Department of Physics

1	MAN-001	Mathematics-I	BSC	4
2	PHN-001	Mechanics	BSC	4
3	CEN-105	Introduction to Environmental Studies	GSC	3
4	HSN-001A	Communication Skills (Basic)	HSSC	
5	HSN-001B	Communication Skills (Advanced)	HSSC	2
6	HSN-002	Ethics and Self Awareness	HSSC	2
7	PHN-101	Introduction to Physical Science	DCC	2
8	PHN-103	Computer Programming	ESC	4
9	MAN-004	Numerical Methods	BSC	4
10	CYN-004	General Chemistry-I	BSC	4
11	PHN-110	Introduction to Electronics	DCC	4
12	EEN-112	Electrical Science	ESC	4
13	MIN-106	Engineering Thermodynamics	ESC	4
14	MIN-108	Mechanical Engineering Drawing	ESC	4
15	CYN-201	Physical Chemistry-I	BSC	3
16	CYN-202	Basic Inorganic Chemistry	BSC	3
17	MAN-205*	Ordinary and Partial Differential Equation	BSC	4
18	PHN-201	Optics	DCC	5
19	PHN-203	Elements of Classical Mechanics	DCC*	4
20	CYN-203*	Organic Chemistry-I	BSC	4
21	MAN-102	Linear algebra	BSC	4
22	PHN-202	Electricity and Magnetism	DCC	5
23	PHN-212	Thermal Physics	DCC	5

24	PHN-301	Plasma Physics	DCC	3
25	PHN-303	Quantum Physics	DCC*	4
26	PHN-305	Properties of Matter and Acoustics	DCC	4
27	PHN-307	Atomic Physics	DCC*	4
28	PHN-309	Laboratory Work I	DCC	3
29	PHN-302	Laboratory Work II	DCC	3
30	PHN-304	Elements of Condensed Matter Physics	DCC*	4
31	PHN-306	Special Theory of Relativity	DCC	3
32	PHN-308	Nuclear Physics and its Applications	DCC*	4
33	PHN-501	Semiconductor Devices	DCC	3
34	PHN-503	Quantum Mechanics – I	DCC	4
35	PHN-505	Mathematical Physics	DCC	3
36	PHN-507	Classical Electrodynamics	DCC	4
37	PHN-509	Classical Mechanics	DCC	3
38	PHN-511	Computational Physics	DCC	3
39	PHN-502	Laboratory Work III	DCC	3
40	PHN-504	Condensed Matter Physics	DCC	3
41	PHN-506	Statistical Mechanics	DCC	3
42	PHN-508	Quantum Mechanics - II	DCC	3
43	PHN-510	Nuclear and Particle Physics	DCC	2
44	PHN-512	Physics of Earth's Atmosphere	DCC	2
45	PHN-514	Molecular Spectroscopy and Lasers	DCC	2

List of Minor Specialization courses of Physics for other Departments

1	PHN-203	Elements of Classical Mechanics	Autumn	DCC/MSC	4
2	PHN-303	Quantum Physics	Autumn	DCC/MSC	4
3	PHN-307	Atomic Physics	Autumn	DCC/MSC	4
4	PHN-304	Elements of Condensed Matter Physics	Spring	DCC/MSC	4
5	PHN-308	Nuclear Physics and its Applications	Spring	DCC/MSC	4

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 A Primer in Quantum Field Theory

PH- 621 Astrophysics

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

PH-608 Fiber and Nonlinear Optics

PH-610 Quantum Optics

PH-612 Advanced Topics in Mathematical Physics

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-001** Course Title: **Physical Chemistry**

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

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

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

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

8. Pre-requisite: **Nil**

9. Objective: To provide a theoretical and experimental knowledge of fundamental physical chemistry to engineering students.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Quantum Chemistry:** Postulates, commuting and non-commuting operators, Schrödinger equation, particle in a one-, two- and three dimensional box and their implications, H-atom - radial and angular wave functions, shapes of orbitals (s, p and d), application of quantum chemistry concepts to hydrogen-like atoms and their atomic spectra.	**7**
2.	**Chemical Equilibria:** Description of equilibrium, feasibility of chemical reaction, Gibbs-Helmholtz equation, phase transition - Clapeyron equation, Clapeyron-Clausius equation, free energy changes in reversible processes, chemical potential, partial molar quantities, activity coefficient and fugacity, basic concepts of statistical thermodynamics.	**6**
3	**Reaction Dynamics:** Collision theory of bimolecular reactions and its drawbacks, potential energy surfaces, transition state theory using partition functions, thermodynamic formulation of transition state theory, mapping of transition states using ultrafast processes.	**6**
4.	**Photochemistry:** Laws of photochemistry, photophysical and photochemical processes and their quantum efficiencies, spontaneous and stimulated processes. Franck-Condon principle, photosensitizers - photosynthesis and solar cells.	**6**
5.	**Catalysis:** Homogeneous catalysis – kinetics of acid, base and enzyme catalyzed reactions with suitable examples. Heterogeneous catalysis – surface phenomenon, porosity, derivation of Langmuir adsorption isotherm, Langmuir-Hinshelwood and Rideal-Eley mechanisms, comparison of rates of homogeneous and heterogeneous reactions based on activated complex theory.	**6**
6.	**Spectroscopy:** Interaction of electromagnetic radiation with matter, instrumental spectroscopic techniques (AAS, ICP, UV-Vis and IR spectroscopy), application of spectroscopy techniques to atomic and molecular systems.	**6**
7.	**Solid-State Chemistry:** Bonding in solids, diffraction methods – scattering of X-rays from a crystal, structure factor and systematic absences, methods of synthesis of solids–ceramic, sol-gel, hydrothermal, microwave and sonochemical.	**5**
	Total	**42**

List of Experiments:

1. Determination of iron in iron ore using potassium dichromate (internal indicator method).
2. Heat of neutralization of a strong base by a strong acid.
3. Determination of surface excess concentration of 1-butanol in aqueous solution.
4. To study the kinetic of a redox reaction.
5. Blue Printing using sunlight.
6. pH metry/ potentiometry titrations
   a) Strong acid – strong base; b) Strong acid – weak base
   c) Weak acid – strong base; d) Redox titration: Fe^{2+} or Mn^{2+}
7. Acid-base titrations using conductivity meter.

a) Strong acid – strong base; b) Strong acid – weak base; c) Weak acid – strong base;

8. Spectrophotometry: Determination of [Fe (III)] by colorimetry.

9. Determination of hardness of water by EDTA- complexometry titration.
10. Determination of the composition of mixtures of liquids using viscometry.

11.**Suggested Books**:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Silbey R.J. and Alberty R.A., "Physical Chemistry", 3rd Ed., John Wiley & Sons, Inc.	**2003**
2.	Atkins P.W., Physical Chemistry, 8th Ed., Oxford University Press.	**2006**
3.	West A.R., Solid State Chemistry and its Applications, Wiley-India Edition.	**2003**
4.	Levine, I. N., Quantum Chemistry, Pearson Education.	**2000**
5.	Turro N.J., Ramamurthy V. and Scaiano J.C., Modern Molecular Photochemistry of Organic Molecules, University Science Books.	**2008**
6.	Skoog D.A., Holler F.J. and Crouch SR, "Principles of Instrumental Analysis", 6th Ed., Thomson Brooks.	**2006**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-002** Course Title: **Organic and Inorganic Chemistry**

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

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

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

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

8. Pre-requisite: **Nil**

9. Objective: To impart basic knowledge of organic and inorganic chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Heteroatoms i n O rganic C hemistry:** Introduction to heterocyclic chemistry, aromaticity, reactivity and synthesis of thiophene, pyridine, furan and pyrrole.	**6**
2.	**Stereochemistry a nd R eaction Mechanisms:** Stereochemistry of addition at carbon-carbon double bond, addition of bromine to cis-, and trans- butene, oxidation across the double bond through peroxides and permanganate, Diels Alder reaction [4+2] and [2+2] cycloaddition reactions. Aromatic nucleophilic substitution mechanisms (S_NAr, S_N1 and arynes), reactivity and reactions.	**8**
3.	**Synthesis a nd Ch aracterization** of some important compounds such as benzocaine, saccharin, salbutamol and thyroxine. Introduction to mass spectroscopy and NMR spectroscopy for structural prediction of organic compounds.	**9**
4.	**Novel Polymers:** Stereo chemical control of synthesis, molecular mass of polymers, polyurethanes, conducting polymers, doping, Shirakawa experiments, oxidation of aniline, biopolymers, and plastics.	**5**
5.	**Coordination Chemistry:** Comparison of the stability of octahedral and tetrahedral complexes on the basis of crystal field stabilization energy, factors affecting the magnitude of Δ, applications of crystal field theory, variation of hydrated ionic radii and hydration enthalpy/stability of complexes, Jahn-Teller effect– definition and examples from d^9 and high-spin d^4 systems, static and dynamic Jahn-Teller effects.	**7**
6.	**Organometallic C hemistry:** Factors affecting M-C bond formation, synthesis, reactions and structures including spectroscopic features of metal carbonyls, transition metal-π alkene complexes– synthesis, reactions, bonding and stability. Applications of organometallic compounds in catalytic processes such as hydroformylation, hydrogenation, catalytic decarbonylation, olefin metathesis and enantioselective hydrogenation of alkenes.	**7**
	Total	**42**

List of Experiments:

1. Determination of sodium carbonate in baking/washing soda.
2. Determination of Zn by EDTA- complexometric titration.
3. Solvent less synthesis- Wittig reaction.

4. Determination of the equivalent weight of an organic acid.
5. Identification of functional groups in an organic compound.
6. Characterization of an organic compound by UV-Vis and IR spectra.
7. Synthesis of a polymer.
8. Determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$ spectrophotometrically.
9. Determination of ligand field strength of ligands.
10. Synthesis of potassium trisoxalatochromate(III).
11. Preparation of p-nitroacetanilide and determination of melting point, and matching with known sample.
12. Synthesis of an azo dye and its application in textiles.
13. Test of carbohydrate as osazone
14. Determination of calcium in chalk/toothpaste.

11. Suggested Books:

S.N	Name of Authors/ Books/ publisher	Year of Publication/ Reprint
1	Morrison R. T. and Boyd R.N., " Organic Chemistry", 6th Ed., Prentice Hall of India.	**2001**
2	Clayden, J., Greeves, N., Warren, S., and Wothers, P., "Organic Chemistry" Oxford University Press.	**2009**
3	Lee, J.D., "Concise Inorganic Chemistry", 5th Ed., Chapman & Hall.	**2010**
4	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education.	**2009**
5	March, J, Organic Chemistry: Reaction Mechanism and Structures, 6th Ed, John Wiley & Sons.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-004** Course Title: **General Chemistry-I**

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

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

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

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

8. Pre-requisite**: Nil**

9. Objective: To provide a theoretical and experimental knowledge of basic/fundamental chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Quantum Mechanics:** Introduction to quantum chemistry, particle in a box − implication of i concepts, H atom, radial and angular wave functions, and shapes of orbital (*s*, *p*).	**4**
2.	**Thermodynamics***:* Statistical concept of entropy, description of equilibrium, feasibility of chemical reactions, Clausius-Clapeyron equation, partial molar quantities, chemical potential.	**4**
3.	**Kinetics and Catalysis:** Theories of chemical reactions – Draw-backs of collision theory, transition state theory using partition functions, thermodynamic formulation of transition state theory, homogeneous catalysis.	**4**
4.	**Corrosion and Fuel cells:** Electrochemical corrosion and fuel cells.	**2**
5.	**Stereoisomerism:** Stereochemistry of addition at carbon-carbon double bond, addition of bromine to cis-, and trans- butene, oxidation across the double bond through peroxides and permanganate, Diels Alder reaction [4+2] and [2+2] cycloaddition reactions.	**5**
6.	**Synthesis** of some important compounds such as benzocaine, saccharin, salbutamol and thyroxine. Introduction to spectroscopic techniques for structural prediction of organic compounds.	**7**
7.	**Novel P olymers:** Stereo chemical control of synthesis, Ziegler-Natta catalyst, polyurethanes, conducting polymers.	**2**
8.	**Coordination C hemistry:** Comparison of the stability of octahedral and tetrahedral complexes on the basis of crystal field stabilization energy, factors affecting the magnitude of Δ, applications of crystal field theory, variation of hydrated ionic radii and hydration enthalpy/stability of complexes, Jahn-Teller effect− definition and examples from d^9 system, static and dynamic Jahn-Teller effects.	**5**
9.	**Organometallic C hemistry:** Factors affecting M-C bond formation, transition metal-π alkene complexes− synthesis, reactions, bonding and stability. Applications of organometallic compounds in catalytic processes such as hydroformylation, hydrogenation, catalytic decarbonylation, olefin metathesis and enantioselective hydrogenation of alkenes.	**6**
10.	**Spectroscopic Techniques:** Interaction of electromagnetic radiation with matter, spectroscopic techniques viz., UV-Vis and IR, and their applications for characterization of simple compounds.	**3**
	Total	**42**

List of Experiments:

1. Determination of sodium carbonate in baking/washing soda.
2. Determination of Zn by EDTA- complexometric titration.
3. Solvent free synthesis -Wittig olefination of aldehyde or ketone by grinding.

4. Determination of viscosity of a polymer in a solution /or in a mixture of liquid.
5. Determination of surface excess concentration of 1-butanol in aqueous solution.
6. Kinetics of a reaction between hydrogen peroxide and iodine in acidic medium.
7. Photochemical reduction of ferric oxalate in cyanotype blue printing.
8. Spectrophotometric determination of [Fe (III)] by using KSCN.
9. Identification of functional groups in an organic compound.
10. Characterization of an organic/inorganic compound by UV-Vis and IR spectra.
11. Spectrophotometric determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$.
12. pH metry/ potentiometry titration: strong acid – strong base.
13. Preparation of potash alum from scrap aluminium.
14. Synthesis of potassium trisoxalatochromate(III).
15. Synthesis of a polymer.

