(R) 022 25701659	Physical Chemistry	9819807691 FAX: 022 25767152 Email: aqcontractor@iitb.ac.in	D302, Powai Park, High St., Miranandani Gradens, Powai, Mumbai 400076
S13	Dr. P.K. Chattaraj Professor	Department of Chemistry Indian Institute of Technology Kharagpur 721 302 Tel(O) 03222 283304 Tel(R) 03222 283305 03222 278156	Physical and Theoretical Chemistry	FAX: 03222 255303 Email: pkc@che.iitkgp.ernet.in	B-212, IIT Campus, Kharagpur-721 302

S14	Dr. M.K. Mishra Professor	Chemistry Department IIT Bombay Powai Mumbai-400 076 Tel(O) 022 2576 7158 Tel(R) 022 2577- 0871	Physical/ Theoretical Chemistry	09876678960 FAX: 022 2576-7152 Email: mmishra@iitb.ac.in	A-604 Blue Nile, Near Hiranandani Hospital Powai, Mumbai-400 076
S15	Dr. P.K. Das	Department of Inorganic and Physical Chemistry Indian Institute of Science Bangalore- 560 012 Tel(O) 80 22932662 Tel(R) 80 23602223	Physical Chemistry	09480258065 FAX: 80 23601552 Email: pkds@ipc.iisc.ernet.in	E-16, New Housing Colony Indian Institute of Science Campus Bangalore 560012
S16	Dr. S Vasudevan	Deptt. Of Inorganic &Physical Chemistry , Indian Institute of Science, Bangalore 560 012 Tel(O) 080 22932661 Tel(R) 080 23601484	Physical Chemistry, Materials, Heterogeneous Catalysis	09448094448 0944805444 Email:svipc@ipc.iisc.ernet.in	NE-21, Housing Colony Indian Institute of Science, Bangalore-560 012
D.	**ANALYTICAL CHEMISTRY**				
S17	Dr. A. Datta	Analytical Sciences Division & Catalytic Conversion Processes Division, Indian Institute of Petroleum Dehradun- 248 005 Tel(O) 0135 2660263 Tel(R) 0135 2660119	Analytical Chemistry	09897228241 FAX; 0135 2660263 Email: adatta@iip.res.in a_datta50@yahoo.co.in	C-1 IIP Colony Mohkampur Dehradun 248 005

S18	Dr. A.K. Singh	Department of Chemistry IIT Delhi, Hauz Khas , New Delhi 110 016 Tel(O) 011 26591379 Tel(R) 0129 4134344	Analytical Chemistry	9810408226 Email: aksingh@chemsitry.iitd.ac.in	-
S19	Dr. S.K. Aggarwal	Homi Bhabha National Institute Head, Fuel Chemsitry Section Bhabha Atomic Research Centre Trombay, Mumbai 400 084 Tel(O) 022 25593740 Tel(R) 022 255655694	Analytical Chemistry	09892578865	1106, Neelkanth Gardens Govandi (E) Mumbai-400 088
S20	Dr. B.K. Sahu Vice Chancellor's	Vice Chancellor's office Berhampur University Berhampur-760007 (Orissa) Tel.(O) 0680 2242233	Analytical Chemistry	Tel.(O) 0680-2242233 Tel.(R) 0680-2243460 Fax: 0680-2243322 E-mail: bijoy_sahu@yahoo.com	Vice Chancellor's residence Berhampur University Berhampur-760 007 (Orissa)

SENATE NOMINEES (S1 – S18)

Department: Civil Engineering

(A) Specialization: Geotechnical					
SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Dr. D.M. Dewaikar	Department of Civil Engineering, IIT Bombay, Powai, Mumbai-400076 Tel.(O) 022-25767325 Tel.(R) 022-25768325	Geotechnical Engg.	09820055838 Fax: 022-25767302 E-mail: dmde@civil.iitb.ac.in	
S2	Dr. P.K. Basudhar	Department of Civil Engineering IIT Kanpur, Kanpur-208016 Tel.(O) 0512-2597029 Tel.(R) 0512-2598744	Geotechnical Engg.	Fax: 0512-2597395 E-mail: pkbd@iitk.ac.in	
S3	Dr.K.S. Subba Rao	Chairman, Project Management Group, TIFR Building, Indian Institute of Science, Bangalore-560012 Tel.(O)080-2293 2904, 2293 2061 Tel.(R)080-2667 7494, 2660 2763	Geotechnical Engg.	09448277494 E-mail: kssubbarao7@gmail.com	No. 4, National High School Road, Visweswarapuram, Bangalore 560004

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(B) Specialization: Geomatics					
S4	Prof. S.K. Govil (Retd. Professor)	Retired From Indian Institute of Remote Sensing 4, Kalidas Road Dehradun Tel.(O) Tel.(R)	Surveying, Photogrammetry, Remote Sensing	09358889306 Fax: 0135-2741987	Triveni Vihar, Deola Kalan, P.O. Mahobewala, Dehradun
S5	Maj Gen (Dr.) R Siva Kumar	CEO NSDI & Director, NRDMS Ministry of Science & Technology Technology Bhawan New Mehraulli Road New Delhi-1100016 Tel.(O)011-26519530 26590308 Tel.(R)	Surveying, Photog. Mapping, Remote Sensing, GIS	09968291882 Fax: 011-26519530 E-mail: siva_k@nic.in	
S6	Dr. S.M. Ramaswamy	Centre of Remote Sensing Bhartidasan University Khajamalai Campus Tiruchirappalli-620023 Tel.(O) 0431-2331667 2420667 Tel.(R) 0431-2459662	Remote Sensing, GIS	09443352543 Fax: 0431-2422902 E-mail: smrsamy@gmail.com smrbard@hotmail.com	

(C) Specialization: Hydraulic Engineering					
S7	Prof. P.P. Mujumdar	Department of Civil Engineering , Indian Institute of Science, Bangalore 560012 Tel.(O)080-2293 2323 2293 2669 Tel.(R)080-2360	Hydrology and water Resources	09845215612 Fax: 080- 2360 0404 E-mail: pradeep@civil.iisc.ernet.in	E-32, Indian Institute of Science Campus, Bangalore 560012
S8	A.K.Gosain	Department of Civil Engineering ,IIT Delhi, Hauz Khas, New Delhi 110016 Tel.(O)011-26591186 Tel.(R)011-26851889	Hydrology and water Resources Engineering	09810944776 Fax: 011-26581117 E-mail: gosain@civil.iitd.ac.in	61, New Campus, IIT Delhi, Hauz Khas, New Delhi- 110016
S9	Prof. Bidya Sagar Pani	Civil Engineering Department , University of Hong Kong, Pokfulam Road, Hong Kong Tel.(O) (852) 28592649 Tel.(R) 022-25720339	Fluid Mechanics	09820120057 E-mail: bspani@civil.iitb.ac.in Bidyasagar.pani@gmail.com	B-118, White House, P.O. IIT Powai, Mumbai-400076
(D) Specialization: Structural Engineering					
S10	Dr. V. Kalyanaraman	STR 205 IIT Madras, Chennai-600036 Tel.(O) +91 -44-2257 4256 Tel.(R)	Structural Engineering	E-mail: kalian@iitm.ac.in	

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S11	Prof. Ashwini Kumar	Professor of Civil Engineering IIT Kanpur Kanpur 208016 Tel.(O) (91-512) 2597756 Tel.(R) (91-512) 2598366	Structural Engg.	E-mail: asdwini@iitk.ac.in	
S12	Prof. J.N Bandopadhyay	Professor Deptt. of Civil Engineering IIT Kanpur Tel.(O) 0322-283404 Tel.(R)03222-283405	Structural Engineering	E-mail: jnb@civil.iitkgp.ernet.in	B-165, IIT Campus, Kharagpur 721302
(E) Specialization: Transportation Engineering					
S13	Dr. S. Gangopadhyay	Central Road Research Institute Delhi, Mathura Road , P.O. CRRI, New Delhi- 110 020 Tel (O)+91-1126310399 Tel (R)+91-11-26914178	Urban Transport Planning, Traffic Safety	E-mail: spg.crri@nic.in	
S14	Dr. A. Veeraragavan	Transportation Engg. Division Deptt. Of Civil Engineering IIT Madras Chennai-600 036 Tel.(O) +91-44-22575272 Tel (R) +91-44-22579313	Highway Materials, Pavement Design, Rural Road Planning, Pavement Management System	09444742710 Fax: +91-44-22570509 E-Mail: av@iitm.ac.in, aveeraragavan@rediffmail.com	

