Physics

Sl.No	Course Code		Name of Course	L-T-P-C
1	PH 101	PH101T	Quantum Physics and Application II	2-1-0-6
2	PH 102	PH102T	Electricity and Magnetism	2-1-0-6
3	PH 111		Physics Lab	0-0-3-3
4	PH 113	PH101L	Hand on Science Laboratory -1	0-0-3-3
5	PH 201	PH301T	Electrodynamics	2-1-0-6
6	PH 403	PH302T	Classical Mechanics	3-0-0-6
7	PH 203	PH303T	Quantum Mechanics - I	2-1-0-6
8	PH 211	PH201L	Introductory Physics Laboratory	2-1-0-6
9	PH 312	PH301L	General Physics Lab	0-0-3-3
10	PH 302	PH401T	Quantum Mechanics-II	2-2-0-6
11	PH 304	PH305T	Statistical Physics	3-0-0-6
12	PH 401	PH403T	Condensed Matter Physics	2-1-0-6
13	PH 307	PH401S	Seminar – I	0-0-3-3
14	PH 308	PH402S	Seminar – II	0-0-3-3
15	PH 411	PH401L	Advanced Physics Lab	0-0-3-3
16	PH 401	PH403T	Laser Physics and Technology	2-1-0-3
17	PH 402	PH404T	Astrophysics	3-0-0-6
18	PH 404	PH405T	Introduction to Quantum Information and Computation	2-1-0-6
19	PH 406	PH406T	Classical Electrodynamics	2-1-0-6
20	PH 407	PH407T	Nonlinear Optics	2-1-0-3
21	PH 409	PH408T	Quantum Physics and Application II	2-1-0-6
22			Advanced Mathematical Methods of General Relativity	2-1-0-6
23	PH 420	PH409T	Advanced Topics in Quantum Mechanics and Special Relativity	2-1-0-6
26	PH 305	PH412T	Thin-Film Science and Technology	2-1-0-3
27	PH 424	PH413T	Photonics	2-1-0-6
28	PH 425	PH414T	Atomic and Molecular Physics	2-1-0-6
29	PH 426	PH415T	Special Theory of Relativity	2-1-0-6

30	PH 706	PH601T	Theory of Laboratory Techniques	2-1-0-6
31	PH 707	PH601P	Research Project in Physics	2-1-0-6
32	PH 801	PH602T	Advanced Mathematical Physics	3-0-0-6
33	PH 910	PH601S	Research Seminar	0-0-4-4
34	PH 701	PH701T	Photonics: Fundamentals and Technology	2-1-0-6
35	PH 703	PH702T	Advanced Atomic and Molecular Physics	2-1-0-6
36	PH 704		Molecular Spectroscopy	2-1-0-6
37	PH 705	PH704T	Remote Sensing	2-1-0-6
38	PH 708	PH705T	Superconductivity and Magnetism	2-1-0-6
39	PH 709	PH706T	Quantum Computation	2-1-0-6
40		PH410T	General Relativity and Cosmology	2-1-0-6
41	PH 802	PH801T	Quantum Information Theory	2-1-0-6
42	PH 803	PH802T	Quantum Optics	4-0-0-8
43	PH 702	PH803T	Tunable Coherent Optical Devices	2-1-0-6
44	PH 427	PH416T	Hydrogen Technology	3-0-0-6
45	PH 805	PH804T	Molecular Dynamics Imaging: Methodologies and Applications	3-0-0-7
46	PH 605	PH603T	Silicon Photovoltaics	3-0-0-6
47	PH 807	PH805T	Third Generation Photovoltaics: Materials, Integration and Devices	3-0-0-6
48		PH501C	Numerical Methods	2-0-2-6
49		PH420T	Electronics	2-1-0-6
50		PH402L	Electronics Laboratory	0-0-3-3
51		PH201T	Waves, Oscillations & Optics	2-1-0-6
52		PH301L	General Physics Laboratory	0-0-3-3
53		PH301P	Research and Developeemnt Project-I	0-0-6-6
54		PH302P	Minor Project-I	0-0-6-6
55	PH 322	PH304T	Mathematical Physics - I	2-1-0-6
56	PH 432	PH401P	B.Tech.Project -EP I	0-0-6-6
57	PH 433	PH402P	B.Tech.Project -EP II	0-0-6-6
58	PH 320	PH404P	Research and Development Project-II	
59		PH302P	Minor Project-II	0-0-6-6
60		PH403S	Seminar – I	0-0-3-3