11. Suggested Books:

S. No.	**Authors/ Title/ Publisher**	**Year of Publication/ Reprint**
1.	Lee, J.D., "Concise Inorganic Chemistry", 5th Ed., Chapman & Hall.	**2002**
2.	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	**2009**
3.	Morrison, R.T., Boyd, R.N. and Bhattacharjee, S.K., "Organic Chemistry", 7th Ed., Pearson Education in South Asia.	**2013**
4.	Silbey, R.J. and Alberty, R.A., "Physical Chemistry", 3rd Ed, John Wiley & Sons, Inc.	**2003**
5.	Atkins, P.W., Physical Chemistry, 8th Ed., Oxford University Press.	**2006**
6.	March, J., "Organic Chemistry: Reactions, Mechanisms and Structures", 6th Ed., John Wiley & Sons.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-006** Course Title: **General Chemistry-II**

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

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

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

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

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of general chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Molecular Reaction Dynamics:** Collision theory of bimolecular reactions and its drawbacks, transition state theory and its thermodynamic formulation, comparison of collision theory and transition state theory.	**4**
2.	**Catalysis:** Homogeneous catalysis – kinetics of acid and base catalyzed reactions with suitable examples, heterogeneous catalysis – surface phenomenon, porosity, derivation of Langmuir adsorption isotherm, Langmuir-Hinshelwood mechanism.	**5**
3.	**Photochemistry:** Laws of photochemistry, photophysical and photochemical processes and their quantum efficiencies, Franck-Condon principle, photosensitizers and their application to solar cells.	**5**
4.	**Polymerization:** Synthesis of polymers, properties of polymers – degree of polymerization, molecular mass of polymers, tacticity and glass transition temperature. High temperature and conductive polymers, methods of modifying polymers, biopolymers.	**6**
5.	**Energy R esources:** Coal − calorific value, analysis, carbonization, petroleum − fractional distillation, gasoline/petrol − classification, knocking, octane number, natural gas.	**3**
6.	**Organometallic Chemistry**: Factors affecting M−C bond formation, general methods of formation of organometallic compounds, reactions of organometallic compounds, comparison of main group and transition metal organometallics, bonding in transition metal-π alkene complexes. Applications of organometallic compounds in catalytic processes such as hydroformylation, hydrogenation, Ziegler-Natta catalysis, catalytic decarbonylation and olefin metathesis.	**6**
7.	**Volumetric a nd G ravimetric D etermination o f M etals a nd N on-metals:** Redox titration− iodometric titration, acid-base titration, complexometric titrations, co- and post-precipitation, schematic description of methods for determination of Fe, Cu, Al, Zn, Ni, Pb, Sn, P and S.	**5**
8.	**Spectroscopic T echniques**: Interaction of electromagnetic radiation with matter, spectroscopic techniques viz., AAS, ICP, UV-Vis, IR and Mass spectroscopy, and their application to atomic and molecular systems.	**8**
	Total	**42**

List of Experiments:

1. Determination of sodium carbonate in baking/washing soda.
2. Determination of Zn by EDTA− complexometric titration.
3. Determination of nitrogen as ammonia in a sample.
4. Determination of viscosity of a polymer in a solution /or in a mixture of liquid.
5. Determination of surface excess concentration of 1-butanol in aqueous solution.
6. Kinetics of a reaction between hydrogen peroxide and iodine in acidic medium.
7. Photochemical reduction of ferric oxalate in cyanotype blue printing.
8. Spectrophotometric determination of [Fe (III)] by using KSCN.
9. Synthesis of a polymer.
10. Characterization of an organic/inorganic compound by UV-Vis and IR spectra.

11. Spectrophotometric determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$.
12. pH metry/ potentiometry titration: strong acid – strong base.
13. Preparation of potash alum from scrap aluminium.
14. Synthesis of potassium trisoxalatochromate(III).
15. Determination of Cu by iodometric titration.

11. Suggested Books:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Atkins, P.W., "Physical Chemistry", 8th Ed., Oxford University Press.	**2006**
2.	Turro, N.J., Ramamurthy, V. and Scaiano, J.C., "Modern Molecular Photochemistry of Organic Molecules", University Science Books.	**2008**
3.	Skoog, D.A., Holler, F.J. and Crouch, S.R., "Principles of Instrumental Analysis", 6th Ed., Thomson Brooks.	**2006**
4.	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	**2009**
5.	Christian, G.D., "Analytical Chemistry", 6th Ed., John Wiley & Sons Inc.	**2004**
6.	Morrison, R.T., Boyd, R.N. and Bhattacharjee, S.K., "Organic Chemistry", 7th Ed., Pearson Education in South Asia.	**2013**
7.	Mallick, A., " Engineering Chemistry", Viva Books Pvt. Ltd.	**2009**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-008** Course Title: **General Chemistry-III**

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

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

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

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

8. Pre-requisite: **Nil**

9. Objective: To impart basic knowledge of chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Thermodynamics***:* Statistical concept of entropy, description of equilibrium and feasibility of chemical reactions, Clausius-Clapeyron equation, partial molar quantities-chemical potential, ionic activity coefficients.	**4**
2.	**Kinetics:** Theories of chemical reactions – Draw-backs of collision theory, transition state theory using partition functions and its thermodynamic formulation, consecutive and parallel reactions.	**4**
3.	**Photochemistry**: Basics of photochemistry, photochemical reactions in aqueous medium and environment, free radicals as reactive intermediates, their methods of preparation and use in synthesis, CFCs and alternatives to CFCs.	**4**
4.	**Chemistry o f N atural Water:** Speciation of acids and bases, pC-pH diagrams and their applications, redox potentials − their uses in chemic al speciations, acid-base and redox chemistry of compounds of sulphur, nitrogen and phosphorus including their environmental implications. Heavy metals (Pb, Hg and As) and their speciation causing toxicity.	**7**
5.	**Corrosion:** Corrosion processes in metals – electrochemical aspects, prevention strategies for corrosion.	**2**
6.	**Cement C hemistry:** Cement− its constituents and their structures, classification of cement, hydration process and importance of the products of hydration, chemistry of pozzolanic reactions. Analysis of Portland cement with reference to insoluble residue, total silica, sesquioxides, iron, lime and manganese. Role of calcium hydroxide in cement.	**7**
7.	**Soil Chemistry:** Chemical composition of soils, types of clay minerals, soil colloids, diffused double layers, sorption processes, cation and base exchange phenomenon in soils, isomorphous substitution.	**5**
8.	**Petroleum Chemistry:** Overview of petroleum processing − fractional distillation, gasoline/petrol − classification, knocking, octane number.	**3**
9.	**Spectral T echniques**: Introduction of spectroscopic techniques viz., UV-Vis, IR, and Mass spectroscopy for structural prediction of organic compounds.	**6**
	Total	**42**

List of Experiments:

1. Determination of sodium carbonate in baking/washing soda.
2. Determination of Zn by EDTA- complexometric titration.
3. Determination of nitrogen as ammonia in a sample.
4. Determination of viscosity of a polymer in a solution /or in a mixture of liquid.
5. Determination of surface excess concentration of 1-butanol in aqueous solution.
6. Kinetics of a reaction between hydrogen peroxide and iodine in acidic medium.
7. Photochemical reduction of ferric oxalate in cyanotype blue printing.
8. Spectrophotometric determination of [Fe (III)] by using KSCN.
9. Identification of functional groups in an organic compound.
10. Characterization of an organic/inorganic compound by UV-Vis and IR spectra.

11. Sectrophotometric determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$.
12. pH metry/ potentiometry titration: strong acid – strong base.
13. Preparation of potash alum from scrap aluminium.
14. Synthesis of potassium trisoxalatochromate(III).

11. Suggested Books:

S. No.	Authors / Title/ Publisher	Year of Publication/ Reprint
1.	Atkins, P.W., "Physical Chemistry", 8th Ed., Oxford University Press.	**2006**
2.	Turro, N.J., Ramamurthy, V. and Scaiano, J.C., "Modern Molecular Photochemistry of Organic Molecules", University Science Books.	**2008**
3.	Manahan, S.E., "Environmental Chemistry", 8th Edition, CRC Press.	**2005**
4.	Masters, G.M. and Ela, W.P., "Introduction to Environmental Engineering and Science", 3rd Ed. Pearson Education.	**2008**
5.	Taylor, H.F.W., Cement Chemistry, 2nd Ed. (reprinted), Thomas Telford Services Ltd., London.	**2004**
6.	Morrison, R.T., Boyd, R.N. and Bhattacharjee, S.K.,"Organic Chemistry", 7th Ed., Pearson Education in South Asia.	**2013**
7.	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	**2009**
8.	Sposito, G., "Chemistry of Soils", 2nd Ed., Oxford University Press.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject: CY**N- 201M** Course Title: **Physical Chemistry -1**
2. Contact Hours: **L: 2 T: 1 P: 0**
3. Examination Duration (Hrs): Theory **02** Practical **00**
4. Relative weightage: CWS **25** PRS - MTE **25** ETE **50**
5. Credits: **03** 6. Semester: **Autumn** 7. Subject Area: **BSC**
8. Pre-requisite: **CY-101**
9. Objective of Course: To make students familiar with the essentials of Physical Chemistry and to build foundation for learning advanced topics in the area.
10. Details of Course:

S.No	Particulars	Contact Hours
1.	**Colloidal s tate:** Introduction, coagulation, kinetics of coagulation, sensitization, protection, stability of sols, electrophoresis, electroosmosis, origin of charge, determination of charge and zeta potential, emulsions, gels, Liesegang ring phenomenon, sol-gel transformation, thixotropy.	**5**
2.	**Chemical k inetics:** Introduction to its concepts, differential and integrated rate expressions for various reactions, methods for studying the kinetics of reactions, theories of reaction rates, complex reactions.	**7**
3.	**Phase r ule:** Concepts and derivation of phase rule, phase diagrams of 1,2 and 3 component systems, Lever rule.	**7**
4.	**Electrochemistry:** Introduction, anomaly of strong electrolytes, interionic attraction theory, Debye – Hückel – Onsager equation, Wein effect, Debye – Falkenhagen effect, types of electrodes, galvanic cells, liquid junction potential, concentration cells with and without transference, polarization, decomposition voltage, over voltage.	**9**
	Total	**28**

11. Suggested Books:

S.No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Levine I.N, "Physical Chemistry", 5th Ed., Tata McGraw-Hill Publishing Company, Ltd., New Delhi.	**2001**
2.	Silbey R.J. and Alberty, R.A., "Physical Chemistry", 3rd Ed., John Wiley and Sons, Inc.	**2003**
3.	Atkins P.W., "Physical Chemistry" 6th Ed., Oxford University Press.	**1998**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject: **CYN- 211M** Course Title: **Basic Inorganic Chemistry**
2. Contact Hours: **L: 02 T: 01 P: 0**
3. Examination Duration (Hrs) Theory **02** Practical **00**
4. Relative weightage: CWS **25** PRS - MTE **25** ETE **50**
5. Credits: **03** 6. Semester: **Autumn** 7. Subject Area: **BSC**
8. Pre-requisite: **CYN-101**
9. Objective of Course: To impart knowledge of structure, bonding and reactivity of compounds of s, p, d and f-block elements.
10. Details of Course:

S.No.	Particulars	Contact Hours
1.	Periodic trends and its relation to chemical bonding and reactivity.	**2**
2.	**Introduction to molecules and their chemical bonding:** Simple molecules, macromolecules and supramolecules. Ionic bonding: energetics of ionic bond, and lattice energy. Covalent bonding: energetics of covalent bond in hydrogen molecule –valence bond theory, VSEPR concept and hybridization (involving s, p, d orbitals) and shapes of molecules of higher (5, 6 and 7) co-ordination numbers, elementary ideas of molecular symmetry; Molecular orbital theory of both homo- and hetero-nuclear diatomic molecules, resonance and delocalized molecular orbitals; H-bonding, inter- and intramolecular and their effects; Weak intermolecular forces. Metallic bonding: band model, soft X-ray spectra and N(E) curves, binding energy in metals, conductors, semiconductors and insulators, effect of temperature and impurity on conductivity.	**8**
3.	**Representative chemistry of main group elements:** solvated electron in alkali metals, multicentre bonds; structures, bonding and applications– boron halides, diborane, tetraborane, borazines, boronitrides, crown ethers, carbides, fullerenes, fluorocarbons, silicon halides, silicates, siloxanes, silicon polymers, phosphonitrilic halides, synthesis, structures and reactivity of compounds of xenon, bonding in xenon fluorides.	**6**
4.	**Principles and applications of transition metal chemistry:** Variable valency, colour, spectral, magnetic and catalytic properties, ability to form complexes, stability constant of coordination compounds, importance of transition metals in biological systems and in medicine.	**4**
5.	**Lanthanides and actinides:** Separation and isolation of lanthanides, separation of Np, Pu and Am from U, comparison of lanthanides and actinides, and their applications in technology.	**2**
6.	**Introduction of metal ions in medicine and materials:** Preliminary ideas on bio-inorganic chemistry, oxygen transport and storage, metalloenzymes.	**6**
	Total	**28**

11. Suggested Books:

S.No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Greenwood N.N. and Earnshaw A., "Chemistry of the Elements", 2nd Ed., Butterworth Heinemann, Oxford.	**1997**

2.	Cotton F.A., Wilkinson G. and Gaus P.L., "Basic Inorganic Chemistry", 3rd Ed., John Wiley & Sons, Inc. New York.	**2002**
3.	Shriver D.F. and Atkins P.W., "Inorganic Chemistry", 3rd Ed., Oxford University Press.	**1999**
4.	Huheey J.E., Keiter E.A. and Keiter R.L., "Inorganic Chemistry, Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	**2001**
5.	Cotton F.A., Wilkinson G. Murillo C.A. and Bochmann M., "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, New York.	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject: **CYN-202 M** Course Title: **Organic Chemistry - 1**
2. Contact Hours: **L: 3 T; 1 P: 0**
3. Examination Duration (Hrs) Theory **03** Practical **00**
4. Relative weightage: CWS **25** PRS - MTE **25** ETE **50**
5. Credits: **04** 6. Semester: **Spring** 7. Subject Area: **BSC**
8. Pre-requisite: **CY-101**
9. Objective of Course: To develop concepts of stereochemistry and organic reactions.
10. Details of Course:

S.No.	Particulars	Contact hours
1.	**Nature of Bonding in Organic Molecules**: Delocalised chemical bond, hyperconjugation, tautomerism, hydrogen bonding, aromaticity of benzenoid and nonbenzenoid compounds, Hückel rule, energy levels of pi-molecular orbitals in simple systems.Brief discussion on the strength of organic acids and bases.	**08**
2.	**Stereochemistry:** Configuration and chirality, optical isomerism of compounds containing chiral centres optical isomerism of compounds without chiral centres (allenes, spiro compounds, diphenyl derivatives, and compounds containing exocyclic double bonds), R, S- convention. Prochirality, enantiotopic and diastereotopic groups, methods of resolution. Geometrical isomerism in acyclic, cyclic, condensed and bridged systems and oximes (Beckmann rearrangement) E, Z-convention.	**14**
3.	**Reactive Intermediates:** General methods of generation, their reactivity and stability.	**04**
4.	**Aliphatic Substitution:** SN_1, SN_2 and SNi mechanisms, stereochemistry, relative reactivity in substitutions, effect of substrate structure, attacking nucleophile, leaving group and reaction medium, neighbouring group participation, competitive reactions. Introduction to SE_1 , SE_2 and SEi reactions.	**08**
5.	**Elimination Reactions:** Introduction, discussion of E_1, E_2, E_1cB and E_2C mechanisms, stereochemistry, relative reactivity in elimination, effect of substrate structure, attacking nucleophile, leaving group and reaction medium, competitive reactions, orientations/orientation of the double bond, Saytzeff and Hoffman rules, β-eliminations (Fritsch-Buttenberg-Wiechell rearrangements).	**08**
	Total	**42**