S15	Dr. B.R Marwah (Executive Director)	N. C. College Of Engg. Israna Panipat- 132 107 Tel (O)+91-180-2579674 180-2579678 Tel (R) +91-180-2571756	Transportation Network, Optimization Transport System Analysis, Genetic Algorithm	09896410123 Fax: +91-180-2579678 E-mail: info@ncce.edu	
(F) Specialization: Environmental Engg.					
S16	Dr. Khare Mukesh	Professor Deptt. Of Civil Engg., IIT Delhi, Hauz Khas, New Delhi-110016 Tel (O) 91-11-26591212 Tel (R) 91-11-26859284	Air & Vehicular Pollution Modeling, Indoor Air Pollution	Fax: 91-01126582037 E-mail: mukeshk@civil.iitd.ac.in	
S17	Dr. S. Mohan	Professor, Department Of Civil Engg., Indian Institute Of Technology, Madras, CHENNAI-600 036, India. Tel (O)91-(44)-22574261 Tel (R)91-(44)-22576261	Water Quality Modeling, Water Resources Management, Groundwater Assessment And Management	Fax: 91-044-22574252/91-044-22570509 E-mail: smohan@iitm.ac.in, Smohan1959@gmail.com	
S18	Dr. (Mrs) Rashmi S. Patil	Professor, Center for Environmental Science And Engg., IIT Bombay, Powai, Mumbai-400076 Tel (O)91- 22-25767851 Tel (R) 91-22-25764650	Air Pollution, Aerosol Science	Fax: 91-22-25764650 E-mail: rspatil@iitb.ac.in	

SENATE NOMINEES (S1 S5)

Department: Paper Technology Saharanpur Campus

SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Prof. Ranjan Kumar Malik Professor	Department of Chemical Engg., IIT Bombay Tel(O) 022 2576/7796/ 70107011 Tel(R) 022 25834606	Chemical Engineering	09820782138 Fax: 022 25726895, 25764060 Email: rkmalik@iitb.ac.in	B-0201, Ascona Building, Raheja Gardens, Thane (West) Mumbai-400604
S2	Prof. Anil Kumar Professor	Department of Chemical Engg., IIT Kanpur,Kanpur Tel(O) 0512 297195 Tel(R) 0512 2597811	Chemical Engineering	Fax: 0512 2597195 Email: anilk@iitk.ac.in	649, IIT Kanpur , Kanpur
S3	Prof. B.L. Deopura Professor	Head, Room No. TX 211 Department of Textile Technology, IIT Huaz Khas, New Delhi 110 016 Tel(O) 011 26591408 Tel(R) 011 26591938	Polymer Science & Technology	9818054192 Fax: 011 26581103 Email: bdeopura@yahoo.com	30 West Avenue, IIT Delhi Campus, New Delhi
S4	Prof. K.D.P. Nigam Professor	Department of Chemical Engineering, IIT New Delhi Tel(O) 011 26591020 Tel(R) 011 26853748	Chemical Engineering	09810641255 Fax: 011 26501020 Email: nigamkdp@gmail.com	69, New Campus, Hauz Khas , New Delhi-110 016

S5	Mrs. Veena Choudhary Professor	Centre for Polymer Science & Engg. (CPSE), IIT Delhi, Hauz Khas, New Delhi 110 016 Tel(O) 011 265914423 Tel(R) 011 26591972	Polymer Science and Engineering	09810028839 Fax: 011 26591421 Email: veenach@hotmail.com	27-Taxila Appartment, IIT Delhi Hauz Khas, New Delhi 110 016

SENATE NOMINEES (S1-15)

Department: Earth Sciences

Structural Geology/Tectonics/Geochemistry/Petrology/Paleontology/Stratigraphy/ Sedimentology/Geohydrology					
SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Dr. Hari B. Srivastava	Department of Geology BHU Varansi -221 005 Tel.(O) 0542 6701825 Tel(R) 2575311	Structural Geology and tectonics	09415353606 Email: :hbsrivastava@gmail.com	-
S2	Dr. R.S. Shrama,F.N.A.	Dr. R.S. Sharma Professor (Retd.) Geology Department Rajasthan University Jaipur -302 004 Tel. (O) 041 2711572 Tel(R) 041 2791317	Petrology (Metamorphic) Geochemistry	09414888025 Fax 041 2702792 E-Mail r.sw@gmail.com.	7-/36 Sector 7 pratapnagar Sanganer Jaipur 303906
S3	Prof. Mallickarjun Joshi	Prof. Mallickarjun Joshi, Professor, Department of Geology Banaras Hindu University VAranasi 221 005 Tel.(O) 0542 2369239 2307310 2307311	Petrology (Metamorphic), Structural Geology	09336911770 Fax: 0542 2368130 Email:Josjimallickarjun@gmail.com	P-13, New Medical Enclave B.H.U. Varanasi-221 005

S4	Dr. C. Srikantappa	Dr. C. Srikantappa , Professor Department of Geology Mysore University Manasgangotri Mysore-570006 Tel. (O) 0821 2510964 Tel. (R) 0821 2419724	Metamorphic petrology ,fluid inclusions and mineralization	09448247444 E-Mail: srikantappa@googlemail.com	-
S5	Dr. A.K. Jauhri	Dr. A.K. Jauhri Professor Department of Geology , University of Lucknow Lucknow-226007 Tel.(O) 0522 2740015 Tel (R) 0522 263748	Geology: Micropaleontology	09415111071 Fax: 0522-2470037 Email:akakjauhri@yahoo.com jauhri@rediffmail.com	1, Lokmanganj, Charbagh Lucknow-226 004
S6	Dr. A.K. Singhvi	Dr. A.K. Singhvi, Department of Geology, University of Lucknow, Lucknow-226 007 Tel.(O) 079-26314366 Tel. (R) 07926855831	Quaternary Climate, Geochronology	09909950962 Fax: 079-26301502 E-mail: singhvi@prl.res.in	B-31, Shakti Enclave Near Judges Bunglows Satya Marg Bodakdev Ahmedabad-380054

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Economic Geology/Mineral Exploration Engg. Geology/Geohydrology/Environmental Geosciences/Petroleum Geology/Remote Sensing/GIS/Coal Geology					
S7	Dr. H.S. Pandalai	Dr. H.S. Pandalai Deptt. Of Earth Sciences IIT Bombay Mumbai Tel.(O) 022 25767265	Geochemistry, Ore Geology, Geostatistics, Mineral Exploration	09820988245	B-45, Lake Side IIT Bombay Campus Powai, Mumbai
S8	Dr. Nirmalya Ghosh	Dr. Nirmalya Ghosh Retired as Addl. Director from CWPRS, Pune Tel.(R) 020 25690657	Exploration Geophysics (Engineering Geophysics & Engineering Geology)	09764004538 E-Mail: Nirmalya1949@yahoo.com	Flat No. 401, A Building, Royal Residency, 48 Aundh Road Pune-411 020 Maharashtra
S9	Dr. D. Chandrasekaram	Dr. Chandrasekaram, Professor, Department of Earth Sciences Indian Institute of technology Bombay, Mumbai-400 076 Tel. (O) 022 25767263 Tel(R) 022 25768263	Hydrogeochemistry Geothermics Deccan Volcanics	E-Mail:dchandra@iitb.ac.in	-
S10	Sri R.K. Sharma	Sri R.K. Sharma General Manager (Reservoir) Instt. Of Reservoir Studies Oil & Natural Gas Corporation LTd. Chandkheda, Ahmedabad Tel(O) 079 23295648 Tel.(R) 079-27570640	Petroleum Geo-Sciences	9426614815 Fax: 079-23294033 E-Mail: Sharma_rkl@yahoo.co.in rakesh_ongc@yahoo.co.in	F/401, Sangath Silver Behind, D-Mart, Gandhinagar Highwaty Motera Area Ahmedabad -380 005