61		PH402T	Condensed Matter Physics	2-1-0-6
62		PH411T	Physics of Photovoltaics	2-1-0-3
63		PH413T	Photonics	2-1-0-6
64		PH417T	Nuclear and Particle Physics	2-1-0-6
65		PH418T	Experimental Techniques	2-1-0-6
66		PH419T	Thin Film Science and Technology	2-1-0-6
67	PH 503	PH501P	Physics Project-I	0-0-6-6
68	PH 504	PH502P	Physics Project-II	0-0-18-18
69		PH501T	Mathematical Physics - II	2-1-0-6
70	PH 603	PH602T	Advanced Mathematical Physics	3-0-0-6
71	PH 606	PH604T	Advanced Mathematical Physics	4-0-0-8
72	PH 704	PH703T	Spectroscopy	2-1-0-6
73		PH803T	Tunable Coherent Optical Devices	2-1-0-6
74		PH605T	Radiative Processes in Astrophysics	3-0-0-6

1	**Title of the course** (L-T-P-C)	**Quantum Physics and Applications** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Quantum nature of light: Photoelectric Effect and Compton Effect. • Stability of atoms and Bohr`s rules. • Wave particle duality: De Broglie wavelength, Group and Phase velocity, Uncertainty Principle, Double Slit Experiment. • Schrödinger Equation. • Physical interpretation of Wave Function, Elementary Idea of Operators, Eigen-value Problem. • Solution of Schrödinger equation for simple boundary value problems. • Reflection and Transmission Coefficients. Tunneling. • Particle in a three dimensional box, Degenerate states. • Exposure to Harmonic Oscillator and Hydrogen Atom without deriving the general solution. • Quantum Statistics: Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics by detailed balance arguments. • Density of states. • Applications of B-E statistics: Lasers. Bose-Einstein Condensation. • Applications of F-D statistics: Free electron model of electrons in metals. Concept of Fermi Energy. • Elementary Ideas of Band Theory of Solids. • Exposure to Semiconductors, Superconductors, Quantum Communication and Quantum Computing.
4	**Texts/References**	1. Quantum Physics: R. Eisberg and R. Resnick, John Wiley 2002, 2nd Edition. 2. Introduction to Modern Physics: F. K. Richtmyer, E. H. Kennard and J.N. Cooper, Tata Mac Graw Hill 1976, 6th Edition. 3. Modern Physics: K. S. Krane, John Wiley 1998, 2nd Edition. 4. Introduction to Modern Physics: Mani and Mehta, East-West Press Pvt. Ltd. New Delhi 2000. 5. Elements of Modern Physics: S. H. Patil, Tata McGraw Hill, 1984. 6. Concepts of Modern Physics, A Beiser, Tata McGraw Hill, 2009.