11. Suggested Books:

S.No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Sykes P,, "Guide book to Mechanism in Organic Chemistry", Orient Longman.	**2002**
2.	Morrison R.T. and Boyd R.N., "Organic Chemistry", 6th Ed., Prentice Hall of India.	**2001**
3.	March J., "Advanced Organic Chemistry", John Willey & Sons.	**1992**
4.	Eliel E.L., "Stereochemistry of Carbon Compounds", Tata McGraw Hill.	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code : **ICY-01** Course Title : Fundamentals of Polymer Science

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: **Autumn/Spring** 7. Subject Area: **BSC**

8. Pre-requisite: Nil

9. Objective: To introduce the fundamental and technological importance of polymers.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** General idea of the polymers and their classifications, molecular forces and chemical bonding; Polymers in technological and biomedical fields.	**4**
2.	**Polymer C hains a nd Mo lecular We ights:** Degree of polymerization, number and weight average, molecular weights; Molecular weight dispersity and characteristics of polymers; Weight and composition heterogeneity in polymers; Polymer chain dimension and solution viscosity; Thermal and spectral characteristics of polymers.	**6**
3.	**Methods o f Polymers S ynthesis:** Synthesis of polymers using bulk, solution, emulsion, suspension and interfacial route of polymerization and characteristics of polymers; Addition and step growth polymers.	**6**
4.	**Technological Polymers:** Polymer blends, polymer composites, polymer films, resins, foams, polymer liquid crystals and engineering plastics, smart and responsive polymers, polymers for device applications, biodegradable polymers, conducting polymers.	**6**
5.	**Industrial Po lymers:** Vinylic and phenolics, polyessters, polyamides, polyphosphazenes, polysilanes, polysiloxanes, coordination and organometallic polymers, polyacrylates.	**6**
Total		**28**

11. Suggested Books:

S. No.	Authors/Title/ Publisher	Year of Publication/ Reprint
1.	Billmeyer Jr. F.W., "Text Book of Polymer Science", 3rd Ed. , Wiley-Interscience	**1994**
2.	Fried J.R., "Polymer Science and Technology", Prentice-Hall of india.	**2002**
3.	Stevens M.P., "Polymer Chemistry: An Introduction", 3rd Ed., Oxford University Press.	**1999**
4.	Seymour R.B. and Carraher Jr C.E., "Polymer Chemistry", Marcel Dekker.	**1991**
5.	Sinha R., "Outlines of Polymer Technology: Manufacture of Polymers", Prentice-Hall of India	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **ICY-02** Course Title: **Nuclear Science and Technology**

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**: Autumn** 7. Subject Area**: BSC**

8. Pre-requisite: **Nil**

9. Objective: To impart fundamental concepts and applications of nuclear science and technology to the students.

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Basic nuclear science: Elementary particles, nuclear stability, properties of nucleons, mass-energy relationship, nuclear models, radioactivity, decay methods, radioactive equilibrium, nuclear reaction	**7**
2.	Nuclear detectors and measurements: Concept of α, β and γ radiation detection, different types of detectors – gas filled, scintillation, solid state, semiconductor.	**5**
3..	Particle accelerators and their application: Cyclotron, Van de Graaf, Cockroft Walton, applications– ion implantation, material modification and characterization, nanostructured materials by ion beam, trace element mapping, nuclear dating	**8**
4.	Nuclear Reactor and applications: types of nuclear reactor enrichment of radioisotopes, power generation, isotope production, isotope, radiotracer applications, radioimmunoassay, radiopharmaceuticals, neutron activation analysis.	**8**

11. Suggested Books:

Sl. No.	Authors/Title/Publisher	Year of Publication/ Reprint
1.	W.D. Ehmann and D.E. Vance, "Radiochemistry and Nuclear Methods of Analysis" John Wiley and Sons, New York.	**1991**
2.	H.J. Arnikar, "Essentials of Nuclear Chemistry" 4th Edition, New Age International (P) Ltd. New Delhi.	**2003**
3.	J.R. Bird, J.S. Williams, (Eds.) "Ion Beam for Material Analysis" Academic Press, Inc. London.	**1989**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **ICY-03** Course Title: **Introduction of Photochemistry**

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: **Autumn/Spring** 7. Subject Area: **BSC**

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

9. Objective: The objective of the course is to learn photochemistry concepts related to physical processes and chemical reactions induced by proton absorption and their applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Electromagnetic radiation, color, electronic states, absorption and emission. Excited states and photophysical processes, annihilation, emission, and sensitization. Jablonski diagrams, excited state lifetimes, fluorescence and phosphorescence and quantum yield.	4
2	**Photophysical P rocesses:** Intramolecular radiationless transitions of excited states energy gap law, Frank-Condon factor, intersystem crossing, heavy atom effects and selection rules. Intermolecular physical processes of excited states – quenching, excimers, exciplexes, electronic energy transfer and photoinduced electron transfer.	8
3	**Photochemical reactions:** Classification of photochemical reaction pathways, and mechanisms – electron transfer and proton transfer, photochemical intermediates, photoisomerizations, chemiluminescence, bioluminescence and related processes. Chemistry of excited state molecules (alkenes, aromatics, ketones, molecular oxygen etc.). Photosensitizers, photoinitiators and photocatalysts.	9
4	**Photochemical de vices:** Photochemical molecular machines, photodynamic therapy applied to cancer, photochromatic imaging, photostabilizers, fluorescent sensors, polarity probes, switches, light emitting diodes and photovoltaics.	7
	Total	28

11. Suggested Books:

Sl. No	Name of Authors/Books/Publisher	Year of Publication/ Reprint
1.	Valerum B., Molecular Fluorescence: Principles and Applications, Wiley.	2002
2.	Coyle, J.D., Introduction to Organic Photochemistry, John Wiley & Sons.	1991
3.	Turro, N.J., Ramamurthy V., Scannio J.C., Principles of molecular photochemistry: an introduction, University Science Books.	2008
4.	Klan, P., Wirz J., Photochemistry of Organic Compounds: From Concepts to Practice Wiley-Blackwell.	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code : **ICY-04** Course Title : Functional Materials: Structure and Properties

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

3. Examination Duration (Hrs.): **Theory 03** **Practical 0**

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

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

8. Pre-requisite: None

9. Objective: To introduce the students to the area of functional materials-structure, properties, synthesis and processing

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Introduction to Functional Materials:** Solids and materials, advanced functional materials and their technological applications; *classification of materials* – molecular and extended solids, low dimensional materials, mesoporous and microporous materials, nanomaterials and liquid crystals.	6
2.	**Structure and Symmetry of Solids:** Bonding in solids, arrangement of atoms and molecules in crystalline and amorphous solids, lattice, point group, space groups and crystal structure; *description of structures* – rock salt, zinc blende, wurtzite, perovskite, spinel, rutile, pyrochlore, honey-comb and low dimensional structures- chains, ladders, layered, tunnel, spiral.	8
3.	**Materials and Properties of Technological Importance:** Optical, magnetic, transparent conductors, superconductors, piezoelectric, relaxor ferroelectric, magnetoresistance (GMR, CMR, TMR); *SMART materials*-multiferroic, spintronic, shape memory alloys, thermoelectric.	10
4.	**Synthesis and Processing of Materials:** Solid state synthesis (ceramic method), precursor route, arc melting, induction method, sol-gel, hydrothermal, thermo-mechanical, pulsed laser deposition (PLD), chemical vapour deposition (CVD), molecular beam epitaxy (MBE), physical vapour deposition (PVD), inert atmosphere synthesis.	3
5.	**Material Characterization: Structure/morphology/chemical composition :** X-ray diffraction (systematic absences, indexing, lattice refinement and pattern simulation), neutron diffraction, UV-visible, IR, SEM, TEM, EDAX, XRF, TGA-DTA, DSC, XPS, XAS, ARPES; *electrical/magnetic/thermal*-resistivity, VSM, SQUID, XMCD, specific heat, thermal transport.	10
6.	**Electronic Structure Theory:** Concept of density of states (DOS) and elementary band theory, band structures and selected metals and simple solids, introduction to quantum mechanical methods based on density functional theory (DFT)	5
Total		**42**

11. Suggested Books:

S.No.	Authors/Title/Publisher	Year of Publication/ Reprint
1.	West, A.R., **"Solid State Chemistry and its Applications",** , Reprint, Wiley India	**2013**
2.	Rao, C.N.R. and Gopalakrishnan J., **"New Directions in Solid State Chemistry",** , 2nd Ed., Cambridge University Press.	**1997**
3.	Stout G.H. and Jensen, L.H. **"X-Ray Structure Determination: A Practical Guide",** , 2nd Ed., Wiley-Interscience.	**1989**
4.	**"Fundamentals of Crystallography",** C. Giacovazzo, G. Artioli, H.L. Monaco, Oxford University Press.	**2006**

5.	**"Structural Inorganic Chemistry",** A.F. Wells, 5th Ed, Clarendon Press, Oxford.	**1984**
6.	**"Magnetic M aterials: F undamentals a nd D evice A pplications",** Nicola Spaldin, Cambridge University Press.	**2003**
7.	**"Electronic Structure of Materials",** A.P. Sutton, A.D. Sutton, Oxford University Press.	**1993**
8.	**"The Electronic Structure and Chemistry of Solids",** P.A. Cox, Oxford University Press.	**1987**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **CYN-004** Course Title: **General Chemistry-I**

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

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

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

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

8. Pre-requisite**: Nil**

9. Objective: To provide a theoretical and experimental knowledge of basic/fundamental chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Quantum Mechanics:** Introduction to quantum chemistry, particle in a box − implication of its concepts, H atom, radial and angular wave functions, and shapes of orbital (*s, p*).	**4**
2.	**Thermodynamics*:*** Statistical concept of entropy, description of equilibrium, feasibility of chemical reactions, Clausius-Clapeyron equation, partial molar quantities− chemical potential.	**4**
3.	**Kinetics and Catalysis:** Theories of chemical reactions – Draw-backs of collision theory, transition state theory using partition functions, thermodynamic formulation of transition state theory, homogeneous catalysis.	**4**
4.	**Corrosion and Fuel cells:** Electrochemical corrosion and fuel cells.	**2**
5.	**Stereoisomerism:** Stereochemistry of addition at carbon-carbon double bond, addition of bromine to cis-, and trans- butene, oxidation across the double bond through peroxides and permanganate, Diels Alder reaction [4+2] and [2+2] cycloaddition reactions.	**5**
6.	**Synthesis** of some important compounds such as benzocaine, saccharin, salbutamol and thyroxine. Introduction to spectroscopic techniques for structural prediction of organic compounds.	**7**
7.	**Novel Polymers:** Stereo chemical control of synthesis, Ziegler-Natta catalyst, polyurethanes, conducting polymers.	**2**
8.	**Coordination Chemistry:** Comparison of the stability of octahedral and tetrahedral complexes on the basis of crystal field stabilization energy, factors affecting the magnitude of Δ, applications of crystal field theory, variation of hydrated ionic radii and hydration enthalpy/stability of complexes, Jahn-Teller effect− definition and examples from d^9 system, static and dynamic Jahn-Teller effects.	**5**

9.	**Organometallic C hemistry:** Factors affecting M-C bond formation, transition metal-π alkene complexes − synthesis, reactions, bonding and stability. Applications of organometallic compounds in catalytic processes such as hydroformylation, hydrogenation, catalytic decarbonylation, olefin metathesis and enantioselective hydrogenation of alkenes.	**6**
10.	**Spectroscopic Techniques:** Interaction of electromagnetic radiation with matter, spectroscopic techniques viz., UV-Vis and IR, and their applications for characterization of simple compounds.	**3**
	Total	**42**

List of Experiments:

i)	Determination of sodium carbonate in baking/washing soda.
ii)	Determination of Zn by EDTA- complexometric titration.
iii)	Solvent free synthesis -Wittig olefination of aldehyde or ketone by grinding.
iv)	Determination of viscosity of a polymer in a solution /or in a mixture of liquid.
v)	Determination of surface excess concentration of 1-butanol in aqueous solution.
vi)	Kinetics of a reaction between hydrogen peroxide and iodine in acidic medium.
vii)	Photochemical reduction of ferric oxalate in cyanotype blue printing.
viii)	Spectrophotometric determination of [Fe (III)] by using KSCN.
ix)	Identification of functional groups in an organic compound.
x)	Characterization of an organic/inorganic compound by UV-Vis and IR spectra.
xi)	Spectrophotometric determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$.
xii)	pH metry/ potentiometry titration: strong acid – strong base.
xiii)	Preparation of potash alum from scrap aluminium.
xiv)	Synthesis of potassium trisoxalatochromate(III).
xv)	Synthesis of a polymer.