S11	Dr. R.R. Navalgund	Dr. R.R. Navalgund Space Application Centre P.O. SAC Ahmedabad - 380 015 Tel(O) 079 26913344 Tel (R) 079-26764956	Remote Sensing –GIS	Fax: 079-26915843 E-Mail: director@sac.isro.gov.in	-
Exploration Geophysics/Signal Processing/Theoretical Geophysics/Solid Earth Geophysics Inversion/Seismology/Seismotectonics					
S12	Dr. Sankar K. Nath	Dr. Sankar K. Nath, Professor, Department of Geology & Geophysics IIT Kharagpur Kharagpur-721 302 Tel(O) 0322 2283374/2220042 Tel (R) 0322 2283375/2277757	Seismology, Seismic Exploration, Inversion Sesmotectonics, Electrical	09434005953 Fax: 0322-2220042 E-Mail: nath@gg.iitkgp.ernet.in	Flat No. B-215, Block A IIT Campus, Kharagpur-721 302
S13	Prof. N.L. Mohan	Prof. N.L. Mohan Professor, Department of Geophysics Osmania University Hyderabad-500007	Exploration Geophysics, Signal Modelling	-	P-1, Professors Quarter, Osmania University Campus, Tarnaka, Hyderabad-500007
S14	Dr. O.P. Pandey	Dr. O.P. Pandey, Scientist 'G' NGRI Uppal Road, Hyderabad-500 007 Tel(O) 040 23434618 Tel(R) 040 23434811	Exploration Geophysics, Solid Earth Geophysics	Fax. 040 27171564 E-Mail: oppandey@ngri.res.in	H.No. 1-49/3/37(Plot No. 37) Surya Nagar Colony Uppal Road Hyderabad 500 039

S15	Dr. R.K. Tiwari	Dr. R.K. Tiwari, NGRI Uppal Road Hyderabad - 500 007 Tel. (O) 040 23434648 Tel(R) 040-23434831	Fax. 040 27171564 E-Mail: rktiwari@ngri.res.in	H.No. 1-49/22/B Surya Nagar Colony Uppal Road, Hyderabad-500 039	

S4	Dr. Meher Prasad A.	Professor, Deptt. Of Civil Engg. IIT Chennai Tel. (O) 44 22574260 Tel.(R) 044 26261205	Structural Engineering	09444017194 Fax: 044 22575286 Email: prasadam@iitm.ac.in	STR 210 IIT Madras, Chennai-600 036
S5	Dr. Alok Goyal	Department of Civil Engg. Indian Institute of Technology Powai, MUMBAI-400 076 Tel. (O) 022 25767342, 25722545 Tel (R) 022 25768342	Structural Dynamics and Earthquake Engineering Condition Monitoring of Bridges using Vibration Signature Analysis Blast-Resistant Design of Structures, Bridges and Tall Buildings	982022654 Fax: 022 25723480, 25767302 E-mail: agoyal@civil.iitb.ac.in	B-125 Bldg. No. 21 IIT Campus Powai Bombay-400076
S5	Dr.Vinay Kumar Gupta	Professor, Civil Engineering IIT Kanpur IIT Kanpur 208 016 Tel. (O) 512 597118 Tel. ® 512-591828,598425	Earthquake Engineering & Structural Dynamics	Fax: 512597395, 590260 Email: vinayakg@iitk.ac.in vinaykg@iitk.ernet.in	House No. 432 IIT Kanpur-208016

S7	Dr. C.V.R. Murty	Professor Deptt. of Civil Engg. and Co-Chair, IIT Hyderabad Task Force, Indian Institute of Technology Hyderabad Yeddumailaram-502205 (A.P.) Tel. (O) 040 2301 6040 Tel ® 040 2301 6000	Civil Engineering Structural Engineering Earthquake Engineering	94907 93470 Fax : 040 2301 6003 Email: cvrm@iith.ac.in	5033 Ordance Factor Estate Indian Institute of Technology Hyderabad Yeddumailaram 502205 (A.P.)
B. SOIL DYNAMICS					
S8	Prof. S.P. Dasgupta	Professor Deptt. Of Civil Engineering IIT Kharagpur, Kharagapur West Bengal-721 302 Tel. (O) 03222 283414 Tel. (R) 03222 283415	Soil-Structure Interaction	09434018212 Fax 03222 282253 Email: dasgupta @civil.iitkgp.ernet.in	A-8; IIT Campus IIT Kharagpur West Bengal 721 302
S9	Prof. K. Rajagopal	Prof. & Head Deptt. Of Civil Enginering IIT Madars, Chennai Tamil Nadu-600 036 Tel. (O) 044 22574263/4250 Tel. (R) 044 22576263	Soil-Structure Interaction	09444008280 Fax 044 2257-4252 Email: gopalkr@iitm.ac.in	CI-4-3 First Loop Road IIT Madras Chennai-600036

B. Instrumentation					
S10	Prof. V. K. Jain	Deptt. Of Electrical Engg. Indian Isntitute of Technology Delhi Hauz Khas New Delhi Tel. (O) 011-2591079 Tel. (R) 011-26581896	Instrumentation	- Fax -11-26581606 011 26581264 Email: vkjain@ee.iit.ac.in	-
S11	Prof. G.J. Nair	Head Seismology Division BARC Trombay Mumbai Tel. (O) 022 255505420 022 25594587 Tel. (R) 022 27892057	Seismology & Instrumentation	0981919112736 Email: ginair08@gmail.com ginair@barc.gov.in	-
S12	Mr. Vinayak G Kilvankar	Computer Division Bhabha Atomic Research Centre Trombay Mumbai-400851 Tel. (O) 022 25593942 Tel. (R) 02220592070	Seismic Instrumentation	09869131007 Email: vgk@barck.gov.in vkolvankar@yahoo.com.	5/28 Aradhana, New MIG Colony Behind PF Office, Bandra (E) Mumbai-400 051

C. Engineering Seismology & Seism tectonics					
S13	Dr. Sankar Kumar Nath	Department of Geology and Geophysics, Indian Institue of Technology Kharagpur 721302, West Bengal Tel. (O) 03222 283374/220042 Tel. (R) 03222 283375/277757	• Earthquake Seismology • Engineering seismology • Seismic Hazard Assessment • Seismic Microzonation • Seismic Prospecting • Geophysical Signal Processing • Geophysical Tomography • Computational Geophysics	09434005953 Fax: 03222-220042/282268/255303 Email: nath@gg.iitkgp.ernet.in	Flat No. #B-215, Block A, IIT Campus P.O. Kharagpur Tech-721302 Dist . Midnapore, West Bengal
S14	Dr. S.S. Rai	Professor Indian Institute of Science Education & Resarch – Kolkata Mohanpur Campus PO: BCKV Campus Main Office Mohanpur-741252 NADIA Dist West Bengal Tel.(R) 040 2344815	Geophysical Exploration Seismology, Geophysical data modeling	09433690672 Fax: 03473-279131 Email: shyamsrai@gmail.com	Qtr No. A/5 NITTR Housing Complex Sector-V, DN Block Salt Lake Kolkata-91 (when in Kolkata) Or Qrt. VI/I NGRI Staff Quarter Habsiguda, Uppal Road Hyderbad -500 007 (AP) (when in Hyderabad)