1	**Title of the course** (L-T-P-C)	**Electricity and Magnetism** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Review of vector calculus: Spherical polar and cylindrical coordinates; gradient, divergence and curl; • Divergence and Stokes` theorems; • Divergence and curl of electric field, Electric potential, properties of conductors; • Poisson's and Laplace's equations, uniqueness theorems, boundary value problems, separation of variables, method of images, multipoles; • Polarization and bound charges, Gauss` law in the presence of dielectrics, Electric displacement D and boundary conditions, linear dielectrics; • Divergence and curl of magnetic field, Vector potential and its applications; • Magnetization, bound currents, Ampere`s law in magnetic materials, Magnetic field H, boundary conditions, classification of magnetic materials; • Faraday's law in integral and differential forms, Motional emf, Energy in magnetic fields, Displacement current, Maxwell's equations, • Electromagnetic (EM) waves in vacuum and media, Energy and momentum of EM waves, Poynting`s theorem; • Reflection and transmission of EM waves across linear media.
4	**Texts/References**	1 Introduction to Electrodynamics (4th ed.), David J. Griffiths, Prentice Hall, 2015. 2 Classical Electromagnetism, J. Franklin, Pearson Education, 2005.

1	**Title of the course** (L-T-P-C)	**Physics Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Experiments on • Young's Modulus by Koenig's Method • Thermal Conductivity by Lee's Disc • Helmholts Coils • LCR Circuit • Specific Charge of Electron • Grating Spectrometer • Fresnel's Bi-Prism • Single Slit Diffraction
4	**Texts/References**	(1) Practical Physics: S. L. Squires, Cambridge University Press, 2017. (2) Advanced Practical Physics, B. L. Worsnop and H. T. Flint, Littlehampton Book Services Ltd, 1951. (3) Physics, Vols. 1 & 2, D. Halliday, R. Resnick, and K. S. Krane, Wiley, 2007, 5th edition. (4) Fundamentals of Optics, F.A. Jenkins and H. E. White, McGraw Hill Education, 2017, 4th edition.

1	**Title of the course** (L-T-P-C)	**Electrodynamics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Successful completion of PH102
3	**Course content**	Review of electrostatics and magnetostatics. Electrodynamics: Differential and integral forms of Maxwell's equations, Scalar and vector potentials, gauge transformations, Coulomb and Lorentz Gauge; Maxwell's equations in terms of potentials. Energy and momentum in electrodynamics. Electromagnetic waves: Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media; Boundary conditions; Reflection and transmission at interfaces. Fresnel's laws; Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media, Dispersion: Dispersion in non-conductors, free electrons in conductors and plasmas. Guided waves. Retarded potentials, Electric dipole radiation, magnetic dipole radiation. Radiation from a point charge: Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge. Electrodynamics and Relativity: Review of special theory of relativity, Lorentz transformations, Minkowski four vectors, energy-momentum four vector, covariant formulation of mechanics; Transformation of electric and magnetic fields under Lorentz transformations, field tensor, invariants of electromagnetic field, Covariant formulation of electrodynamics, Lorentz force on a relativistic charged particle. Waveguides, Resonant Cavities and Optical Fibers, Basics of Antennas.
4	**Texts/References**	(1) D. J. Griffith: Introduction to Electrodynamics, 4th edition, Pearson, 2015. (2) J.D. Jackson: Classical Electrodynamics, Wiley student edition, 3rd edition, 2007. (3) Modern Electrodynamics, Andrew Zangwill, Cambridge University Press, 2012. (4) Foundations of Electromagnetic Theory, J. R. Reitz, F. J. Milford, and R. W. Christy, Addison-Wesley, 4th edition, 2008. (5) W K H Panofsky and M Philips: Classical Electricity and Magnetism Addison Wesley, 2nd edition, 1962. (6) W Greiner: Classical Electrodynamics, Springer, 1998. (7) Hayt, William H., Jr., and John A. Buck, "Engineering Electromagnetics", 7th ed. McGraw-Hill, 2006. (8) M.A. Heald and J.B. Marion, Classical Electromagnetic Radiation, Saunders, 1983.