11. Suggested Books:

S. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Lee, J.D., "Concise Inorganic Chemistry", 5th Ed., Chapman & Hall.	2002
2.	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	2009
3.	Morrison, R.T., Boyd, R.N. and Bhattacharjee, S.K., "Organic Chemistry", 7th Ed., Pearson Education in South Asia.	2013
4.	Silbey, R.J. and Alberty, R.A., "Physical Chemistry", 3rd Ed, John Wiley & Sons, Inc.	2003
5.	Atkins, P.W., Physical Chemistry, 8th Ed., Oxford University Press.	2006
6.	March, J., "Organic Chemistry: Reactions, Mechanisms and Structures", 6th Ed., John Wiley & Sons.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **EEN-112** Course Title: **Electrical Science**

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

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

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

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

8. Pre-requisite**: NIL**

9. Objective: To introduce the students to the fundamentals of Electrical Engineering concepts of network analysis, principles of electrical machines, basics of electrical measurement and measuring instruments.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Energy Resources an d U tilization:** Conventional and non-conventional energy resources; Introduction to electrical energy generation from different resources, transmission, distribution and utilization.	**5**
2.	**Network Fundam entals**: Types of Sources and elements, Kirchoff's Laws, Mesh and Node Analysis of D.C. Networks, Network Theorems: Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum Power Theorem, Star-Delta Transformation.	**5**
3.	**A.C. F undamentals**: Concept of phasor, impedance and admittance; Mesh and Node analysis of AC networks; Network theorems in AC networks; Active and reactive power in AC circuits; Resonance in series AC circuits; Power factor correction.	**4**
4.	**Three-phase A .C. Circuits**: Analysis of 3-phase balanced start-delta circuits, Power in 3-phase Circuits.	**2**
5.	**Measurement of E lectrical Qu antities**: Measurement of Voltage, Current, and Power; Measurement of 3 phase power; Energy meters.	**5**
6.	**Single P hase T ransformer**: Introduction to magnetic circuit concepts, Basic constructional features, operating principle, phasor diagram, equivalent circuit, voltage regulation; Eddy current and Hysteresis losses, efficiency; Open circuit and Short Circuit tests.	**5**

7.	**D.C. Machines**: Principle of operation, constructional features; Emf and torque equations; Types of excitation; Generator characteristics; Starting and speed control of D.C. motors.	**5**
8.	**AC Machines**: Three-phase Induction Motor - Operating principle, constructional features, torque-speed characteristics, starting and speed control; Single-phase Induction Motor - Operating principle, constructional features, torque-speed characteristics, starting methods.	**5**
9.	**Industrial Applications an d C ontrol: V** arious industrial loads, traction, heating, lighting; Concept of power electronic control of AC and DC motors.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Mukhopadhyaya P., Pant A.K., Kumar V. and Chittore D.S., "Elements of Electrical Science", M/s Nem Chand & Brothers.	1997
2.	Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India.	2002
3.	Dubey G. K., "Fundamentals of Electric Drives", 2nd Ed., Narosa Publishing House.	2007
4.	Alexander C.K., Sadiku M.N.O., "Fundamentals of Electric Circuits", McGraw Hill, 5th Edition.	2012
5.	Chapman, Stephen, J., "Electric Machinery Fundamentals", McGraw Hill Book Company.	1985
6.	Hughes Edward, "Electrical & Electronic Technology", Pearson Publishing, 8th edition.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-001** Course Title: **Mechanics**

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 15 30 40 0

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

8. Pre-requisite**:** **None**

9. Objective: **To familiarize students with the basic principles of mechanics**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**STATICS OF PARTICLES** Vectorial representation of forces and moments- Vector Operation-Concepts of Particles and Rigid bodies – Composition of concurrent forces in Plane Free body Diagram – Equilibrium of Rigid bodies in Two and three dimensions-Moment of a force about a point and about an axis-Couple moment-Reduction of a force system to a force and a couple	8
2.	**PROPERTIES OF SURFACES, MOMENTS AND PRODUCTS OF INERTIA** Definition of Moment of Inertia for areas- Parallel axis theorem - Perpendicular axis theorem-Moment of inertia for composite area-product of inertia for an area-mass moment of inertia	6
3.	**FRICTION** Laws of coulomb Friction – Coefficient of Friction – Dry Friction – Sliding Friction –Ladder friction – Belt friction — Rolling Resistance.	4
4.	**KINEMATICS OF PARTICLES** Principle of virtual work for a particle and rigid body-condition for equilibrium for a conservative system, stability-particle dynamics in rectangular coordinate, cylindrical coordinate and in terms of path variables-General motion of a system of particles-	8
5.	**WORK ENERGY METHODS, IMPULSE AND MOMENTUM** Work Energy Method – Conservation of Energy – Impulse and Momentum Relation – Impulsive Forces – Impact force – Conservation of momentum – Moment of Momentum Equation.	8
6.	**RIGID BODY MOTION;** Translation and rotation of rigid bodies- Derivative of a vector fixed in moving reference-General relationship between time derivative of a vector for different references-Moment of momentum equations-Kinetic energy of a rigid body-Work and energy relations-Euler's equation of motion-Three dimensional motion about a fixed point	8
	Total	**42**

List of experiments:

1. Study of magnetic field of a pair of coils in Helmholtz arrangement
2. Determination of e/m
3. Determination of first excitation potential of a gas by Frank-Hertz experiment
4. Determination of Stefan's constant
5. Determination of Planck's constant by radiation
6. To study and verify Malus' law
7. Study of polarization of light using quarter wave plate
8. Determination of Brewster's angle at glass-air interface
9. Determination of width of a slit by single-slit diffraction pattern
10. Four probe method of finding resistivity of semiconductor
11. Quinck'e Method for determining mass susceptibility
12. Wavelength of Na light by Newton's ring method

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Shames I. H. and Rao G. K., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education	**2006**
2.	Beer F.P and Johnson E.R., "Vector Mechnics for Engineers – Statics and Dynamics", 9th Edition, Tata McGraw-Hill Publishing Company Ltd.,	**2009**
3.	Pytel A. and Kiusalaas J., "Engineering Mechanics: Statics" 3rd Edition, Cengage Learning	**2010**
4.	Pytel A. and Kiusalaas J., "Engineering Mechanics: Dynamics" 3rd Edition, Cengage Learning	**2010**
5.	Hibbeler R. C. and Gupta A., Engineering Mechanics, ", 12th Edition, Pearson Education	**2012**
6.	Meriam J.L. and Kraige L.G., "Engineering Mechanics: Statics", 6th Edition, John Willey and Son's	**2012**
7.	Meriam J.L. and Kraige L.G., "Engineering Mechanics: Dynamics", 6th Edition , John Willey and Son's	**2012**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-101** Course Title: **Introduction to Physical Sciences**

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

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

4. Relative Weightage**:** **CWS** 00 **PRS** 00 00 100 0

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

8. Pre-requisite**:** **None**

9. Objective: To introduce physics discipline

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Introduction: History, Philosophy, Core theories, Classical physics, Modern physics, Difference between classical and modern physics. Relation to other fields such as chemistry, mathematics, astronomy and geology. Application and influence as Applied Physics	**6**
2.	General aspect of physics: Physics concepts in primary and secondary education curricula, important publications in physics and physicists, Perfection in physics and chemistry Time line of fundamental physics discoveries Time line of developments in theoretical physics	**8**
3.	Research**:** Scientific method, Theory and experiment, Scope and aims. Major research fields of physics, along with their subfields and the theories they employ viz. Condensed matter , Atomic, molecular, and optical physics, High-energy physics (particle physics) and nuclear physics, Astrophysics , nano-technology, Geophysics and biophysics. Current research and some well known unsolved problems of physics	**14**
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Bose D.M., Sen S.N. & Subbarayappa B.V., (eds), "A Concise History of Science in India", Universities Press, Hyderabad, 2nd Edition.	**2009**

2.	Varadaraja V. Raman, "Glimpses of Indian Scientists", Samvad India Foundation, New Delhi.	**2006**
3.	Subbarayappa B.V., "Indian Perspectives on the Physical World", vol. IV part 3 in History of Science, Philosophy and Culture in Indian Civilization, Centre for Studies in Civilization, New Delhi.	**2004**
4.	Nobel Lectures in Physics, 1901-1995, World Scientific, CD-ROM	**2010**
5.	Feynman R. P., Leighton R. B. and Sands M., "The Feynman Lectures on Physics", Addition-Wesley Publication	**1964**
6.	http://en.wikipedia.org/wiki/Physics	**2013**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**: PHN-103** Course Title**: Computer Programming**

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

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

4. Relative Weightage**: CWS** 15 **PRS** 15 30 40 00

5. Credits**:** | 0 | 4 | 6. Semester: **Autumn** 7. Subject Area**:** **ESC**

8. Pre-requisite**: None**

9. Objective: This course provides students with an entry-level foundation in computer programming.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to computer hardware and software, information storage in computer memory, stored program concept, storage media. Computer operating system.	**4**
2	Basic concept of FORTRAN/C language and program organization. Arithmetic expressions, Numerical input/output statement, Loop instructions, Transfer of control through logical statements, arrays and subscripted variables, Standard I/O in "Fortran language", Fundamental Data Types and Storage Classes: Character types, Integer, short, long, unsigned, single and double-precision floating point, storage classes, automatic, register, static and external, Operators and Expressions: Using numeric and relational operators, mixed operands and type conversion, Logical operators, Bit operations, Operator precedence and associativity,	**6**
3	Use of functions, subroutines, Complex numbers, Common statement, Block data, Developing and testing of computer programs for various numerical problems	**8**
4	Conditional Program Execution: Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch, Program Loops and Iteration: Uses of while, do and for loops, multiple loop variables, assignment operators, using break and continue,	**8**
5	Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size, Structures: Purpose and usage of structures, declaring structures, assigning of structures,	**6**

6	Solution of linear and quadratic equations, matrix addition, subtraction and multiplication, Trace and Norm of matrix, Inverse of matrix, Numerical interpolation, differentiation and integration (Simpson, Trapezoidal and Gauss' Quadrature methods).	**10**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Books / Authors**	**Year of Publication/Reprint**
1.	Metcalf M., Reid J. & Cohen M., Modern, "Fortran Explained (Numerical Mathematics and Scientific Computation)" Oxford University Press, USA; 4 edition	**2011**
2.	Clerman N. S. & Spector W., "Modern Fortran: Style and Usage", Cambridge University Press	**2011**
3.	Hoffmann J. D., "Numerical Methods for Engineers and Scientists", Marcel Dekker Inc. 2nd edition	**2001**
4.	Sastry S. S., "Introductory Methods of Numerical Analysis", PHI Learning, 5th edition	**2012**
5.	Smolarski D. C., The essentials of FORTRAN, Research and Education Association, USA	**1989**
6.	Lipschutz S. & Poe A, "Theory and problems of Programming with Fortran", Schaum's Series Publications	**1982**
7.	McCormick J. M. & Salvodori M. G., "Numerical methods in Fortran" Prentice Hall Publications	**1964**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**: PHN-110** Course Title**: Introduction to Electronics**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory** 0 3 **Practical** 0 0
4. Relative Weightage**: CWS** 25 **PRS** 00 25 50 00
5. Credits**:** 0 4 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite: None

9. Objective: To impart knowledge of basic concepts of electronics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Semiconductor:** Energy band structure of Insulators, Semiconductors and Metals, Element and Compound semiconductors, Intrinsic semiconductors, Extrinsic semiconductors, electrons and holes , conductivity and mobility, effect of temperature and doping on mobility, carrier concentration and their temperature dependence, Fermi level in a semiconductor having impurities, p-n Junction fabrication (Simple Idea). Qualitative theory of the p-n junction**,** Volt-Ampere characteristics, Static and Dynamic Resistance of Diode.	**10**
2	**Bipolar J unction tr ansistors:** n-p-n and p-n-p transistors, Characteristics of CB, CE and CC configurations. Current gains α, β and γ and relations between them, Active, Cutoff, and Saturation regions.	**6**
3	**Amplifiers & Os cillators :** Analysis of a single-stage CE amplifier,,Coupled Amplifiers : RC-Coupled Amplifier and its Frequency Response of Voltage Gain, Operational Amplifiers: Inverting and noninverting Amplifiers. Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise, Sinusoidal Oscillators : Barkhauson's Criterion for self-sustained oscillations, RC Phase Shift Oscillator, Determination of frequency.	**10**
4	**Field Effect Transistors**: Junction Field Effect Transistors, Pinch-Off Voltage, Volt-Ampere Characteristics of JFET, Insulated -Gate FET (MOSFET) , Enhancement MOSFET, Depletion MOSFET, circuit symbols.	**8**
5	**Digital C ircuits:** Difference Between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND AND NOR Gates. Exclusive OR and Exclusive	**8**

	NOR Gates, Basic concepts of flipflops.	
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication/Reprint
1.	Streetman B. G. and Banerjee S., "Solid State Electronic Devices" , Prentice Hall, 6th Ed.	**2006**
2.	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education, 11th Ed.	**2012**
3.	Albert Malvino, David J. Bates, "Electronic Principles", McGraw Hill Publication, 7th Ed.	**2007**
4.	Donald P Leach, Albert Paul Malvino, Goutam Saha, "Digital Principles and Applications", Tata Mcgraw Hill Education Pvt. Ltd., 7th Ed	**2010**
5.	Floyd T. L. and Buchla D. L., "Electronics Fundamentals: Circuits, Devices and Applications", 8th Ed.	**2010**
6.	Mottershead A., "Electronic Circuits and Devices", PHI	**1997**
7.	Dube D. C., "Electronics: Circuits and Analysis" Narosa Publication, 2nd Edition	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**:** **PHN-201** Course Title**: Optics**

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

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

4. Relative Weightage**:** **CWS** | **15** | **PRS** | **15** | **30** | **40** | **00** |

5. Credits**:** | **0** | **5** | 6. Semester: **Autumn** 7. Subject Area**:** **DCC**

8. Pre-requisite**:** **None**

9. Objective: **To familiarize students with the basic principles of optics**

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Geometrical optics**: Fermat's principle, the ray equation and its solutions, matrix method in paraxial optics, unit planes, nodal planes, system of thin lenses.	**10**
2.	**Interference:** Huygen's principle and its applications, interference by division of wavefront, two slit interference, Fresnel's Biprism, interference with white light, displacement of fringes, interference by division of amplitude, thin parallel films, antireflection coatings, wedge shaped films, Newton's rings, Michelson interferometer and its applications, multiple beam interference, Fabry Perot interferometer and etalon.	**12**
3.	**Diffraction:** Fraunhofer diffraction, single, double and multiple slit diffraction, diffraction grating, diffraction at a circular aperture, Fresnel diffraction, Fresnel half period zones, the zone plate, diffraction at a straight edge, diffraction of a plane wave by a long narrow slit and transition to Fraunhofer region.	**10**
4.	**Polarization:** Polarization and double refraction, production of polarized light, Brewster's law, Malus's law, double refraction, interference of polarized light, quarter and half wave plates, analysis of polarized light, optical activity, polarimeters, Laurent's half shade and biquartz polarimeters,.	**10**
	Total	**42**

List of experiments:

i. Determination of wavelength of sodium light by Fresnel biprism.
ii. Determination of Young's modulus of a glass plate by Cornu's method.
iii. Determination of wavelength of laser light by Fabry Perot etalon.
iv. Normal dispersion curves and Cauchy's relations.
v. Fresnel equations: rotation of plane of polarization by reflection.
vi. Study of single, double and multiple slit diffraction.
vii. Study of diffraction of light by a thin wire.
viii. Determination of wavelength of light by Diffraction grating.
ix. Production and analysis of polarized light using quarter wave plates.
x. Nodal Slide Experiment.
xi. $\Delta\lambda$ by Michelson Interferometer
xii. Thickness of Mica sheet by Michelson Interferometer

11. Suggested Books:

S.No.	Names of Books/Authors	Year of Publication/Reprint
1.	Ghatak A., "Optics" 3rd Ed., Tata McGraw Hill	**2004**
2.	Hecht E., "Optics" 4th Ed., Addison Weseley	**2001**
3.	Jenkins F. A, and White H. E., "Fundamentals of Optics" 3rd Edition, McGraw Hill New York	**1976**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-203** 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 25 50 0

5. Credits**:** 4 6. Semester**: Autumn** 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.	**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.	10
2.	**Small Oscillations**: Eigenvalue problem, normal coordinates, frequencies of vibrations, forced vibrations, examples.	07
3.	**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
4.	**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
	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**
4.	Upadhyaya J.C., "Classical Mechanics", Himalaya Publishing House	**2005**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-202** Course Title: **Electricity and Magnetism**