S3	Dr. Avinash Joshi Professor	Department of Electrical Engineering Indian Institute of Technology Knapur, Kanpur-208 016, India Tel(O) 91 512 2597801 Tel (R) 91 512 2598342	Power Electronics and Drives	Fax: 91 512 2590063 Email: ajoshi@iitk.ac.in	House No. 3057, IIT Campus, Kanpur 208016
S4	Dr. Ranganathan V. T. Professor	Department of Electrical Engineering Indian Institute of Science, Bangalroe 560 012 Tel(O) 080 2293 2929 Tel(R) 080 2341 6540	Power Electronics, Industrial Drives	09980039828 Fax 080 2360 0444 Email: vtran@ee.iisc.ernet.in	Shubha Shree Niyalam No 41 1st A-Main , (Opp. Varun Apts) R.M.V, 2nd Stge Bangalore 560 094
S5	Dr. Kalra Prem Kumar Professor	Department of Electrical Engg. Indian Institute of Technology Kanpur, Kanpur-208 016 Tel(O) 91 512 2597032 Tel(R) 91 512 2598785	Power Systems, Expert Systems HVDC Transmission, Deregulated Power System, Educational Paradigms, Data Mining, Fuzzy Logic System, Neural Networks, Computational Neuroscience mage Processing	09415042487 Fax: 91 512 2590063 Email: kalra@iitk.ac.in	House No- IIT Campus Kanpur -208 016

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B.	Power System Engg. Including High Voltage Engg.				
S6	Prof. D. Thukaram Professor	Deptt. Of Electrical Engg. Indian Institute of Science, Bangalore-560 012 TelO) 91 (0) 80 22932362 Tel(R) 19 (0) 80 23600336	Artificial Intelligence (AI) techniques in Power Systems, Energy Management System (EMS) Reactive Power Control, Voltage Stabiligy De-regulated Power Systems Distribution Automation	09448383392 Fax 91 (0) 80 23600444 Email: dtram@ee.iisc.ernet.in Dtram200@yahoo.com	Qrt. NO. NE-102 New Housing Colony IISc Campus , Bangalore 560 012
S7	Prof. Padiyar K R Emeritus Professor	Deptt. Of Electrical Engg. India Institute of Science Bangalore -560012 India Tel(O) 91 (O) 802293 2694 Tel (R) (080) 23671924	FACTS Controller, HVDC Transmission Power System Dynamics & Control	09341378331 Fax 91 (0) 80 2360 0444 Email: krpyar@eeiisc.ernet.in, krpyar@gmail.co,	306, Shashikiran Apartment, 18th Cross Road Malleswaram Bangalore 560 055
S8	Prof. Lawrence Jenkins Professor	Deptt. Of Electrical Engineering, Indian Institute of Science Bangalore0560012 Tel(O) 91 (0) 80 2293 Tel(R) (0) 802221 9683	Power System Analysis, Real Time Systems, Fault Tolerant Architecture	09900600376 Fax 91 (0) 80 23600444 Email: lawrn@ee.iisc.ernet.in	C-13 Manish Complex, Convert Road, Bangalore 560 025

S9	Prof. Avinash Kumar Sinha Professor	Head of the Department Electrical Engg. IIT, Kharagpur-721302 Tel (O) 91 3222 283088 Tel(R) 92 3222 283089 91 3222 277771	Control Systems Neural Networks Power System Deregulation Power System Simulation Power Systems	9434020350 Fax: 03222 282262/283088 Email: aksinha@ee.iitkgp.ernet.in	A-49, IIT Campus, Kharagpur-721 302
S10	Prof. Nagendra Rao P.S. Professor	Deptt. Of Electrical Engg. Indina Institute of Sciences Bangalore-560012 Tel(O) 91 o 80 22932365 Tel ® 91 0 8023490951	Power Systems: Analysis , Design and Operation Parallel Computing	Fax: 91 (0) 80 23600444 Email: nagendra @ee.iisc.ernet.in	119, VHBCS Layout Mahalakshmi Puram Bangalore-560086
C. System Engineering and Operation Research Including Robotics Centre					
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S14	Dr. Kalra Prem Kumar Professor	Department of Electrical Engg. Indain Institue of Technology Kanpur, Kanpur-208-016 Tel(O) 91 512 2597032 Tel (R) 91 512 2598785	Power Systems, Expert Systems, HVDC Transmission, Deregulated Power System, Educational Paradigms, Data Mining, Fuzzy Logic System, Neural Networks, Computational Neuroscience Image Processing	09415042487 Fax: 91 512 2590063 Email: kalra@iitk.ac.in	House No.- IIT Campus Kanpur 208 016
S15	Dr. R.K. Patny Professor & Head	Electrical Engg. Deptt. Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110 016 Tel(O) 011 26581069 Tel(R) 011 26591884	DSP	9868156373 Fax: 011 26581606 Email: rkpatney @ee.iitd.ac.in	4 West Avenue, IIT Delhi , Hauz Khas New Delhi 110016
D. Measurement and Instrumentation Including Biomedical Engg.					
S16	Dr. Jagadeesh Kumar V. Professor	ESB 210 Department of Electrical Engg. IIT Madras Chennai-600036 Tel(O) 044 2257 4401 Tel (R) 044 2257 4406	Sensor, Instrumentation Signal Processing	944408360 Fax: 04422574402 Email: vjk[AT]iitm.ac.in; vjkumar[AT] ee.iitm.ac.in	C2-2-10 , Third Loop Road IIT Madras Chennai 600036

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S19	Dr. G.K. Prabhu Professor	Professor Department of Biomedical Engineering Manipal Institute of Technology Manipal University Manipal 576 104 Tel(O) 0820 2922323 Tel(R) 0820 2574014	Biomedical Instrumentation	9845216840 Fax: 0820 2570062 Email: gk.prabhu@manipal.edu	"Kasturi" No. 5 -297-A5, Anantha Kalyana Nagar, Manipal-576 104

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D. English					
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S20	Dr. S.C. Choudhary Professor	Dr. S.C. Choudhary Professor & Former Head Humanities Deptt. IIT Madras, Chennai – 600036 Tel.(O) 044-22574503 Tel.(R) 044-22435463	English Language Teaching Communication, Linguistics	09444028434 Fax: 044-22570509 E-mail: scc@iitm.ac.in	17, Thiruvalluvar Salai, Taramani, Chennai – 600113

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S29	Dr. Vibha Chaturvedi Professor	Dr. Vibha Chaturvedi Professor & Former Head Deptt. of Philosophy Faculty of Arts, Delhi University, Delhi – 110007 Tel.(O) 01127666629 Tel.(R)	Western Philosophy, Philosophy of Religion, Pluralism, Classical Indian Philosophy	Mob.: Fax: 011-27666350 E-mail: chaturvedivibha@yahoo.com	
S30	Dr. Roop Rekha Verma Professor	Dr. Roop Rekha Verma Professor & Former V.C. Tel.(O) Tel.(R) 05222374202	Philosophy of Gender, Western and Indian Philosophy	9335905337 Fax: E-mail: rooprekha@eth.net	M-1/14, Aliganj Housing Scheme, Sector B, Lucknow – 226024

SENATE NOMINEES(S1 – S9)

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S2	Prof. S.A. Abbassi	Prof. S.A. Abbassi Senior Professor Coordinator Center for Pollution Control & Energy Technology Pondicherry University, Kalapet, Pandicherry - 605014 Tel (O) 04132654497 04132655262 Tel. (R) 04132655262	Surface Water (Environmental)	09443265262 Fax: E-mail: prof.s.a.abbasi@gmail.com	