1	**Title of the course** (L-T-P-C)	**Classical Mechanics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Review of Newtonian Mechanics - Newton's Laws of Motion and Conservation Laws. Principles of Canonical Mechanics - Constraints and generalized coordinates, Alembert's principle, Lagrange's equation, Hamilton's variational principle, canonical systems, symmetries and conservation laws, Noether's theorem, Liouville's Theorem. Central Force: Equations of motion Virial Theorem, Kepler's Laws, Scattering in a Central Force Field. Rigid Body: Euler angles, Coriolis Effect, Euler equations, moment of inertia tensor, motion of asymmetric top. Small Oscillations: Eigen value problem, frequencies of free vibrations and normal modes, forced vibration, dissipation. Special Theory of Relativity: Newtonian relativity, Michelson-Morley experiment, Special theory of relativity, Lorentz transformations and its consequences, addition of velocities, variation of mass with velocity, mass-energy relation, Minkowski four-dimensional continuum, four vectors. Hamiltonian Equation, Gauge transformation, canonical transformation, Infinitesimal transformation, Poisson brackets, Hamilton-Jacobi equations, Separation of variables Lagrangian and Hamiltonian formulation of continuous systems.
4	**Texts/References**	1. Classical Mechanics: H. Goldstein, C. P. Poole, and J. Safko, Pearson 2011. 2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, 2017. 3. Introduction to Classical Mechanics: David Morin, Cambridge University Press, 2008. 4. Mechanics: L.D. Landau and E. M. Lifshitz, Butterworth- Heinemann, 3rd edition, 1982. 5. Mechanics: From Newton's Laws to Deterministic Chaos, F. Scheck, Springer, 5th edition, 2010. 6. Introduction to Classical Mechanics, R G Takwale and P S Puranik, Tata McGraw Hill, 2008.

1	**Title of the course** (L-T-P-C)	**Quantum Mechanics - I** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	PH101 MA101
3	**Course content**	Review of Wave mechanics, Schrodinger equation, Uncertainty principle, wave packets, group velocity and phase velocity. Postulates of quantum mechanics, probability and probability current density, operators, eigenvalues and eigenfunctions. Bound states, delta-function potential, and harmonic oscillator. Formalism: Hilbert space, Observables, Eigenfunctions of Hermitian operator, Dirac's notation, matrix representations of vectors and operators, parity operation, matrix theory of harmonic oscillator. Theory of Angular Momentum: Spherical harmonics, eigenvalues of L^2 and L_z, addition of angular momentum, commutation relations, degeneracies. Hydrogen atom, quantum numbers, two particle systems.
4	**Texts/References**	1. Introduction to Quantum Mechanics, D. J. Griffiths and D. F. Schroeter, Cambridge University Press, 3rd edition, 2019. 2. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press, 2017. 3. Principles of Quantum Mechanics, R. Shankar, Springer, 2014. 4. Quantum Physics, S. Gasiorowicz, John Wiley, 2000. 5. Quantum Mechanics, L. D. Landau and E.M. Lifshitz, Pergamon press, 1965

1	**Title of the course** (L-T-P-C)	**Quantum Mechanics-II** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	PH101-Quantum Physics and Applications Quantum Mechanics - I
3	**Course content**	Time independent Perturbation Theory – Zeeman and Stark effects. Wentzel–Kramers–Brillouin approximation Variational method Time dependent perturbation theory, Scattering Theory, Born Approximation, Partial Wave analysis, Path Integral approach to Quantum Mechanics, Relativistic Quantum Mechanics Introduction to Quantum Field Theory, Quantization of free scalar field. Master equations, open and closed quantum system dynamics.
4	**Texts/References**	1. Modern Quantum Mechanics, J J Sakurai, Addison-Wesley, Reading, MA, 1994 2. Advanced Quantum Mechanics, J J Sakurai, Pearson, 1967. 3. Quantum Mechanics (Vol 1 and 2), C. Cohen-Tannoudji, B. Diu, and F. Laloe, Wiley VH; 2nd edition 2019. 4. R. Shankar, Principles of Quantum Mechanics, 2nd Ed. (Plenum Press, New York, 1994) 5. Quantum Mechanics and Path Integrals, R. P. Feynman and A. R. Hibbs, McGraw-Hill, New York, 1965. 6. An Introduction to Quantum Field Theory, M.E. Peskin, D. V. Schroeder, Westview Press, 1995. 7. The theory of open quantum systems, H. P. Breuer and F. Petruccione, Oxford University Press, 2002.