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

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

4. Relative Weightage**: CWS** 15 **PRS** 15 30 40 0

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

8. Pre-requisite**: None**

9. **Objective of Course:** The course aims to familiarize students with the elements of Electricity and Magnetism.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Vector calculus:** Vectors in Cartesian, Cylindrical, and Spherical Polar coordinate system and transformation among themselves. Vector calculus: differential length, area, volume, Del operator, line, surface and volume integrals,in all the three coordinate systems. Gradient of a scalar, divergence (Gauss's theorem) and curl of a vector (Stoke's theorem) with their physical interpretations, delta function.	**10**
2.	**Electrostatics:** Electric field, Coulomb's law, continuous charge distribution, Gauss's law and its applications. Electric potential, Poisson's equations and Laplace's equation, boundary conditions, electrostatic energy, Laplace equation (boundary value problems in 1D or reducible to 1D and in Spherical coordinates), Boundary conditions and Uniqueness theorems, method of images, multipole expansion, Polarization, bound charges, electric displacement vector, linear dielectrics (susceptibility, permittivity, dielectric constant), energy in dielectric systems, force on dielectrics, boundary conditions.	**12**
3.	**Magnetostatics:**Currents, continuity equations, Biot-Savart law, Ampere's law and its applications, magnetic vector potentials, multipole expansion , Magnetization, dia-, para- and ferromagnetism, , bound currents, Ampere's lawin magnetized materials, linear media (magnetic susceptibility and permeability, boundary conditions).	**10**
4.	**Electrodynamics:** Faraday's Law of induction, self-inductance, transient currents, magnetic energy and mechanical forces, Maxwell equations with corrections, Maxwell equations in matter.	**10**

	List of experiments:	
I	To determine the self-inductance of a given coil.	
II	To find the resonant frequency of series LCR circuit.	
III	To obtain hystersis curve (B-H Curve) for a given ferromagnetic material.	
IV	To study transient effect in LCR circuits.	
V	To measure the dielectric constant and dielectric loss of given material by using LCR metre.	
VI	To measure the magnetic flux density in the middle of various wire loops with the Hall probe and to investigate its dependence on the radius and number of turns.	
VII	To measure the magnetic flux density along the axis of long coils and compare it with the theoretical values obtained from Biot-Savart's Law.	
VIII	Comparison of capacities (De-Sauty method)	
IX	Dielectric constant of material by Resonance method	
X	Determination of Inductance by Raleigh method	

11. Suggested Books:

S.No.	Names of Books/Authors	Year of Publication/ Reprint
1.	Hayt Jr. W. H., and Buck J. A., "Engineering Electromagnetics", Tata McGraw Hill Publishing Company Ltd, New Delhi, 7th edition	**2005**
2.	Sadiku N. O, "Elements of Engineering Electromagnetics", Oxford University Press, 3rd Edition	**2003**
3.	Rao N. N., "Elements of Engineering Electromagnetics", Prentice Hall of India, New Delhi, 4th Edition	**2000**
4.	Griffiths D J, "Introduction to Electrodynamics" 3rd Ed., Prentice Hall.	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**: PHN-212** Course Title**: Thermal Physics**

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

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

4. Relative Weightage**: CWS** 15 **PRS** 15 15 40 15

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

8. Pre-requisite**: None**

9. Objective: The course aims at familiarizing students with laws of thermodynamics and their correspondence with statistical mechanics.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Thermodynamic Po tentials a nd R elations:** Characteristic functions, Enthalpy, Helmholtz & Gibb's functions, Maxwell's thermodynamic relations and their applications, Volume expansivity, cubic expansion coefficient and compressibility, Closed & Open systems, Chemical potential, Internal energy equation, Heat capacity equation, Third law of thermodynamics, Equilibrium conditions, Phase Equilibrium, Phase transitions.	**12**
2.	**Low T emperatures a nd T hird L aw:** Joule-Kelvin effect, Liquefaction of gases, Magnetic cooling, Third Law of Thermodynamic and it's applications, Phase behaviour of Helium.	**08**
3.	**Thermodynamics o f Radiation:** Thermal Radiation, Radiation in a constant temperature enclosure, Kirchoff's Law, Properties of Black-body radiation, Stefan-Boltzmann Law, Wien's Law, Rayleigh-Jeans Law, Wien's displacement Law, Planck's distribution.	**07**
4.	**Statistical Mechanics:** Fundamental principles, Equilibrium distribution, phase space, Lagrangian multipliers, ensembles, Partition function, Equipartition of energy, distribution of speeds, Derivation of Classical and quantum statistics, Thermal properties of solids.	**15**
	Total	**42**

Laboratory work related to the course:

I	Measurement of temperature using thermister.
II	Specific heat measurements.
III	Stefan's constant and work function of a photo cathode using incandescent lamp.
IV	Thermal conductivity of metal by Searle's apparatus.
V	Verification of Stefan's law.
VI	J by Callendar and Barn's method.
VII	Temperature coefficient of resistance by Callandar and Griffiths bridge.
VIII	Thermal conductivity of Glass (Tube form)
IX	Co-efficient of thermal expansion
X	Thermo e.m.f by Potentionmeter

11.

Suggested Books:

S.No.	**Names of Books/Authors**	**Year of Publication /Reprint**
1.	Zemansky M.W. & Dittman R.H., "Heat & Thermodynamics" 8th Edition, McGraw Hill	**2011**
2.	Reif F., "Fundamentals of Statistical and Thermal Phsyics", McGraw Hill	**2008**
3.	Guha E., "Basic Thermodynamics", Narosa Publishers	**2002**
4.	Sears F.W. & Salinger G.L., "Thermodynamics, Kinetic Theory & Statistical Thermodynamics" Narosa Publishers	**1998**
5.	Huang K., "Statistical Mechanics", 2nd Edition, John Wiley	**1987**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-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 35 50 0

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

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

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 t o Plasma Physics:** Plasma definition; Debye shielding; Plasma parameters; Criteria for Plasma	6
2.	**Motion of Particles i n t he P resence of E lectric an d M agnetic Fields:** Motion of charge particle in uniform and non-uniform E and B fields; Time varying E and B fields.	6
3.	**Plasma as Fl uids:** 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 P lasma:** 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**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-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 25 50 0

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

8. Pre-requisite**:** **Nil**

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 P ackets an d U ncertainty 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 i n on e-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.	Beiser A**, "**Concepts of Modern Physics**"**, McGraw Hill International	**2004**
3.	Ghatak A and Lokanathan S, "Quantum Mechanics**"**, Mcmillan India Ltd.	**2004**
4.	Griffiths, D. J., **"**Introduction to Quantum Mechanics", Pearson Prentice Hall, 2nd Edition	**2004**
5.	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: **PHYSICS**

1. Subject Code: **PHN-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 25 50 0

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

8. Pre-requisite**:** **Nil**

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 - Expressions for Poisson's ratio in terms of elastic constants - 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.-Elastic materials-Tensor of strain-Tensor of elasticity	**8**
2.	**Bending of beams:** Cantilever - Expression for bending moment - Expression for depression - Cantilever oscillations - Expression for time period - Experiment to find Young's modulus - Non uniform bending - Experiment to determine Young's modulus by Koenig's method - Uniform bending - Expression for elevation - Experiment to determine Young's modulus using microscope	**4**
3.	**Fluids:** Surface Tension: Definition and dimensions of 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. Viscosity: Steady flow of Newtonian fluids – Poiseuille's equation for incompressible fluids: Statement of Stoke's law – Terminal velocity-Effect of temperature on viscosity-Reynold's number –Turbulent flow and critical velocity-Experiment to determine co-efficient of viscosity of a liquid - Applications of viscosity. Condition of equilibrium of a fluid-Fluid dynamics-Equation of continuity-Bernoullie's theorem& conservation of energy Physics of Low Pressure. Production and Measurement of low pressure - Grades' molecular pump - Rotary pump - Knudsen absolute	**12**

	gauge - Detection of leakage.	
5.	**Waves and Oscillations:** Simple harmonic motion - Free, Damped, Forced vibrations and Resonance – Coupled harmonic oscillator-eigen frequencies and normal modes-Transverse vibrations in stretched strings-Wave equation for a string-Velocity of transverse wave along a string –Energy of a vibrating string-Fourier's analysis for plucked and bowed string	**10**
6.	**Ultrasonics**: Production of ultrasonic waves - Piezo electric crystal method - Magnetostriction method - Properties - Application 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: **PHYSICS**

1. Subject Code: **PHN-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** **25** **50** **0**

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

8. Pre-requisite**:** **Nil**

9. Objective: To familiarize students with the basics of Atomic Physics and Atomic Spectroscopy

10. Details of Course:

Sl.No	**Contents**	**Contact Hours**
1.	Basic Principles of Spectroscopy; The Optical Spectrum of the Hydrogen Atom; Bohr's Postulates; Motion of the Nucleus; Spectra of Hydrogen-like Ions; Excitation of Quantum Jumps by Collisions; Sommerfeld's model; Lifting of Orbital Degeneracy by the Relativistic Mass Change; Quantum Mechanics of hydrogen atom and selection rules for electric dipole transtions	**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; Stark effect; Quantum Mechanics of Zeeman 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.	Eisberg R. and Resnick R., "Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles" , 2nd Edition, John Wiley & Sons Inc.	**1985**
3.	Bransden B. H. and Joachian C. J., "Physics of Atoms and Molecules" 2nd Edition, Prentice Hall,	**2003**
4.	Beiser A, **"**Concept of Modern Physics**"**, 6th Ed., Tata McGraw Hill	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-309** Course Title: **Laboratory Work-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 0 0 50

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

8. Pre-requisite**:** **Nil**

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

10. Details of Course:

S. No.	Contents	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: **Physics**

1. Subject Code: **PHN-302** Course Title: **Laboratory work II**

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 50

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

8. Pre-requisite**:** **None**

9. Objective: The laboratory work aims to familiarize students with the basic experiments based on various Electronic Circuits.

10. Details of Course:

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

Suggested Books:

S. No.	Name of Books / Authors	Year of Publication/Reprint
1.	Chattopadhyay D. and Rakshit P. C. , "An advanced course in Practical Physics" 7th Edition; New Central Book Agency (P) Ltd.	**2005**
2.	Gupta S. L. and Kumar V., "Practical Physics" 25th Ed. Pragati Prakashan	**2002**
3.	Paul P., Malvino A. and Miller M., " Basic Electronics: A Text-Lab Manual, Tata McGraw Hill	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-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 25 50 0

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

8. Pre-requisite**: Nil**

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 M echanical Pr operties:** Covalent bonding, ionic bonding, metallic bonding, hydrogen bonding and Van der waals bonding. Elastic constants and elastic waves.	6
2.	**Crystal S tructure:** 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 V ibrations:** One dimensional lattices (monoatomic and diatomic), quantization of elastic waves, phonon momentum, density of modes.	7
4.	**Electrons i n Solids:** Free electron gas in metals, periodic potential and Bloch's theorem and Kronig-Penney model.	8
5.	**Defects in S olids:** 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**
4.	Ibach H. and Lüth H., "Solid-State Physics: An Introduction to Principles of Materials Science", Springer; 4th Edition	**2009**
5.	Blundell S., "Magnetism in Condensed Matter", Oxford University Press, Oxford	**2001**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-306** Course Title: **Special Therory of Relativity**

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

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

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

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

8. Pre-requisite**: Nil**

9. **Objective o f Co urse:** The course aims to familiarize students with the special theory of relativity.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Relativistic K inematics:** Attempts to Locate the Absolute Frame; the Michelson-Morley Experiment, The Relativity of Simultaneity, Derivation of the Lorentz Transformation Equations, Some Consequences of the Lorentz Transformation Equations, A More Physical Look at the Main Features of the Lorentz Transformation Equations, The Observer in Relativity, The Relativistic Addition of Velocities, Aberration and Doppler Effect of Relativity	**6**
2.	**Relativistic D ynamics:** Mechanics and Relativity, Relativistic Momentum, Alternative Views of Mass in Relativity, The Relativistic Force Law and the Dynamics of a Single Particle, The Equivalence of Mass and Energy, The Transformation Properties of Momentum, Energy, Mass and Force	**6**
3.	**Relativity a nd E lectromagnetism:** The Interdependence of Electric and Magnetic Fields, The Transformation for E and B, The field of a Uniformly Moving Point Charge, Forces and Fields near a Current-Carrying Wire, Forces between Moving Charges, The Invariance of Maxwell's Equations, The Possible Limitations of Special Relativity, The Geometric Representation of Space-Time, The Twin Paradox The Principle of Equivalence and General Relativity	**10**
4.	**Four-Vectors a nd Rel ativistic In variance:** Vectors and Transformations, Rotation about the Z axis, Invariants of a Transformation, The Transformation Properties of Physical Law, Scalar invariants, Minkowski Space and Four-Vectors, The Momentum-Energy Four-Vector	**6**
	Total	**28**

11. Suggested Books:

S.No.	**Name of Authors/ Books/Publishers**	**Year of Publication /Reprint**
1.	Resnick R, “Introduction to Special Relativity”, Wiley Eastern	1986
2.	Kleppner and Kolenkow, “An Introduction to Mechanics”, McGraw Hill	1999
3.	Das Anadijban, “The Special Theory of Relativity”, Springer Verlag	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-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 25 50 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	**2007**
2.	Ghoshal S.N., "Nuclear Physics", S. Chand & Comp. Ltd	**2012**
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: **PHYSICS**

1. Subject Code: **PHN-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 35 50 0

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

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

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 I njection:** 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.	10
3.	**Junction Diodes:** 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
5.	**FET and MOSFET:** Ideal MOS capacitor, effect of work function and interface charge on threshold voltage, MOSFET.	8
6.	**Gunn D iode:** 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: **PHYSICS**

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

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

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

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

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

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

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 P otential:** 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 T heory:** 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 M ethods:** 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: **PHYSICS**

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

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

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

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

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

8. Pre-requisite: **Nil**

9. Objective: **To familiarize the students with the standard techniques with advance 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**"** , 5^{th} 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: **PHYSICS**

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

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

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

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

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

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

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 E quation:** 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 f rom A ccelerated C harges:** 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 F ields:** 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: **PHYSICS**

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

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

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

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

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

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

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 E quation: C** onstraints; 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 E quations:** Hamilton's equation of motion, cyclic co-ordinates, Routh's procedure, relativistic formation, variational principle, principle of least action.	8
3.	**Canonical T ransformations:** 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 T heory:** Hamilton-Jacobi equation's of motion, harmonic oscillations, separation of variables, action-angle variables, Kepler problem, geometrical optics and wave mechanics.	8
5.	**Canonical Pe rturbation T heory:** 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: **PHYSICS**

1. Subject Code: **PHN-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** 15 **PRS** 15 15 40 15

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

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

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

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Introduction t o m athematical so ftware:** 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.	**08**
3.	**Sub programs:** Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules.	**03**
4.	**Graphics:** 2D plots, style options, axis control, overlay plots, subplot, histogram, 3D plots, mesh and surface plots, contour plots.	**04**
5.	**Numerical c omputation:** 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)

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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 50

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

8. Pre-requisite**: Nil**

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

10. Details of Course:

S. No.	Contents	Contact Hours
1	Study of Hall effect and to determine the Hall coefficient	14 x 6
2	To measure resistivity of semiconductor by Four Probe method and determination of band gap.	
3	To determine reverse saturation current, material constant and band gap of PN Junction	
4	To ascertain of the Random nature of nuclear radiation	
5	To study G.M. tube characteristics and to calculate the dead time,	
6	To determine the relative beta counting of two strong β-sources of nuclear radiation and to determine the absorption coefficients,	
7	To determine the distribution of the size of Aerosol.	
8	To measure the attenuation of laser radiation in varying atmospheric condition.	
9	The measurement of precipitation rate of water using rain gauge.	
10	To determine the numerical aperture of a given multimode fiber using the far field measurements.	