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D. HR					
S13	Prof. Anu Singh Lather	Prof. Anu Singh Lather Professor & Dean University School of Management Studies, GGS Indraprastha University, Kashmere Gate, Delhi – 110403 Tel.(O) 01123900253 Tel.(R) 01203200270	HR	09871433504 Fax: 011-23900111 E-mail: anusinghlather@yahoo.com anusinghlather@gmail.com	
S14	Prof. H.C. Chaudhary	Prof. H.C. Chaudhary Professor of Management Faculty of Management Studies Banaras Hindu University, Varanasi Tel.(O) 05422369332 Tel.(R) 05422222518	HR/Marketing	09415618946 Fax: 0542-2369332 0542-2307430 E-mail: fmsbhu@sify.com	
E. General Management					
S15	Prof. T.T. Narendran	Prof. T.T. Narendran Professor Indian Institute of Technology Madras, I.I.T. Post Office Chennai – 600 036 Tel.(O) 04422574557 04422574550 Tel.(R)	General Management/ HR	Mob.: Fax: 044 2257 4552 E-mail: ttn@iitm.ac.in	HSB 332B IIT Madras, Chennai – 600 036

F. Marketing					
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S17	Prof. G.P. Sharma	Prof. G.P. Sharma Professor Indian Institute of Foreign Trade, IIFT Bhawan, Qutab Institutional Area, Delhi, Delhi – 110016 Tel.(O) 01126966563 01126965124 01126965051 Tel.(R)	Marketing	Mob.: Fax: 011-26853956 E-mail: gpsharma@iift.ac.in	
S18	Prof. Vijay Kapur	Prof. Vijay Kapur Professor Faculty of Management Studies, University of Delhi, Delhi PIN: 110007 Tel.(O) 01127666382 01127666388 Tel.(R)	Marketing & Strategic Management	Mob.: Fax: 011-27667002 E-mail: vijaykapur@fms.edu	

S19	Prof. Ashok P. Arora	Prof. Ashok P. Arora Professor Management Development Institute Mehrauli Road Sukhrali, Gurgaon – 122 007 Tel.(O) 01242349831 01242349836 4013050 4013059 Tel.(R)	Marketing	Mob.: Fax: 0124-2341189 E-mail: aparora@mdi.ac.in	

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Department: Mathematics

SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
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A. Fluid Mechanics					
S1	Dr. S.K. Dube Professor & Head	Centre for Atmospherice Sciences IIT Delhi , Delhi Tel(O) 3222-255221 Tel(R)11-26591308	Fluid Mechanics, Mathematical Modeling, Atmospheric Science, Meteorology & Oceanography	9871119384 Fax: 3222-255303, 011-26591386 Email: skdube@cas.iitd.ac.in	-
S2	Dr. V.D. Sharma Professor	Department of Mathematics, IIT Bombay Powai, Mumbai 400 076 India Tel(O) 022 25767482 Tel® 022 2576 8482. 25720076	Applied Maths, Partial Differential Equations, Nonlinear Waves, Fluid Mechanics	Fax: 022-25783480 Email: vsharma@math.iitb.ac.in	C-CSRE-149 Hill Side Area, IIT Bombay, Powai, Mumbai-400 076, India
B. Solid Mechanics					
S3	Dr. A.K. Joshi Professor	Department of Aeronautical Engineering, IIT Bombay , Powai, Mumbai-400 076 Tel(O) 022 25767113, 25767840, 25767001	Control System and Solid Mechanics	Fax: 25722602;25729511 Email:ashok@aero.iitb.ac.in	-

C. Numerical Analysis					
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D. Computer Application					
S5	Dr. P.K. Suri Professor	Department of Computer Science & Applications, Kurukshetra University, Kurukshetra Tel(O) 01744 239595	Applied Mathematics, Mathematical Modelling	Email: pksuriiff25@rediffmail.com	F-2, University Campus, Kurukshetra -132 119 (Haryana)
E. Operation Research					
S6	Dr. C. Mohan Professor	Ambala Colelge of Engineering And Applied Research , Saha Ambala Cantt, Haryana Tel(R) 0171-2822719	Operation Research Fuzzy Sets	09315113268 Email: chander_mohan2@rediffmail.com	C/OMr. R.K. Garg 42 B, Inder Puri, Ambala Cant, Haryana

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S7	Ms. Manu Lata Agarwal Professor	Department of Operational Research, Faculty of Mathematical Science, New Academic Block, Unviersity of Delhi Delhi-110 007 Tel(O) 011 27666672 011 27666041 Tel(R) 011 26108849	OR, Stochastic Models in Reliability and Queuing Theory, Transient and Numerical solutions of queuing Models, Queuing Networks etc.	9811868367 Fax: 011 27666672 Email: agarwala_manjulata@ yahoo.com	-
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F. Relativity and Astrophysics					
S9	Dr. Akhil Ranjan Roy Professor	Head, Department of Mathematics IIT Kharagpur Kharagpur-721 302 Tel(O) 3222 283670 Tel(R) 3222 283671	Relativistic/Cosmology, Relativistic, Fuzzy Optimization, chaos, Astro Physics	Email: arroy@maths.iitkgp.ernet.in	A-46, IIT Campus, Kharagpur-721 302

G.	**Complex Analysis**				
S10	Dr. G.P. Kapoor Professor	FB565, Department of Mathematics and Statistics Indian Institute of Technology Kanpur Kanpur 208 016 , India Tel(O) 512-2597609 Tel(R) 2598253	Pure Mathematics, Fractals, Complex Dynamics, Bifurcation And Chaos, Complex Analysis etc.	Fax: 512-2597500 Email: gp@iitk.ac.in	-
H.	**Approximation theory**				
S11	Dr. R.K.S. Rathore, Professor	FB-518, Department of Mathematics and Statistics IIT Kanpur 208016, U.P. Laboratory: FB-562, Department of Mathematics and Statistics Tel(O) 512-2597228 512-2597742	Approximation Theory, Numerical Analysis, Computer Aided Tomography, Magnetic Resonance/Spectroscopy	Email: rksr@iitk.ac.in	-
I.	**Real Analysis**				
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J.	Functional Analysis, Fourier Analysis				
S13	Dr. P.D. Srivatava Professor	Department of Mathematics Indian Institute of Technology , Kharagpur (W.B.) 721 302 (India) Tel(O) 3222-283678 Tel(R) 11 283679 11-277846	Functional Analysis & Complex Analysis	9434719549 Fax: 03222-282276/255303 Email:pds@n aths.iitkgp.ernet.in	A-66,IIT Campus , Kharagpur 721302
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B. Production/Industrial Engineering					
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C. Thermal Engineering					
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S20	Prof. J.P. Subramaniyam	Prof. J.P. Subramaniyam Professor Department of Mechanical Engineering, IIT Delhi, Hauz Khas, New Delhi – 110016 Tel.(O) 01126591055 Tel.(R)	Thermal Engineering	Mob.: Fax: 011-2659-2037 E-mail: jpsm@mech.iitd.ac.in	
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S22	Prof. M.S. Kalra	Prof. M.S. Kalra Professor Department of Mechanical Engineering, IIT Kanpur, Kanpur – 721302 Tel.(O) 05122597527 05122598269 Tel.(R) 05122594069	Thermal Engineering	Mob.: Fax: E-mail: msk@iitk.ac.in	

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S25	Prof. T. Sundarajan	Prof. T. Sundarajan Professor Thermodynamics & Combustion Engg. Laboratory Deptt. of Mechanical Engineering IIT Madras Chennai – 600036 Tel.(O) 04422574683 Tel.(R) 04422576683	Thermal Engineering	09444065565 Fax: 044-22574652 E-mail: tsundar@iitm.ac.in	TDCE 203, IIT Madras Chennai – 600036

S26	Prof. A. Ramesh	Prof. A. Ramesh Professor Department of Mechanical Engineering IIT Madras, Chennai – 600036 Tel.(O) 04422574676 Tel.(R) 04422576676	Thermal Engineering	Mob.: Fax: 044-22574652 E-mail: aramesh@iitm.ac.in	

SENATE NOMINEES (S1 - S20)