1	**Title of the course** (L-T-P-C)	**Statistical Physics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Thermodynamics: Thermal equilibrium, the laws of thermodynamics; temperature, energy, entropy, and other functions of state. Probability Theory: Probability densities, cumulants and correlations; central limit theorem; laws of large numbers. Kinetic Theory: Phase space densities; Liouville's theorem, the Boltzmann equation; transport phenomena. Classical Statistical Mechanics: Postulates; microcanonical, canonical and grand canonical ensembles; Gibb's paradox, non-interacting examples. Maxwell Boltzmann distribution, ideal gas. Quantum Statistical Mechanics: Indistinguishability, Bose-Einstein and Fermi- Dirac distributions and Applications Interacting Systems: Virial and cluster expansions; van der Waals theory; liquid- vapor condensation. Quantization effects in molecular gases; phonons, photons; density matrix formulation. Identical Particles: Degenerate quantum gases; Fermi liquids; Bose condensation; superfluidity.
4	**Texts/References**	1. Huang, Kerson. Statistical Mechanics. 2nd ed. Wiley, 1987. 2. Baierlein, Thermal Physics (Cambridge University Press, 1999). 3. Pathria, R. K. Statistical Mechanics. Pergamon Press, 1972. 4. Ma, Shang-keng. Statistical Mechanics. Translated by M. K. Fung. World Scientific Publishing Company, 1985. 5. J. K. Bhattacharjee, Statistical Physics: Equilibrium and Non-Equilibrium Aspects, Allied Publishes, 2000 6. F. Reif, Fundamentals of Statistical and Thermal Physics Statistical Physics :Amit and Verbin, Word Scientific, 1999

1	**Title of the course** (L-T-P-C)	**Condensed Matter Physics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Successful completion of the first two semesters
3	**Course content**	Crystal structure: Miller indices, Bravais and reciprocal lattice, Bragg and von Laue diffraction, structure factor; Lattice vibration and thermal properties: harmonic approximation, monatomic and diatomic lattices, Brillouin zone, density of states, acoustic and optical modes, phonons, crystal momentum, Debye model of specific heat, thermal expansion and conductivity; Free electron theory: Fermi gas, specific heat, Ohm's law, magneto- resistance, thermal conductivity; Band theory: Electrons in a periodic potential, Nearly free electron model, Bloch's theorem, Kronig Penny model, effective mass, concept of hole, classification of metal, insulator and semiconductor; Semiconductor: Intrinsic and extrinsic semiconductors, mobility and electrical conductivity, Fermi level, Hall effect; Magnetism: Diamagnetism, Hund's rules, Lande g-factor, quantum theory of paramagnetism, Pauli paramagnetism, exchange interaction, ferromagnetism, hysteresis; Superconductivity: Meissner effect, London equations, type-I and type-II superconductors, Outlines of BCS theory, flux quantization, Josephson tunneling, high temperature superconductors.
4	**Texts/References**	1. C. Kittel, Introduction to Solid State Physics, 8th Edition, Wiley 2. N. W. Ashcroft, N. D. Mermin, Solid State Physics, CENGAGE 3. A. J. Dekker, Solid State Physics, Mcmillan, 1986. 4. J. R. Christman, Fundamentals of Solid State Physics, Wiley, 1988.

1	**Title of the course** (L-T-P-C)	**Laser Physics and Technology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	PH101
3	**Course content**	Optical radiation processes, conditions for the amplification of radiation, three level and four level lasers, optical beams, resonators and cavity designs, laser oscillation and dynamics, Q-switching, mode-locking, practical laser systems till date with their applications.
4	**Texts/References**	1.William. T Silfvast , “Laser fundamentals”, 2nd edition, Cambridge University Press, 2004. 2.Orazio Svelto, “Principles of lasers”, 5th edition, Springer Science & Business Media, 2010. 3.Anthony E. Siegman, “Lasers”, University Science Books, 1986. 4.Majid Ebrahim-Zadeh and Irina T. Sorokina, eds., Mid-Infrared Coherent Sources and Applications (Springer, 2008).