11	To measure the spot size and the angle of divergence of a laser beam, to produce the elliptically and circularly polarized light from an unpolarized laser beam and study their angular intensity profiles.	
12	Design of counter using JK flip flop and a relaxation oscillator with given frequency and duty cycle	
13.	Design a Schmitt trigger with given UTP LTP and hysteresis	
14.	To design a binary/BCD up-down counter using IC 74190/74191	
	Total	**84**

11. Suggested Books:

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

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

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

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

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 Mat erials:** 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: **PHYSICS**

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

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

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

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

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

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

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

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Classical Statistical Mechanics:** Macro and microstates, connection between statistics and thermodynamics, phase space; Liouville's Theorem. Microcanonical, canonical and grand canonical ensembles; Energy and Density fluctuations; equivalence of various ensembles. Equipartition and virial theorem, partition function; Derivation of thermodynamic properties; some examples including (i) classical ideal gas (ii) system of classical harmonic oscillators, (iii) system of magnetic dipoles in magnetic field.	**10**
2.	**Quantum St atistical Me chanics:** 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 B ose a nd F ermi S ystems:** 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: **PHYSICS**

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

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

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

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

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

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

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

10. Details of Course:

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

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Griffiths D J, "Introduction to Quantum Mechanics", 2nd Ed, Pearson Eduction	**2005**
2.	Bransden B H and Joachain C J, "Quantum Mechanics", 2nd Ed, Pearson Eduction	**2000**
3.	Zettili N, "Quantum Mechanics: Concepts and Applications", 2nd Ed, John Wiley	**2009**
4.	Schiff L I, "Quantum Mechanics", 3rd Ed, McGraw Hill Book Co.	**1990**
5.	Schwabl F, "Advanced Quantum Mechanics", 4th Ed, Springer-Verlag	**2008**
6	Bjorken J D and Drell S D, "Relativistic Quantum Mechanics", McGraw Hill Book Co.	**1998**
7.	J.J.Sakurai, "Modern Quantum Mechanics", 1st edition, Addison Wesley	**1993**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-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 35 50 0

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

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

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**
5.	Samuel S.M.Wong, "Introductory Nuclear Physics", Wiley-VCH; 2nd edition	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 0 35 50 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 E volution:** Solar radiation, present atmospheric constituents, evolution of the atmosphere, formation of ozone.	6
2.	**Lower A tmosphere:** 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 A tmosphere:** 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: **PHYSICS**

1. Subject Code: **PHN-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 35 50 0

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

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

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, Classification of molecular electronic states	**9**
2.	Frank-Condon principle; Isotope effect on electronic spectra; Fluorescence and Phosphorecence; Classification of molecular electronic states. Idea of Line broadening mechanisms	**5**
3.	Lasers-Physical principles; Threshold condition; Generation of population Inversion; Properties of Lasers; He-Ne, CO_2 and Nd;Yag Lasers	**7**
4.	Laser absorption Spectroscopy; Saturated absorption spectroscopy; Doppler-free two photon spectroscopy; Level crossing spectroscopy.	**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**"**, (6^{th} 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**
5.	Foot, C. J., "Atomic Physics", 1^{st} edition, Oxford University Press USA	**2005**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

4. Relative Weightage**:** **CWS** 25 **PRS** 0 25 50 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 an d In terfaces:** 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 P roperties:** 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 T ransitions:** Order parameter; Critical points; First and second order phase transitions; Mean field theory; Properties near critical point; Landau theory; Bragg-Williams theory; Liquid-gas transition and Isotropic-mematic transition.	8

5.	**Superconductivity:** Cooper pairing and BCS theory; Ginzburg-Landau theory; Flux quantization; Supercurrent tunneling; DC and AC Josephson effects; High-Tc superconductors.	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Kittel C, "Introduction to Solid State Physics", 6^{th} 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: **PHYSICS**

1. Subject Code: **PHN-603** Course Title: **Advanced Atmospheric Physics**

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

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

4. Relative Weightage**:** **CWS** 25 **PRS** 0 25 50 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, perturbation theory and atmospheric waves, sound waves, gravity waves and Rossby waves, Momentum and energy transports by waves in the horizontal and the vertical.	**12**
2.	**Atmospheric Instabilities** Atmospheric instabilities, dynamical instabilities, barotropic instability, baroclinic inertial instability, Necessary condition of barotropic and baroclinic instability. Combined barotropic andbaroclinic instability. Kelvin-Helmholtz instability	**10**
3.	**Ionosphere:** Formation of Ionosphere,Chemical processes, Ionospheric conductivity, Planetary ionospheres, Ionospheric exploration using rockets and satellites, langmuir probe, temperature measurements, airglow and aurora, radio wave propagation in the ionosphere.	**10**
4.	**Magnetosphere:** Earth as a magnet, solar wind, types and theory of solar wind, frozen-in magnetic field, interaction of solar wind with Earth's magnetic field and formation of magnetosphere, inter planetary magnetic field (IMF), geomagnetic storms, van-allen	**10**

	radiation belts, plasmasphere,coronal holes, CMEs, satellite observations of various plasma domains and plasma instabilities.	
	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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 25 **PRS** 0 25 50 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: **PHYSICS**

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

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

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

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

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

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

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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 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**
3.	Lab Manual for Flame Photometer, Elico Ltd.	
4.	Lab Manual for Aerosol Size distribution, Scientific India	
5.	Lab Manual for Attenuation Constant, Spectra Laser	
6.	Lab Manual for Rain Gauge, Weather Measure Corp.	
7.	Lab Manual for Electric Field Simulation, Atmospheric Lab, IITR	

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 0 **PRS** 50 0 0 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.	Contents	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/Reprint**
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: **PHYSICS**

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

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

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

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

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

8. Pre-requisite**:** **PH-201, PH-202**

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 M icroscopes:** 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: **PHYSICS**

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

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

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

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

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

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

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

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Basics:** Action principle; Euler-Lagrange equations of motion, second quantization; Symmetry (space-time and internal) Conserved Nöther charges.	**4**
2.	**Tensors:** Definitions of contravariant, covariant and mixed tensors, need to use tensors in relativistic quantum mechanics.	**2**
3.	**Spin-0 (Klein Gordon Field Theory):** Real scalar field theory and its canonical quantization; Normal Ordering; Charged scalar field theory and its canonical quantization, conserved Nöther current and charge, Propagator (also as vacuum expectation value of a time-ordered product), interpretation of negative-energy solutions as anti-matter; Recasting Klein-Gordon equation as a Schrödinger equation, Zitterbewegung.	**7**
4.	**Spin-1/2 (Dirac Field Theory):** Dirac Lagrangian for spinor fields, Feynman Gamma matrices and related identities; Covariance of the Dirac equation; Canonical quantization of the spinor fields, positive- and negative-energy spinors, positive- and negative-energy projectors, Lorentz transformations to boost from rest frame to lab frame; Propagator (also as vacuum expectation value of a time-ordered product), Discrete symmetries: Charge conjugation, Parity and Time reversal symmetries.	**9**
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: **PHYSICS**

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

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

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

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

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

8. Pre-requisite**: PH-202 and PH-303**

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

10. Details of Course:

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

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication
1.	Carroll B W &Ostlie D A, "An introduction to modern astrophysics", 2nd ed., Pearson Education	**2007**

2.	Basu B,Tanuka C, &Nath B S, "An introduction to astrophysics", 2nd ed., Prentice Hall of India,	**2010**
3.	Abhyankar K D, "Astrophysics: Stars and Galaxies", 1st ed., Universities Press (India) Limited.	**2000**
4.	Shu Frank, "The Physical Universe: An Introduction to Astronomy",1st ed., University Science Books	**1982**
5.	Padmanabhan T, "Theoretical Astrophysics: vol.1,2,3", Cambridge University Press	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 0 35 50 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: **PHYSICS**

1. Subject Code: **PHN-625** Course Title: **Particle Physics**

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 0 35 50 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 (Glas how-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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 0 35 50 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 an d t he E lectron 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 i n F ree E lectron 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: **PHYSICS**

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

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 0 35 50 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 Ge neral C irculation:** A symmetric circulation, Inertial instability, Barotropic instability; Baroclinic instability; Sloping convection; The general circulation of the middle atmosphere.	**8**
3.	**Numerical Mod elling of Weather:** A barotropic model; Baroclinic models; Primitive equation models; Moist processes; Radiation transfer; Forecasting models.	**10**
4.	**Global Ob servations:** 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: **Physics**

1. Subject Code: **PHN-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** **25** **50** **0**

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

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

9. Objective: To introduce the emerging field of nuclear astrophysics which attempts to understand how nuclear processes generate the energy of stars over their lifetimes and synthesize heavier elements.

10. Details of Course:

S. No.	Contents	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: **PHYSICS**

1. Subject Code: **PHN-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 25 50 0

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

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

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

10. Details of Course:

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

6.	**Properties of Nano Materials:** Size dependence of properties, Phenomena and Properties at nanoscale, Mechanical/Frictional, Optical, Electrical Transport, Magnetic properties.	**4**
7.	**Nanomaterial C haracterization:** 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 o f n anomaterials:** 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 N anomaterials:** 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: **PHYSICS**

1. Subject Code: **PHN-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** **25** **50** **0**

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

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

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

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Superfluidity:** Basic properties of superfluid ^{4}He and ^{3}He; Bose-Einstein condensation in an Ideal Bose Gas; Bose-Einstein Condensation in Interacting Gases, Condensate Wave Function.	**8**
2.	**Theory of B ose F luids:** 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 T heory:** 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 S uperconductivity:** 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**
6.	Annett J. F., "Superconductivity, Superfluids and Condensates", Oxford University Press	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

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

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

8. Pre-requisite**:** **PH-201 and PH-202**

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

10. Details of Course:

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

4.	3rd order nonlinear optics: third harmonic generation, optical Kerr effect, self phase modulation, self focusing, spatial solitons, Raman gain, four wave mixing, optical phase conjugation, Raman and Brillouin scattering.	**8**
	Total	**42**

11. Suggested Books:

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

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

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

8. Pre-requisite**:** **PH-201 and PH-202**

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

10. Details of Course:

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

11. Suggested Books:

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

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

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

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

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

10. Details of Course:

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

11. Suggested Books:

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-501J** Course Title: **Semiconductor Devices and Applications**

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 15 30 40 0

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

8. Pre-requisite**:** **Nil**

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

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Semiconductors:** Energy bands, direct and indirect band gap 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.	**Carrier 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, Hetero-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**

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

11. Suggested Books:

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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

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

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

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

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

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

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 P otential:** 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 T heory:** 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 M ethods:** 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: **PHYSICS**

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

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

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

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

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

8. Pre-requisite**:** **Nil**

9. Objective: **To familiarize th e s tudents w ith th e s tandard te chniques 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**"** , 5^{th} 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: **PHYSICS**

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

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

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

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

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

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

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 E quation:** 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 f rom A ccelerated C harges:** 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 F ields:** 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: **PHYSICS**

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

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

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

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

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

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

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 E quation: C** onstraints; 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 E quations:** Hamilton's equation of motion, cyclic co-ordinates, Routh's procedure, relativistic formation, variational principle, principle of least action.	8
3.	**Canonical T ransformations:** 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 T heory:** Hamilton-Jacobi equation's of motion, harmonic oscillations, separation of variables, action-angle variables, Kepler problem, geometrical optics and wave mechanics.	8
5.	**Canonical Pe rturbation T heory:** 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 Mathematics**

1. Subject Code: **MAN-004** Course Title: **Numerical Methods**

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**: BSC**

8. Pre-requisite**: Nil**

9. Objective: To introduce various numerical methods to get approximation solutions.

10. Details of Course:

S.No.	Contents	Contact Hours
1	**Error A nalysis**: Exact and approximate numbers, Rounding of numbers, Significant digits, Correct digits, various types of errors encountered in computations, Propagation of errors.	**3**
2	**Solution of s ystem of lin ear e quations**: (i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU-decomposition method. (ii) Iterative methods: Jacobi and Gauss-Seidel methods.	**8**
3	**Roots of n on-linear e quations**: Bisection method, Regula-Falsi method, Newton-Raphson method, direct iterative method with convergence criteria, Newton-Raphson method for solution of a pair of non-linear equations.	**6**
4	**Eigen val ues an d Eigen vectors**: Dominant and smallest Eigen values/Eigen vectors by power method.	**3**
5	**Interpolation**: Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation.	**6**
6	**Numerical d ifferentiation**: First and second order derivatives by various interpolation formulae.	**4**
7.	**Numerical in tegration:** Trapezoidal, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules with errors and their combinations, Gauss Legendre 2-points and 3-points formulae	**6**
8.	**Solution of first an d s econd or der or dinary differential e quations:** Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.	**4**
9.	Case studies	**2**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1	Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Edition, Wesley.	2002
2	Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.	2000
3	Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw-Hill Publisher	1982
4	Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Mechanical & Industrial Engineering**

1. Subject Code: **MIN-106** Course Title: **Engineering Thermodynamics**

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

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

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

5. Credits: **4** 6. Semester: **Both** 7. Subject Area: **DCC/ESC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize the students with basic concepts of macroscopic thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Introduction to thermodynamic system, surrounding, state, process, properties, equilibrium, heat and work, Zeroth Law of Thermodynamics	**3**
2.	**Properties of Pure Simple Compressible Substance:** PvT surface, Pv, Tv, TP diagrams. Equation of state for ideal and real gases. Virial equation of state, van der Waal equation, use of steam tables and Mollier diagram	**6**
3.	**First Law of Thermodynamics:** First law application to non-flow processes such as isochoric, isobaric, isothermal, adiabatic and polytropic processes. Steady flow energy equation, flow work. Application to various practical systems viz. nozzles, diffuser, turbines, heat exchangers etc. Application of energy equation to transient flow problems.	**7**
4.	**Second Law of Thermodynamics:** Second law, reversible and irreversible processes, Clausius and Kelvin Planck statements, Carnot cycle, corollaries of second law: thermodynamic temperature scale, Clausius inequality, entropy as a property, principle of increase of entropy. Calculation of entropy change.	**6**
5.	**Entropy and Exergy:** Entropy and its generation, entropy balance for closed system and for control volume, basic concepts of exergy and irreversibility, exergy for closed system and control volume, exegetic efficiency.	**5**

6.	**Gas-Vapour M ixtures an d A ir-conditioning:** Properties of gas-vapour mixtures, adiabatic-saturation and wet-bulb temperatures, psychrometric chart, human comfort and air conditioning, various air conditioning processes.	**4**
7.	**Gas and Vapour Power Cycles:** Otto, Diesel, Dual, Stirling, Joule-Brayton cycle. Thermal efficiency and mean effective pressure, Rankine cycle.	**5**
8.	**Refrigeration C ycles:** reverse Carnot cycle, vapour compression refrigeration cycle.	**4**
	TOTAL	**42**

List of Experiments:

1. Study of P-V-T surface of H_2O and CO_2.
2. Determine P-T relationship for steam and verify Clausius Clapeyron equation.
3. Determine the calorific value of coal using Bomb calorimeter.
4. Analysing exhaust gases using Orsat apparatus.
5. Determine Relative Humidity and Specific Humidity of air using Sling Psychrometer and Psychrometric Chart.
6. Determine COP of a vapour compression refrigeration unit.
7. Analysing different processes on an air conditioning unit.