Department: Metallurgical & Materials Engineering

A. Industrial Metallurgy

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S2	Prof. S.D. Pathak	Prof. S.D. Pathak, Deptt. Of Met. & Mat. Engineering Indian Institue of Technology Madras Tel(O) 044 22574759	Industrial Metallurgy	Email: sdpa@iitm.ac.in	

S3	Prof. Subrata Chatterjee	Prof. S.D. Chatterjee Prof. & Head, Deptt. Of Met. & Mat. Engineering Bengal Engineering and Science Unviersity, Shibpur, Howraj-711 103 Tel.)O) 033 2668-4561 to 63 Tel(R) 033 2668 9861	Industrial Metallurgy	Email:schatterjee46@ yahoo.com	-
S4	Prof. B.P. Kashyap	Prof. B.P. Kashyap Professor Deptt. Of Met. & Mat. Engineering Indian Institute of Technology Bombay, Mumbai Tel(O) 022 25767622	Industrial Metallurgy	Email: bpk@iitb.ac.in	-
S5	Dr. A.K. Gupta	Dr. A.K. Gupta Director, Advanced Materials and Processes Research Institue, Hosangabad Road (near Habibgang Naka) Bhopal 462 064	Industrial Metallurgy	EMail: akg@csnpl.ren.nic.in director@ampri.res.in	-

B. Physical Metallurgy and Corrosion

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S7	Prof. S.N. Ojha	Prof. S.N. Ojha Deptt. Of Metallurgical Engineering Institue of Technology, B.H.U., Varanasi-221 005 Tel (O) 7081-233	Physical Metallurgy and Corrosion	09838507888 Email:ojha_bh..@yahoo.co.in	-
S8	Prof. I Manna	Prof. I. Manna Deptt. Of Met. & Mat. Engineering Indian Institue of Technology Kharagpur Tel. (O) 03222 283266 Tel (R) 03222 283267, 277361	Physical Metallurgy and Corrosion	Email: imanna@ netal.iitkgp. Ernet.in	
S9	Prof. B.S. Murty	Prof. B.S. Murty Deptt. Of Met. & Mat. Engineerin, Indian Institute c Technology Mac as Tel. (O) 044 22574754	Physical Metallurgy and Corrosion	Email: murty@iit .ac.in	

S10	Dr. Uma Batra	Dr. Uma Batra Department of Metallurgy Punjab Engineering College Chandigarh Tel (O) 91 1722753951 Tel (R) 91 172 2745331, 2653655	Physical Metallurgy and Corrosion	Email: umabatra@pec.ac.in umabatra2@yahoo.com	-
C. Ceramic and Polymeric Materials					
S11	Prof. K.K. Ray	Prof.K.K. Ray Deptt. Of Met. & Mat. Engineering Indian Institute of Technology Kharagpur Tel(o) 03222 283278 Tel(R) 03222 283279 278405	Ceramic and Polymeric Materials	-	-
S12	Prof. A.N. Tiwari	Prof. A.N. Tiwari Deptt. Of Met. Engg. & Mat. Science Indian Institute of Technology Bombay Res(O) 022 25767613	Ceramic and Polymeric Materials	Email: ant@iitb.ac.in	-

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S13	Prof. D. Bahadur	Prof. D. Bahadur, Dept. of Met. Engg. & Mat. Science Indian Institue of Technology Bombay Tel (O) 022 25767632	Ceramic and Polymeric Materials	Email dhirenb@iitb.ac.in	-
S14	Prof. Gokul Nath Agarwal	Prof. Gokul Nath Agarwal, Deptt. Of Ceramic Engineering Institue of Technology, B.H.U. Varanasi	Ceramic and Polymeric Materials	Email: agrawal_gokul@rediffmail.com, gnagarwal.cer@itbhu.ac.in	-
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D. Extractive Metallurgy					
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S17	Prof. N.B. Ballal	Prof. N.B. Ballal Deptt. Of Met. Engg. & Mat. Science Indian Institute of Technology Bombay Tel (O) 022 25767610	Extractive Metallurgy	Email:nbb@iitb.ac.in	-
S18	Prof. N. Chakraborti	Prof. N. Chakraborti Deptt. Of Met. & Mat. Engg. Indian Institute of Technology Kharagpur Tel (O) 03222 283286 Tel (R) 03222 283603, 278614	Extractive Metallurgy	Email:nchakrab@metal. iitkgp.ernet.in	-
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SENATE NOMINEES (S1 – S28)

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S8	Dr. M.S. Tiwari	Deptt. of Physics & Electronics Dr. H. S. Gour University, Sagar (M.P.)-470003 Tel.(O) Tel.(R)0758-2230685	Atmospheric Physics	E-mail: tiwarims@yahoo.co.in	Road No.3, Anand Nagar, Razakhedi, Makronia, Sagar (M.P.)-470003
S9	Dr. P.C. Pandey	Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL), Indian Institute of Technology, Kharagpur- 721302 Tel.(O) 03222-281780 Tel.(R) 03222-281781	Atmospheric Physics	+91-9434709797 E-mail: pcpandey45@yahoo.co.in pcpandey@coral.iitkgp.ernet.in	

(C) Condensed Matter Physics					
S10	Prof. G. Baskaran	The Institute of Mathematical Sciences, CIT Campus, Chennai-600113 Tel.(O)044-22544856 (extn. 233) Tel.(R) 044-24510504	Condensed Matter Physics	Fax: +91-44-22541586 E-mail: baskaran@imsc.res.in	19, Kaveri Nagar (Street next to Sivanand Yoga Center), Kottivakkam Kuppam Road, Kottivakka, Chennai-600041
S11	Prof. Manoj Harbola	Professor, Deptt. of Physics , IIT Kanpur, Kanpur-208016 Tel.(O)0512-2597823 Tel.(R) 0512-2598223	Electronic Structure of Matter	Fax: +91-512-2590914 E-mail: mkh@iitk.ac.in	482, IIT Campus Indian Institute of Technology, Kanpur Kanpur-208016
S12	Prof. Deepak Kumar	School of Physical Sciences, JNU New Delhi-110067 Tel.(O) 011-26741907,26741903 Tel.(R)	Condensed Matter Physics	E-mail: dk0700@mail.jnu.ac.in	
S13	Prof. V.D. Vankar	Deptt. of Physics, Institute of Technology, Delhi Hauz Khas, New Delhi-110016 Tel.(O)011-26591329 Tel.(R)011-26591932	Condensed Matter Physics	Fax: 011-26581114 E-mail: vdvankar@physics.iitd.ac.in	

S14	Prof. S.S. Major	Deptt. of Physics, Institute of Technology Bombay. Mumbai-400076 Tel.(O) 022-25767567 Tel.(R) 022-25768567	Condensed Matter Physics	Fax: 022-25767552 E-mail: syed@iitb.ac.in	
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S16	Prof. Dhananjai Pandey	School of Materials Science and Technology Banaras Hindu University, Varanasi-221005 Tel.(O)0542-2307046/2307047 Tel.(R) 0542-2314658	Condensed Matter Physics	09415812424 Fax: 0542-2368707/2368428 E-mail: dpandey_bhu@yahoo.co.in dpandey@bhu.ac.in	

(D) Instrumentation Physics					
S17	Prof. S. Chopra	Deptt. of Physics, Institute of Technology, Delhi Hauz Khas, New Delhi-110016 Tel.(O)011-26591362 Tel.(R)	Quantum optics, Laser Spectroscopy	+91-9811424881 Fax: 011-26581114 E-mail: schopra@physics.iitd.ac.in	
S18	Prof. Jitendra Kumar	Professor and Head,Materials Sciencs Program, IIT Kanpur, Kanpur-208016 Tel.(O) 0512-2597107/2597548 Tel.(R)	Material Science and Engineering, Nanosize particles, Electronic, magnetic and hydrogen energy storage materials, plasma displays, Thin films, Material characterization, Electron microscopy and diffraction.	Fax: 0512-2597664 E-mail: jk@iitk.ac.in; jkiitk@gmail.com	
S19	Prof. R.P. Bajpai	Vice Chancellor, Kurukshetra University, Kurukshetra-136119(Haryana) Tel.(O) 01744-238039 Tel.(R) 01744-238021	Electronics, Nano Science and Material Science, Electronics & Instrumentation	Fax: 01744-238277 E-mail: vc.kuk@rediffmail.com rpbajpai@hotmail.com	
S20	Dr. J.V. Yakhmi	Head, Technical Physics & Phototype engg. Div. (TP&PED) BARC Mumbai 91-22-25593828 25505325	Solid State Physics	ya_kmi@yahoo.com yakhmi@barc.gov.in	-