1	**Title of the course** (L-T-P-C)	**Astrophysics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Successfully finishing first 3 semesters
3	**Course content**	1. a. An inventory of the Universe, b. Celestial sphere, Coordinates c. Units, sizes, masses and distance scale 2. Electromagnetic spectrum a. Radio, Microwave, Infrared, Optical, X-ray and Gamma Ray b. Telescopes and Detectors 3. Stars A. General a. Sun, Planets, (Mother Earth) b. Mass, Radius, Luminosity, Temperature, Chemistry, Age and Types of stars c. Hertzsprung-Russell Diagram d. Birth and Evolution of stars c. Limits on Mass - Quantum mechanism at large scale: Brown Dwarf B. : Structure of a star: a. Virial Theorem (qualitative) b. Nuclear Energy, Pressure, Interaction with radiation. c. Basic Equations of Stellar Structure d. Thermal Equilibrium, Radiation and Convection - Schwarzchild Criterion e. Helioseismology 4. Galactic and Extragalactic Astronomy a. The Milky Way and Andromeda b. Rotation Curve - Dark Matter c. Structures within 500 mega light years d. Clusters of Galaxies, Superclusters, Filaments and Voids 5. Special Topics: a. White Dwarf - Quantum Mechanics and Gravitation: Chandrasekhar limit b. Supernova, Neutron Stars, (Pulsar astronomy), c. Black Holes, Gravitational Wave Astronomy d. Gamma Ray Burst e. Quasars and Active Galactic Nuclei 6. Topics in Cosmology (This will be decided after discussing certain issues with Department members) a. Hubble Expansion - Cosmic Distance Scale - Age of the Universe b. Standard Model of Cosmology c. Cosmic Microwave Background d. Supernova Cosmology Project and Dark Energy e. Gravitational Lens 7. Major Astronomical facilities where India is involved: GMRT, SKA, Thirty Metre Telescope, LIGO, ASTROSAT 8. Open questions in Astrophysics and Cosmology
4	**Texts/References**	1. The New Cosmos: An introduction to Astronomy and Astrophysics, A. Unsold and B. Baschek, Springer, 5th edition, 2010. 2. An Introduction to Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Cambridge University Press, 2nd edition, 2017. 3. Elements of Cosmology, J.V. Narlikar, University Press, 1996.

1	**Title of the course** (L-T-P-C)	**Introduction to Quantum Information and Computation** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	PH101 – Quantum Physics and Application MA102 - Linear Algebra
3	**Course content**	Framework of Quantum Mechanics: Quantum States, Dirac notation and Hilbert Space, Operators, Spectral Theorem, Functions of operators, Tensor Products, Schmidt Decomposition theorem; Time-evolution of a closed system; composite systems, measurement, pure and mixed states and general quantum operations. Quantum systems: Qubits, qudits, bipartite and multipartite systems, Continuous variable states. Quantum Entanglement: Definition, detection, quantification in various quantum systems Quantum Communication: no-go theorems, quantum teleportation, quantum dense coding, and other quantum communication protocols without security. Quantum Cryptography: essentials of classical cryptography, quantum protocols with security like, BB84, B92, Ekert, etc. Quantum Computation: Quantum gates, quantum algorithms, D-wave quantum computer. Status update for experimental realization on some of these protocols.
4	**Texts/References**	1. Quantum Computation and Quantum Information, M. A. Nielsen & I. L. Chuang, 10th Edition, Cambridge University Press, NY, USA (2011). 2. Quantum Information Theory, M. M. Wilde, Cambridge University Press, 2nd edition, 2017. 3. An introduction to Quantum Computing, P. Kaye, R. Laflamme and M. Mosca, Oxford University Press, (2010). 4. Preskill's lecture notes on Quantum Information and Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229/ 5. Principles of Quantum Computation and Information (Vol.-1), G. Benenti, G. Casati, and G. Strini, World Scientific, 2004. Classical and Quantum Computation, A. Yu. Kitaev, A. H. Shen, and M. N. Vyalyi, American Mathematical Society, 2002 7. Quantum Computation and Quantum Communication -Theory and Experiments, M. Pavicic, Springer, 2006. 8. Quantum Computer Science, N. D. Mermin, Cambridge, 2007. 9. Lectures on Quantum Information, Edited by D. Bruss and G. Leuchs, Wiley-VCH Verlag, 2007.