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Borgnakke, C. and Sonntag, R.E., " Fundamentals of Thermodynamics," Wiley India	2011
2.	Cengel, Y.A. and Boles, M.A., "Thermodynamics an Engineering Approach", Tata McGraw-Hill	2008
3.	Moran, M.J. and Shapiro, H.M., "Fundamentals of Engineering Thermodynamics", 4th Ed., John Wiley	2010
4.	Russel, L.D., Adebiyi, G. A.," Engineering Thermodynamics", Oxford University Press	2007
5.	Arora, C.P., "Thermodynamics", Tata-McGraw Hill	2001
6.	Nag, P.K., "Engineering Thermodynamics", Tata-McGraw Hill	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Mechanical and Industrial Engineering**

1. Subject Code: **MIN-108** Course Title: **Mechanical Engineering Drawing**

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

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

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

5. Credits: **4** 6. Semester: **Both** 7. Subject Area: **DCC/ESC**

8. Pre-requisite: **Nil**

9. Objective: The course objective is to teach the basic concepts of Mechanical Engineering Drawing to the students. The emphasis is on to improve their power of imagination.

10. Details of Course:

S. No.	Contents	Contact Hours
1	General Instructions : Sheet Layout, Line Symbols and Groups, Preferred Scales, Technical Sketching	**1**
2	Types of projections: Reference Planes and Quadrants, Orthographic Projection	**2**
3	Projection of point and lines	**3**
4	Projection of plane figures	**2**
5	Projection of solids	**2**
6	Section of solid and development	**2**
7	Shape Description(External): Multiplanar Representation, Systems of Projection, Sketching of Orthographic Views from Pictorial Views, Conventional Practices, Precedence of Views , Precedence of Lines	**2**
8	Uniplaner Representation: Sketching of Pictorial Views (Isometric and Oblique) from Multiplaner Orthographic Views	**2**
9	Shape Description (Internal): Sectioning as an Aid to Understanding internal features, Principles of Sectioning, Types of Sections, Section Lines, Cutting Plane Lines and Conventional Practices	**3**
10	Size Description: Dimensioning, Tools of Dimensioning, Size and Position Dimensions, Unidirectional and Aligned Systems, Principle and Practices of Dimensioning,	**4**
11	Conventional Representation: Representation and	**1**

	Identification of Common Machine Elements and Features	
12	Introduction to Solid Modeling	**4**
	Total	**28**

Practical Exercises:

Topics	**Practice Classes of Two Hour Duration**
Projection of points and lines	04
Projection of plane figures	02
Projection of solids	03
Section and development	02
Sketching of Orthographic Views from Pictorial Views	04
Sketching of Pictorial Views (Isometric and Oblique) from Multiplanar Orthographic Views, Missing Lines Exercise, Missing Views Exercise	04
Sectioning Exercise	02
Dimensioning exercise	02
Identification Exercise	01
Solid Modeling, orthographic views from solid models	04

11. Suggested Books:

S.No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Technical Drawing, Giesecke, Mitchell, Spencer, Hill, Dygdon and Novak, Macmillan Publishing Company	2003
2.	Engineering Graphics, A. M. Chandra and Satish Chandra, Narosa Publishing House, New Delhi	2003
3.	Engineering Drawing and Graphics Technology, T.E. French, C.J. Vierck and R.J. Foster, McGraw-Hill Inc	1993
4.	Fundamentals of Engineering Drawing, W.J. Luzadder, J. Warren and J.M. Duff, Prentice Hall International Editions	1989
5.	SP 46:1988 Engineering Drawing Practice for Schools and Colleges, Bureau of Indian standards	-------

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-003** Course Title: **Electromagnetic Field Theory**

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

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

4. Relative Weight**:** **CWS** 25 **PRS** 0 25 50 0

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

8. Pre-requisite**: NIL**

9. Objective:

The objective of the course is to present the basic elements of electrostatics, magnetostatics, electromagnetic waves, Maxwell's equations, and transmission lines.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Vectors an d F ields:** Cartesian coordinate System, Cylindrical and Spherical coordinate Systems, Constant coordinate surfaces, Del operator, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stoke's theorem, Gradient, Divergence, Curl and Laplacian in the three coordinate Systems, Laplacian of a scalar, Scalar & Vector Fields, Classification of Vector field. Sinusoidally time-varying fields, Complex Numbers and Phasor technique.	**8**
2.	**Electrostatics:**Field intensity, Gauss's law & its applications, Maxwell's 1st eqn. (Electrostatics), Electric Energy and potential, the line integral, Potential gradient, the dipole fields, Energy density in an electrostatic field. Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, the nature of Dielectric materials and related Boundary conditions, Capacitance, Capacitance of a two-wire line, Current analogies. Electrostatic boundary-value problems, Laplace's and Poisson's equations, Uniqueness theorem, General procedure for solving Laplace's and Poisson's equation, Resistance and capacitance, Method of images.	**8**

S. No.	Contents	Contact Hours
3.	**Magnetostatics:** Biot-Savart's law, Ampere's circuital law, Applications of Ampere's law, Magnetic flux and magnetic flux density - Maxwell's eqn., Maxwell's eqn. for static electromagnetic fields, Scalar and vector magnetic potentials. Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Inductors and inductances, Magnetic energy, Magnetic circuits, Potential energy and force on magnetic materials.	**10**
4.	**Maxwell's e quations an d Electromagnetic w ave propagation:** Faraday's law, Displacement current, Maxwell's equations in point form, Maxwell's equations in integral form, Kirchoff's Voltage law and Kirchoff's Current law from Maxwell's equations, EM waves in general, EM wave propagation in Lossy Dielectrics, Wave propagation in lossless dielectrics, Plane waves in free space, Plane waves in Good conductors, Power & Poynting Vector, Reflection of a plane wave at normal incidence, Reflection of a plane wave at oblique incidence.	**8**
5.	**Transmission L ines:** Physical description of transmission lines, The transmission line equation, Lossless propagation, Lossless propagation of sinusoidal voltages, Complex analysis of sinusoidal waves, Transmission line eqns and their solution in phasor form, Lossless and low-loss propagation, Power transmission and loss characterization, Wave reflection at discontinuities, Voltage Standing Wave Ratio, Transmission lines of finite length, Some transmission-line examples.	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Engineering Electromagnetics, William H Hayt, Jr., and John A. Buck, Tata McGraw Hill Publishing Company Ltd, New Delhi, 7th edition	**2005**
2.	Elements of Engineering Electromagnetics, Matthew N.O. Sadiku, Oxford University Press, 3rd Edition	**2003**
3.	Elements of Engineering Electromagnetics, Nannapaneni Narayan Rao, Prentice Hall of India, New Delhi, 4th Edition	**2000**
4.	Introduction to Electrodynamics, D.J. Griffiths, Prentice Hall, 3rd Edition	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-101** Course Title: **Introduction to Physical Sciences**

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

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

4. Relative Weightage**:** **CWS** 00 **PRS** 00 00 100 0

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

8. Pre-requisite**:** **None**

9. Objective: To introduce physics discipline

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Introduction: History, Philosophy, Core theories, Classical physics, Modern physics, Difference between classical and modern physics. Relation to other fields such as chemistry, mathematics, astronomy and geology. Application and influence as Applied Physics	**6**
2.	General aspect of physics: Physics concepts in primary and secondary education curricula, important publications in physics and physicists, Perfection in physics and chemistry Time line of fundamental physics discoveries Time line of developments in theoretical physics	**8**
3.	Research**:** Scientific method, Theory and experiment, Scope and aims. Major research fields of physics, along with their subfields and the theories they employ viz. Condensed matter , Atomic, molecular, and optical physics, High-energy physics (particle physics) and nuclear physics, Astrophysics , nano-technology, Geophysics and biophysics. Current research and some well known unsolved problems of physics	**14**
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	D.M. Bose, S.N. Sen & B.V. Subbarayappa, (eds), *A Concise History of Science in India*, Universities Press, Hyderabad, 2nd Edition.	2009
2.	Varadaraja V. Raman, *Glimpses of Indian Scientists*, Samvad India Foundation, New Delhi.	2006
3.	B.V. Subbarayappa, *Indian Perspectives on the Physical World*, vol. IV part 3 in History of Science, Philosophy and Culture in Indian Civilization, Centre for Studies in Civilization, New Delhi.	2004
4.	Nobel Lectures in Physics, 1901-1995, World Scientific, CD-ROM	2010
5.	R. P. Feynman, R. B. Leighton and M. Sands,The Feynman Lectures on Physics, Addition-Wesley Publication	1964
6.	http://en.wikipedia.org/wiki/Physics	2013

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**:** **PHN-103** Course Title**: Computer Programming**

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

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

4. Relative Weightage**:** **CWS** 15 **PRS** 15 30 40 00

5. Credits**:** 0 | 4 6. Semester: **Autumn** 7. Subject Area**:** **BSC**

8. Pre-requisite**:** **None**

9. Objective:

This course provides students with an entry-level foundation in computer programming.

10. Details of Course:

S. No.	Particulars	Contact Hours
1	Introduction to computer hardware and software, information storage in computer memory, stored program concept, storage media. Computer operating system.	**4**
2	Basic concept of FORTRAN/C language and program organization. Arithmetic expressions, Numerical input/output statement, Loop instructions, Transfer of control through logical statements, arrays and subscripted variables, Standard I/O in "Fortran language", Fundamental Data Types and Storage Classes: Character types, Integer, short, long, unsigned, single and double-precision floating point, storage classes, automatic, register, static and external, Operators and Expressions: Using numeric and relational operators, mixed operands and type conversion, Logical operators, Bit operations, Operator precedence and associativity,	**6**
3	Use of functions, subroutines, Complex numbers, Common statement, Block data, Developing and testing of computer programs for various numerical problems	**8**
4	Conditional Program Execution: Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch, Program Loops and Iteration: Uses of while, do	**8**

	and for loops, multiple loop variables, assignment operators, using break and continue,	
5	Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size, Structures: Purpose and usage of structures, declaring structures, assigning of structures,	**6**
6	Solution of linear and quadratic equations, matrix addition, subtraction and multiplication, Trace and Norm of matrix, Inverse of matrix, Numerical interpolation, differentiation and integration (Simpson, Trapezoidal and Gauss' Quadrature methods).	**10**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Books / Authors**	**Year of Publication**
1.	M.Metcalf, J.Reid & M. Cohen, Modern, "Fortran Explained (Numerical Mathematics and Scientific Computation)" Oxford University Press, USA; 4 edition	2011
2.	N. S. Clerman & W. Spector, "Modern Fortran: Style and Usage", Cambridge University Press	2011
3.	J. D. Hoffmann, "Numerical Methods for Engineers and Scientists", Marcel Dekker Inc. 2nd edition	2001
4.	S. S. Sastry, "Introductory Methods of Numerical Analysis", PHI Learning, 5th edition	2012
5.	D. C. Smolarski, The essentials of FORTRAN, Research and Education Association, USA	1989
6.	S. Lipschutz & A Poe, "Theory and problems of Programming with Fortran", Schaum's Series Publications	1982
7.	J. M. McCormick & M. G. Salvodori , "Numerical methods in Fortran" Prentice Hall Publications	1964

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **DEPARTMENT OF CIVIL ENGINEERING**

1. Subject code: **CEN-105** Course Title: **Introduction to Environmental Studies**
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:** 00
5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **GSC**
8. Pre-requisite: **Nil**
9. Objective: To introduce fundamentals of environmental pollution and its control.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview: Environment and Natural Processes; Development (Resource Utilization & Waste Generation); Environmental issues; Concept of Sustainable Development; Issues affecting future development (population, urbanization, health, water scarcity, energy, climate change, toxic chemicals, finite resources etc.); Environmental units	6
2.	Air –Water interaction: (Liquid phase-gas phase equilibrium) Henry's Law Constant with units, Dimensionless Henry's Law Constant	3
3.	Water –Soil Interaction: Carbonate System (Alkalinity and buffering capacity); Major ions in water; Natural Organic Matter (NOMs); Water quality parameters; Physical processes (Mass Balance): Spatio-temporal variation in quality of river water, lake water, ground water; Water quality standards	9
4.	Wetlands, water treatment and wastewater treatment .	6
5.	Air resources: Atmosphere; Air pollutants; Emissions and control of air pollutants; Atmospheric meteorology and dispersion; Transport of air (global, regional, local); Air/ atmospheric stability; Plume shape; Gaussian modeling; Air quality standards	9
6.	Land pollution and solid waste management	3
7.	Ecosystem: Structure and function; Energy flow in ecosystem; Material flow in ecosystem; Biodiversity and ecosystem health; Bio-amplification and bio-magnification	3
8.	Hazardous Waste: Definition; Classification; Storage and management; Site remediation; Environmental Risk: assessment, and management	3
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davis M. L. and Cornwell D. A., "Introduction to Environmental Engineering", McGraw Hill, New York 4/e	2008
2.	Masters G. M., Joseph K. and Nagendran R. "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi. 2/e	2007
3.	Peavy H. S., Rowe D.R. and Tchobanoglous G., "Environmental Engineering", McGraw Hill, New York	1986
4.	Mines R. O. and Lackey L. W. ""Introduction to Environmental Engineering", Prentice Hall, New Yark	2009
5.	Miheicic J. R. and Zimmerman J. B. " Environmental Engineering: Fundamentals, Sustainability, Design" John Wiley and Sons, Inc.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001A** Course Title: **Communication Skills (Basic)**

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

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

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective:
The course intends to build the required communication skills of the students having limited communicative abilities, so that they may communicate effectively in real-life situations