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S21	Dr. H.K. Sahgal	Chhatrapati Shahu JI Maharaj University Kanpur, UP Tel.(O) 0512-2570450,2570263	Experimental Condensed Matter Physics	-	-
(E) Nuclear Physics					
S22	Prof. H.C. Jain	Retired Professor, TIFR, Bombay, Mumbai Tel.(O) Tel.(R) 022-26712390	Nuclear & Atomic Physics	+91-9867243212 E-mail: hcjain@rediffmail.com	
S23	Prof. M.M. Gupta	Head, Department of Physics, Punjab University, Chandigarh-160014	Nuclear Physics	+91-9815627923 Fax: 0172-2783336 E-mail: mmgupta@pu.ac.in	
S24	Prof. Amit Roy	Inter- University Accelerator Centre, Aruna Asaf Ali Marg, P.O. Box No. 10502 New Delhi-110067 Tel.(O) 011-26893045 Tel.(R) 011-26893523	Nuclear Physics	91-9868113918 Fax: 011-26121960 E-mail: roy@iuac.res.in	
S25	Dr. S. Kailas	Physics Group, VDG, BARC, Trombay, Mumbai-400085 Tel.(O) 25593883/25593885,255 25141 Tel.(R) 022-25512291	Accelerator Based Nuclear Physics and applications	+91-9869480385 Fax: 022-25505151 E-mail: kailas@barc.gov.in	

S26	Dr. Y.K. Gambhir	Deptt. of Physics IIT Powai, Mumbai-400076 Tel.(O) 25767564 Tel.(R) 25768564,25722014	Nuclear Physics	E-mail: yogy@phy.iitb.ac.in	
S27	Dr. L. Chaturvedi	Kulpati Bungalow Guru Ghasidas Vishwavidyalaya Campus, Koni, Bilaspur-495009 Tel.(O) 07752-260283,260353 Tel.(R) 07752-260351,260288	Nuclear Physics	+91-9827122551 Fax: 07752-260148,07752-260352 E-mail: lakshman1944@rediffmail.com lakshman1944@indiatimes.com	B 30/2A-6-1, Ganga Bag Colony, Lanka, Varanasi- 221005
S28	Prof. V.K.B. Kota	Physical Research Laboratory, Navrangpura, Ahmedabad-380009 Tel.(O) 079-26314464 Tel.(R) 079-26861562	Theoretical Nuclear Physics, Mathematical Physics	+91- 9879854080 E-mail: vkbkota@prl.ernet.in	

SENATE NOMINEES (S1 - S28)

Department: Water Resources Development & Management

Design of Irrigation & Hydraulic Structures/Hydro Power Structural and Appurtenant Works. concrete & Gravity Dams etc. (WRD Civil)					
SL. NO.	NAME	CONTACT ADDRESS			RESIDENCE ADDRESS
		OFFICE	SPECIALIZATION	MOB. NO.	
S1	Dr. C.D. Thatte	Dr. C.D. Thatte Chairman (Retd.) CWC Res(O)020-25410223	Hydraulic Structures	EMail: edthatte@hotmail.com cdthatte@yahoo.co.in	C-16, Parnali Cooperative, Hosue Society, Damle Path, Law College, Road Pune-411 004
S2	Shri S.K. Das	Shri S.K. Das Ex-Chairman , CWC Tel.(R) 03324187814	River Basin	09433003508 Fax:033 23599260	16/9, W2A ®, Phase IVB, Golf Green, Kilkata-700 095
S3	Er. Rajesh Chandra Seth	Er. Rajesh Chandra Seth Engineering-in-Chief (Retd.)	Hydro Power & Hydraulic Structures	09968234633 Email: rajesseth1947@gmail. Com	C-1006, Amrapali Green Vaibhav Khand, Indira Puram, Ghaziabad (UP)
S4	Dr. D.V. Thareja	Dr. D.V. Thareja Retd. Member, CWC	Tunnels, Dams	09810990183	BFH-18, Shalimar Bagh, Delhi-110 088

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S5	Prof. P.P. Majumdar	Prof. P.P. Majumdar Chariman & Professor Civil Engg. Deptt. IISc Bangalore Tel(O) 080 2323 08023606082 080 2669080 23600290 Tel(R) 080 23602668	Hydrology & Water Rescources Systems Soil Moisture, Climate Change	Email:pradeep@civil.iisc.ernet.in Tel. 080-2333 080-23606082 080-2669 080-23600290 Tel(R) 80-23602668	-
S6	Dr. N.K. Garg	Dr. N.K. Garg Professor Deptt. Of Civil Engg. , IIT Delhi Hauz Khas , New Delhi-110 016 Tel(O) 011 26591210	Water Resources Systems, Finite Element, Watershed Modeling, Irrigation Management, CAD	Email:nkgarg@civil.iitd.ac.in	
S7	Shri Rakesh Nath	Shri Rakesh Nath Chairman Central Electricity Authority , Sewa Bhawan, R.K. Puram New Delhi 110 066 Tel (O) 011 26102583/26109212 Tel. (R) 011 23070024/23386435	Thermal and Hydro Power Stations and Transmission System, Operation of Large Interconnected Regional Power Grids	9810330909 Fax: 011 261109212 Email: chair@nic.in rakeshnath.cea@nic.in	-

S8	Prof. A.K. Gosain	Prof. A.K. Gosain, Computer Service Centre & ACSS, Professore of Civil Engg. Deptt. Of Civil Engg., IIT Delhi Hauz Khas , New Delhi 110 016 Tel(O) 011 26591186 Tel(R) 011 26851889	Integrated Watershed Modeling , GIS, Hydrological Modeling, Irrigation Management, Environmental Impact Assessment.	9810944776 Fax; 01126581117,011-26581058 Email:gosain@civil.iitd.ac.in akgosain@gmail.com	
S9	Shri R.S. Varshney	Shri R.S. Varshney Engineering in Chief (Retd.) Tel(R) 0120-3292958	Hydrology, Hydraulic Structures, Hydropower and Dams	09818841616	Varshney , Siddhidatri, 8/127,Sector -3 Rajendra Nagar, Ghaziabad-201005
Electrical Design, Operation and maintenance of Hydropower Stations EHV Lines and Sub-Stations (WRD Electrical)					
S10	Shri Rakesh Nath	Shri Rakesh Nath, Chairman Central Electricity Authority, Sea Bhawan, R.K. Puram, New Delhi-110 066 Tel (O) 011 26102583/26109212 Tel.(R) 01123070024/23386435	Thermal and Hydro Power Stations and Transmission System, Operation of Large Interconnected Regional Power Grids	9810330909 Fax: 011 26109212 Email: chair@nic.in,rakeshnath.cea@nic.in	-

