INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **PH-312** Course Title: **Properties of Matter and Acoustics**

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

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**: PCC**

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.	Spherical waves, Large amplitude and Shock waves-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-505** Course Title: **Advanced Mathematical Physics**

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

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

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

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

8. Pre-requisite**: PHN-210 or equivalent**

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

8. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of Special functions: Legendre, Bessel, Hermite and Laguerre functions and their applications.	6
2.	Green's functions and solutions to inhomogeneous differential equations of one-, two- and three-dimensions and their applications.	6
3.	Tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, covariant and contravariant tensors, metric tensor, covariant derivatives, affine connections Christoffel symbols.	8
4.	Finite Groups: Classification and examples, subgroups, conjugacy classes, cosets, invariant subgroups, homomorphic and, isomorphc mappings, direct products.	8
5.	Representation theory for finite groups, reducible and irreducible representations, Schur's Lemma and orthogonality theorem.	6
6.	Continuous Groups: Characters; Lie Groups: SO(2), SO(3), SU(2), SU(3), Vector Spaces; Hilbert Space and operators.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Arfken G. B. and Weber H. J., "Mathematical Methods for Physicists**"** , 5th Ed. Academic Press.	**2005**
2.	Hassani, S., "Mathematical Physics: A modern Introduction to its foundations", 2nd Ed. Springer	**2013**
3.	Duffy, D. "Green's Functions with Applications", 2nd Ed. CRC Press	**2015**
4.	Bourne, D. E. and Kendall, P. C., "Vector Analysis and Cartesian Tensors", 3rd Ed., Springer Science	**1992**
5.	Cornwell, J. F., "Group Theory in Physics: An Introduction", Academic Press	**1997**
6.	Hammermesh M., "Group Theory and Applications to Physical Problems**"**, Dover publications, NY.	**1989**
7.	Akhiezer N. I. and Glazman I. M., " Theory of Linear Operator in Hilbert Space", Dover Publications	**1993**

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

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

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

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

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

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

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

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

10. Details of Course:

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

9. Suggested Books:

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

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

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

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

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

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

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

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

9. Objective: To introduce the basics of elementary particle physics.

10. Details of Course:

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

5.	**Strong Interaction**: (i) **Pre-QCD**: The structure of Hadrons, Probing a charge distribution with electrons: Inelastic electron -proton scattering, Partons and Bjorken scaling; (ii) **QCD** (quantization of non-abelian gauge theories with fermions): Yang-Mills theory, Parton model revisited, Feynman rules, Asymptotic freedom.	8
6.	**Weak Interaction**: (i) **Phenomenology**: Parity violation and the V-A form of the weak current, Muon decay, Pion decay, charged current, neutral currents, Cabibbo angle, weak mixing angle, CP Invariance, CP violation; (ii) **Electroweak Unification (Glashow-Salam-Weinberg model)**: The basic electroweak interaction, effective current-current Interaction, Spontaneous symmetry breaking, Higgs mechanism and choice of the Higgs field, masses of gauge bosons and fermions, the complete Lagrangian.	10
	Total	**42**

11. Suggested Books:

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