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Understanding the Basics of Communication Skills: Listening, Speaking, Reading & Writing, Scope and Importance	**01**
2.	Grammar & Composition: Time and Tense, Agreement, Active-Passive, Narration, Use of Determiners, Prepositions & Phrasal Verbs	**05**
3.	Vocabulary Building & Writing: Word-formation, Synonyms, Antonyms, Homonyms, One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words	**02**
4.	Introduction to Sounds (Vowels & Consonants) Organs of Speech, Place and Manner of Articulation, Stress & Intonation, Listening Comprehension (Practical Sessions in Language Laboratory)	**02**

5.	Speaking, Countering Stage-fright and Related Barriers to Communication.	**02**
6.	Reading and Comprehension: Two lessons to be identified by the department.	**02**
	Total	**14**

List of Practicals:

1. Ice-breaking Exercises
2. Assignments on Time and Tense, Agreement, Active-Passive
3. Laboratory Session on Narration, Use of Determiners, Prepositions & Phrasal Verbs, Revisionary Exercises & Quiz
4. Laboratory Session on Synonyms, Antonyms, Homonyms
5. Assignments and Practice Sheets on One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words
6. Laboratory Session on Practice of sounds, Intonation and Stress, Listening Comprehension
7. Individual presentation, debates, Extempore & Turncoats
8. Exercises in Composition and Comprehension

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Murphy, Raymond. *Intermediate English Grammar*, New Delhi, Cambridge University Press.	**2009**
2.	Quirk, Randolph & Sidney Greenbaum. *A University Grammar of English*, New Delhi, Pearson.	**2009**
3.	McCarthy, Michael & Felicity O' Dell. *English Vocabulary in Use*, New Delhi, Cambridge University Press	**2010**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Birchfield, Susan M. *Fowler's Modern English Usage*, New Delhi, OUP.	**2004**
6.	Llyod, Susan M. *Roget's Thesaurus of English Words and Phrases*. New Delhi: Penguin.	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001B** Course Title: **Communication Skills (Advanced)**

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

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

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective: The course intends to train the learners in using both verbal and non-verbal communication effectively.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Advanced Communication Skills: Scope, Relevance, & Importance	01
2.	Soft Skills: Interpersonal Communication; Verbal & Non-verbal, Persuasion, Negotiation, Neuro-Linguistic Programming	03
3.	Communication and Media (Social and Popular), The Social and Political Context of Communication, Recent Developments and Current Debates in Media	04
4.	Cross-cultural and Global Issues in Communication: Race, Ethnicity, Gender & Diaspora	03
5.	Rhetoric and Public Communication, Audience Awareness, Emotionality	03
	Total	14

List of Experiments:

1. Discussion on the Process of Communication in Personal and Professional Life
2. Group Discussion, Case Studies and Role-Play
3. Assignments on E-mail Etiquette, Social Networking, Blog Writing, Discussions on Current Issues
4. Non-Verbal Communication in Cross-Cultural Situations, Case Studies, Group Discussions and Readings on Topics Related to Race, Ethnicity , Gender and Diaspora
5. Individual Presentations (Audience Awareness, Delivery and Content of Presentation)

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Rentz, Kathryn, Marie E. Flatley & Paula Lentz. *Lesikar's Business Communication CONNECTING IH A DIGITAL WORLD*, McGraw-Hill, Irwin	**2012**
2.	Bovee, Courtland L & John V. Thill. *Business Communication Today*. New Delhi, Pearson Education	**2010**
3.	McMurrey, David A. & Joanne Buckley. *Handbook for Technical Writing*, New Delhi, Cengage Learning.	**2009**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Allan & Barbara Pease. *The Definitive Book of Body Language*, New York, Bantam	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities and Social Sciences**

1. Subject Code: **HSN-002** Course Title: **Ethics and Self-awareness**

2. Contact Hours: **L: 01** **T: 0 1** **P: 0**

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

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

5. Credit **02** 6. Semester**: Autumn** 7. Subject Area**: HSSC**

8. Pre-requisite**: NIL**

9. Objective: To introduce the concepts pertaining to ethical and moral reasoning and action and to develop self - awareness.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction**: Definition of Ethics; Approaches to Ethics: Psychological, Philosophical, Social.	**1**
2	**Psycho-social t heories of m oral d evelopment**: View of Kohlberg; Morality and Ideology, Culture and Morality, Morality in everyday context.	**3**
3	**Ethical C oncerns**: Work Ethics and Work Values, Business Ethics, Human values in organizations.	**3**
4	**Self-Awareness**: Self Concept: Johari Window, Self and Culture, Self Knowledge, Self-Esteem; Perceived Self-control, Self-serving bias, Self-presentation, Self-growth: Transactional Analysis and Life Scripts.	**4**
5.	**Self D evelopment**: Character strengths and virtues, Emotional intelligence, Social intelligence, Positive cognitive states and processes (Self-efficacy, Empathy, Gratitude, Compassion, and Forgiveness).	**3**
	Total	**14**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication
1.	Hall, Calvin S., Lindzey, Dardner., & Cambell, John B.,"Theories of Personality",Hamilton Printing Company.	1998
2.	Car Alan, "Positive Psychology: The Science of Happiness and Human Strengths", Brunner-Routledge.	2004
3.	Leary M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press.	2004
4.	Louis P. P., "The Moral Life: An Introductory Reader in Ethics and Literature", Oxford University Press.	2007
5.	Corey, G., Schneider Corey, M., & Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole.	2011
6.	Snyder, C.R., Lopez, Shane, J., & Pedrotti, J.T., "Positive Psychology" Sage, 2nd edition.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **MAN-102** Course Title: **Linear Algebra**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**
4. Relative Weightage**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**
5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**
8. Pre-requisite**: Nil**
9. Objective: To introduce the basic concepts of vector spaces and linear transformations.
10. Details of Course:

S. No.	Particulars	Contact Hours
1	**Vector S paces:** Vector space, subspace, sum of subspaces, linear combination, linear dependence and independence, basis and dimension, examples of infinite dimensional spaces, ordered bases and coordinates	10
2	**Linear T ransformation:** Basic definitions, rank-nullity theorem, matrix representation, algebra of linear transformations, change of basis, linear functional, Dual Spaces	8
3	**Canonical F orms:** Eigen-values of linear operators, Eigen-space, minimal polynomial, diagonalisation, invariant subspaces, Jordan canonical representation, Norm of a matrix, computation of a matrix exponential	12
4	**Inner Product Space:** Definition of inner product between two vectors, orthogonal and orthonormal vectors, normed space, Gram-Schmidt process for orthogonalisation, projection operator, quadratic forms, positive definite forms, Symmetric, Hermitian, orthogonal, unitary and Normal transformations/matrices.	12
	TOTAL	42

11. Books Recommended:

S.No	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Hoffman, K. and Kunze, R., "Linear Algebra", 2nd edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India	2004
2.	Leon, S.J., "Linear Algebra with Applications", 8th Edition, Pearson	2009
3.	Peter, J. Olever and Shakiban, C., "Applied Linear Algebra", 1st Edition , Prentice Hall	2005
4.	Strang, G., "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia Pvt Ltd	2003
5.	Sudan L., " Applied Linear Algebra ", Prentice Hall	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**:** **PHN-110** Course Title**: Introduction to Electronics**

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 impart knowledge of basic concepts of electronics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Semiconductor D iode:** Energy band structure of Insulators, Semiconductors and Metals, Element and Compound semiconductors, Intrinsic semiconductors, Extrinsic semiconductors, electrons and holes , conductivity and mobility, effect of temperature and doping on mobility, carrier concentration and their temperature dependence, Fermi level in a semiconductor having impurities, p-n Junction fabrication (Simple Idea). Qualitative theory of the p-n junction, Barrier formation in p-n Junction Diode, current flow mechanism in Forward and Reverse Biased Diode, Volt-Ampere characteristics, Static and Dynamic Resistance of Diode, Zener Diode.	**8**
2	**Bipolar Ju nction t ransistors:** n-p-n and p-n-p transistors, Characteristics of CB, CE and CC configurations. Current gains α, β and γ and relations between them, Active, Cutoff, and Saturation regions.	**5**
3	**Amplifiers & Os cillators :** Analysis of a single-stage CE amplifier using DC Load Line,Coupled Amplifiers : RC-Coupled Amplifier and its Frequency Response of Voltage Gain, Operational Amplifiers: Inverting and noninverting Amplifiers. Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise, Sinusoidal Oscillators : Barkhauson's Criterion for self-sustained oscillations, RC Phase Shift Oscillator, Determination of frequency, Non-Sinusoidal Oscillators – Multivibrators.	**10**
4	**Field Effect Transistors**: Junction Field Effect Transistors, Pinch-Off Voltage, Volt-Ampere Characteristics of JFET, Insulated -Gate FET (MOSFET) , Enhancement MOSFET, Depletion MOSFET, circuit	**5**

	symbols.	
5	**Digital C ircuits:** Difference Between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND AND NOR Gates. Exclusive OR and Exclusive NOR Gates, Basic concepts of flipflops.	**8**
6	**Integrated C ircuits:** Basic Monolithic Integrated Circuits, Wafer, Chip, Scale of integration :SSI, MSI, LSI and VLSI (Basic Idea Only), Fabrication of Components on Monolithic ICs., Moore's law, Introduction to Nanoelectronics.	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	By Ben G. Streetman & Sanjay Banerjee, "Solid State Electronic Devices" , Prentice Hall, 6thEd.	2006
2.	Robert Boylestad, Louis, "Electronic Devices and Circuit Theory", Pearson Education, 8thEd.	2004
3.	A.P.Malvino , “Electronic Principles”, MacGraw Hill Publication, 7thEd.	2006
4.	A P Malvino and D P Leach , “Digital Principles and Applications”, MacGraw Hill Publication	1998
5.	Thomas L. Floyd and David L. Buchla “Electronics Fundamentals: Circuits, Devices and Applications”, 8th Ed.	2010
6.	Allen Mottershead, “Electronic Circuits and Devices”, PHI	1997
7.	Dube D C “Electronics: Circuits and Analysis” Narosa Publication, 2nd Edition	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PHN-001** Course Title: **Mechanics**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**
4. Relative Weightage**:** **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: BSC**
8. Pre-requisite**: None**
9. Objective: **To familiarize students with the basic principles of mechanics**
10. Details of Course:

S.No.	Contents	Contact Hours
1	**STATICS OF PARTICLES.** Vectorial representation of forces and moments- Vector Operation-Concepts of Particles and Rigid bodies – Composition of concurrent forces in plane free body Diagram – Equilibrium of Rigid bodies in Two and three dimensions-Moment of a force about a point and about an axis-Couple moment-Reduction of a force system to a force and a couple	8
2	**PROPERTIES OF SURFACES, MOMENTS AND PRODUCTS OF INERTIA** Definition Moment of Inertia for areas-Parallel axis theorem –Perpendicular axis theorem-Moment of inertia for composite area-product of inertia form an area-mass moment of inertia	6
4	**FRICTION** Laws of coulomb friction- Coefficient of Friction-Dry Friction-sliding Friction-Ladder friction-Belt friction – Rolling Resistance.	4
5	**KINEMATICS OF PARTICLES** Principle of virtual work for a particle and rigid body-condition for equilibrium for a conservative system, stability-particle dynamics in rectangular coordinate, cylindrical coordinate and in terms of path variables-General motion of system of particles-	8
6	**WORK ENERGY METHODS, IMPULSE AND MOMENTUM** Work Energy Method-Conservation of Energy-Impulse and Momentum Relation-Impulsive Force-Impact force-Conservation of momentum – Moment of Momentum Equation.	8
7	**RIGID BODY MOTION;** Translation and rotation of rigid bodies- Derivative of a vector fixed in moving reference-General relationship between time derivative of a vector for different references-Moment of momentum equation-kinetic energy of rigid body-work and energy relations-Euler's equation of motion-Three dimensional motion about a fixed point	8
	TOTAL	42

List of experiments:

1. Study of magnetic field of a pair of coils in Helmholtz arrangement
2. Determination of e/m
3. Determination of first excitation potential of a gas by Frank-Hertz experiment
4. Determination of Stefan's constant
5. Determination of Planck's constant by radiation
6. To study and verify Malus' law
7. Study of Polarization of light using quarter wave plate
8. Determination of Brewster's angle at glass-air interface
9. Determination of with of a slit by single-slit diffraction pattern
10. Four probe method of finding resistivity of semiconductor
11. Quinck's Method for determining mass susceptibility
12. Wavelength of Na light by Newton's ring method

11. Suggested Books:

S.No.	Title/Authors/Publishers	Year of Publication
1.	Shames I.H. and Rao G.K., "Engineering Mechanics-Statics and Dynamics" ,4 Edition, Pearson Education	2006
2.	Beer F.P and Johnson E.R., "Vector Mechanics for Engineers- Statics and Dynamics",9 Edition, Tata McGraw-Hill Publishing Company	2010
3.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Statics" 3rd Edition, Cengage Learing	2010
4.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Dynamics"3rd Edition Cengage Learing	2010
5.	Hibberler R.C and Gupta A., Engineering Mechanics,", 12th Edition, Pearson Education	2012
6.	Meriam J.L. and Kraige L.G., "Engineering Mechanics: Statics", 6th Edition, John Willey and Son,s	2012
7.	Meriam J.L., and Kraige L.G., "Engineering Mechanics: Dynamics", 6th Edition , John Willey and Son's	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **MAN-001** Course Title: **Mathematics I**

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

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

4. Relative Weightage**:** **CWS** 25 **PRS** 00 25 50 0

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

8. Pre-requisite**:** **None**

9. Objective: **To provide essential knowledge of basic tools of Differential Calculus, Integral Calculus , Vector Calculus and Matrix Algebra for degree students.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Matrix Algebra:** Elementary operations and their use in getting the Rank, Inverse of a matrix and solution of linear simultaneous equations. Orthogonal, Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, Normal & Unitary matrices and their elementary properties. Eigen-values and Eigenvectors of a matrix, Cayley-Hamilton theorem, Diagonalization of a matrix.	**8**
2.	**Differential Calculus:** Limit, Continuity and differentiability of functions of two variables, Euler's theorem for homogeneous equations, Tangent plane and normal. Change of variables, chain rule, Jacobians, Taylor's Theorem for two variables, Error approximations. Extrema of functions of two or more variables, Lagrange's method of undetermined multipliers	**12**
3.	**Integral Calculus:** Review of curve tracing and quadric surfaces, Double and Triple integrals, Change of order of integration. Change of variables. Gamma and Beta functions. Dirichlet's integral. Applications of Multiple integrals such as surface area, volumes, centre of gravity and moment of inertia..	**12**
4.	**Vector Calculus:** Differentiation of vectors, gradient, divergence, curl and their physical meaning. Identities involving gradient, divergence and curl. Line and surface integrals. Green's, Gauss and Stroke's theorem and their applications.	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	E. Kreyszig, Advanced Engineering Mathematics, 9th edition, John Wiley and Sons, Inc., U.K.	2011
2.	R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House.	2005
3.	M.D. Weir, J. Hass, F.R. Giordano, Thomas' Calculus, 11th Edition, Pearson Education.	2008