S11	Shri Gurdas Singh	Shri Gurdas Singh, Member(HE) Central Electricity Authority , Sewa Bhawan, R.K. Puram New Delhi-110 066 Tel(O) 011 26107783 Tel (R)011 24670578	Electrical Engineering	Email: gdsingh51@yahoo.com	B-3/2,Sector-13, M.S. Flats, R.K. Puram, New Delhi-22
S12	Shri M.K. Sharma	Shri M.K. Sharma, Managing Director , Jal Power Corp. Ltd. , 405-406, Raja Hosue 30-31, Nehru Place New Delhi-110 019 Tel(O) 01126442847/48 Tel.(R) 0129-4117045	Hydro Mechanical Equipment	Fax: 011 26442849 Email:sharmamk@jpcl.co.in Jpcl_delhi@yahoo.com	45/GF/Block-III, Charmwood Village, Faridabad -121009 (Haryana)
S13	Shri S.M. Dhiman	Shri S.M. Dhiman Member (GO&D) Central Electricity Authority Sewa Bhawan, R.K. Puram, New Delhi-110066 Tel (O) 011 26104217 26108834	-	Fax 011-26108834 Email: smdhiman@gmail.com Tel(R) 011-24105354	J-4/2,Sector-13 M.S. Flats. R.K. Puram , New Delhi-22

S14	Dr. R.C. Chauhan	Dr. R.C. Chauhan Ex Director, SLIET, Longowal	Electrical Engineering, hydro power	9417222440 9721811655	-
S15	Dr. Bhim Singh	Dr. Bhim Singh Professor Room No. II/18, Electrical Engg. Deptt., IIT Delhi, Hauz Khas New Delhi Tel(O)011 26591045 Tel(R) 011 26591890 Ext. 011 26516223	Power Electronics , Electrical Machines And Drives, HVDC, FACTS, Power Quality, Renewable Energy, DSP Based control of Power Converter and Drive	Email bsingh@eeiitd.ac.in	60, New Campus , IIT Dellhi
S16	Shri S.K. Shukla	Shri S.K. Shukla Director (Technical) THDC, Rishikesh Tel(O) 0135 2431468	Hydro Power Plant & Pump Storage	Email:dt@thdc.gov.in	-
Hydro Mechanical/Construction Plant & Machinery (WRD Mechanical)					
S17	Shri M.K. Sharma	Shri M.K. Sharma Managing Director , Jal Power Corp. Ltd. 405-406, Raja House, 30-31 Nehru Place New Delhi 110019 Tel (O) 01126442847/48 Tel(R) 0129 26442849	Hydro mechanical equipments	Email:sharmamk@jpcl.co.in Jpcl_delhi@yahoo.com	45/GF/Block-III, Charmwood Vilalge , Faridabad-121 009 (Haryana))

S18	Shri S.K. Shukla	Shri S.K. Shukla Director (Technical) THDC, Rishikesh Tel (O) 0135 2431468	Hydropower Plant & Pump Storage	Email: dt@thdc.gov.in	-
S19	Dr. R.L. Chauhan	Dr. R.L. Chauhan Chairman BOG , National Institue of Technology Kahan Niwas, Kelston Estate, Shimla-171 001 Tel (O) 0177-2813272 Tel(R) 0177 2812488	Hydro mechanical Equipment	09418004501	-
S20	Shri R.K. sharma	Shri R.K. Sharma Member, Joint Electricity Regulatory Commission, Vanijya Nikunj Complex, Udyog Vihar, Phase v, Gurgaon (Haryana) Tel (o) 0124 2342852 Tel (R) 0124 4045216	Construction planning and design	09810137215 Email rav_sharma@hotmail.com	B1/204 PWO Housing Coomplex, Sector 43, Gurgaon, Haryana

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Irrigation Water Management (WRD&M)					
S21	Shri C.D. Thatte	Shri C.D. Thatte Chairman CWC(Retd) Tel (R) 020 5410223	Hydraulic Structures	Email cdthatte@hotmail.com cdthatte@yahoo.co.in	C-16 Parnali Cooperative House Society, Damle Path, Law College road, Pune-411 004
S22	Shri S. K Das	Shri S.K. Das Ex Chairman, CWC Tel. (R)033 24187814	River Basin	09433003508 Fax: 03323599260	16/9, W2A ®, Phase IV B Golf Gren, Kolkata 700095
S23	Shri N.K. Tyagi	Agriculture Scientists Recruitment Board (ASRB), Room No. 204, Krishi Anusandhan Bhawan-1, Pusa, New Delhi 1100 12 Tel(O) 011 25841168 Tel(R) 011-24672758	Irrigation Engineering and Land Reclamation	Fax: 011-25841168 Email: nktyagi@icar.org.in Cssir@x400niegw.mic.in pamember@rediffmail. com.	-
S24	Shri V. B. Patel	Shri V.B. Pate, former Chairman, CWC 079 26764099	Irrigation Structures and Water Management	Fax: 07926664099 Email: vbpate@mmipl.in	128 Manekbaugh Society, Ambawadi, Ahmedabad-380015

S25	Dr. A.K. Singh	Dr. A.K. Singh DDG (NRM), ICAR, Krishi Anusandhan Bhawan –II Room No. 108, Pusa, Complex, New Delhi-100 012 Tel(O) 011 25848364 Tel(R) 011 25833496, 25849786	Irrigation Water Management	09873441488 Fax: 011- 25848366 Email: aksingh@icar.org.in ak_wtc@yahoo.com	B-14, IARI Campus, Pusa New Delhi-110 012
S26	Dr. S.K. Sharma	Dr. S.K. Sharma Consultant IRRI, India, IRRI India Site Office, B-301, IInd College of Biotechnology SVBPU A&T Modipuram Tel(O) 0121 2411568 Tel(R) 0121-2772388	Natural Resource Management, RCTs, Cropping System, Farming System, Organic Farming, Precision Farming, SSNM	09412551914 Fax:0121 2411568 Email: sharmask44@gmail.com	J-22, Shastri Nagar, Meerut - 25004
S27	Prof. B.C. Mal	Prof. B.C. Mal Professor & Ex Head Agricultural & Food Engineering IIT Kharagpur -721 302 Tel(O) 03222 283128 Tel(R) 03222 283129, 03222 279798	Ground Water Engineering, Irrigation & Drainage Engineering, Soil & Water Construction Engineering	09434714077 Email: bmal@agfe.iitkgp.ernet.in	-

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S28	Prof. K.N. Tiwari	Prof. K.N. Tiwari Agricultural & Food Engineering , IIT Kharagpur -721 302 Tel(o) 03222 283150 Tel(R)03222 283153, 03222 277769	Soil & Water Conservation Engineering , Remote sensing and GIS Applications in Water Resources Management	09434944443 Fax:011 25848366 Email:kamlesh@agfe.iitkgp.ernet.in	-

Recommendations

1. The sum of the credits of 4th &5th yr of integrated program should be, by and large, equivalent to the total credits for 2 yr MSc program.
2. The credits for dissertation in 4th semester of 2 yr program should be the same as that for dissertation in 10th semester of 5 yr program.
3. There should be greater emphasis on practical courses and Lab training to earn any Master's degree in science.
4. The practice of Lab courses being run as separate units in certain science departments, covering various aspects of different topics covered in theory papers, should be continued.
5. Having separate / independent courses on laboratory is a well established and standard practice particularly in Chemistry and Physics at all levels, e.g., BSc, MSc, in all the universities in India and equivalent programs in UK, Germany etc.
6. The department should assign more credits to dissertation and certainly less for seminar, project and comprehensive viva at MSc level.
7. In the summer vacation, after 2nd semester, there should be an industrial training or project in an outside institute/industry/national laboratory etc.
8. The practice of tutorial at MSc final year level (5th yr of integrated programs and 2nd yr of 2-yr programs) should be abolished. The courses at MSc level are in fact, by and large, specialized courses.
9. Technical Communication is not required for post BSc programs.
10. A range for credits and distribution among various components is proposed in Table:

Table: Proposed Credit range and distribution among different components

Sl. No	Course Component	Credits
1	Course on Modelling, Simulation and Computer Applications (Optional or modified as per specific needs of the department)	03-04
2	Department Core Courses	32-40
3	Lab / Practical courses	08-12
4	Departmental Electives (DEC)	12-16
5	IE or Minor Electives (electives from other departments / sections within the department / center	06-08
6	• Dissertation • Seminar, Project, field work and comprehensive Viva-voce	12-16 04-10
	Total	85-95