1	**Title of the course** (L-T-P-C)	**Classical Electrodynamics (2-1-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Electricity & Magnetism, Calculus, Linear Algebra and Differential Equations
3	**Course content**	A review of Maxwell's equations, its scope and limitations. Microscopic, Macroscopic fields and fields in materials. Conservation laws, gauge transformations, Green's functions. Plane Electromagnetic Waves and Wave propagation. Waveguides, Resonant Cavities and Optical Fibres. Electromagnetic Radiation, multipoles, Antennae. Diffraction, Scattering, Dispersion, Reflection. Dynamics of Relativistic particles. Radiation from accelerated charges (Additional topics like Faraday Rotation if students ask)
4	**Texts/References**	Text books 1. J.D. Jackson: Classical Electrodynamics (Wiley student edition) 2. W K H Panofsky and M Philips: Classical Electricity and Magnetism (Addison Wesley) 3. W Greiner: Classical Electrodynamics (Springer)

1	**Title of the course** (L-T-P-C)	**Nonlinear Optics** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	PH101
3	**Course content**	Origin of nonlinearity, nonlinear optical susceptibilities and interactions, intensity dependent refractive index, linear and nonlinear absorptions, harmonic generation, frequency conversion, phase matching, bistable devices, nonlinear optical materials, sources based on nonlinear optical interactions and their applications.
4	**Texts/References**	1.Robert W. Boyd, "Nonlinear Optics," 3rd edition, Academic Press, 2008. 2.Richard L. Sutherland, "Handbook of Nonlinear Optics," CRC Press, 2003. 3.Michael Bass, Handbook of Optics: Volume IV - Optical Properties of Materials, Nonlinear Optics, Quantum Optics, Third Edition (OSA, vol IV, 2010). 4.Majid Ebrahim-Zadeh and Irina T. Sorokina, eds., Mid-Infrared Coherent Sources and Applications (Springer, 2008). 5.Saleh and Teich, "Fundamentals of Photonics," 2nd edition, Wiley- Interscience, 2012

1	**Title of the course** (L-T-P-C)	**Quantum Physics and Application II** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Quantum Physics and Applications and Linear Algebra
3	**Course content**	• Recap on Wave Particle duality, Heisenberg Uncertainty Relation, Schrodinger Equation, Harmonic Oscillator. • Hydrogen atom • Dirac notations • Angular momentum algebra • WKB approximation • Time independent perturbation theory • Zeeman and Stark effect • Variational method • Density matrix • Pure and Mixed states • Superposition principle • Quantum measurement • C-bits and Qubits • Entanglement • Decoherence • Quantum logic gates • Introduction to quantum computation • Introduction to quantum communications
4	**Texts/References**	1. Ajoy Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Trinity Press, New Delhi, 5th Edition, 2015. 2. R. Shankar, Principles of Quantum Mechanics, Springer; 2nd ed. 1994. 3. E. Merzbacher, Quantum Mechanics, Wiley, 1970. 4. P.M. Mathews and K. Venkatesan, A text book of Quantum Mechnanics, Tata McGraw Hill, 1976. 5. Messiah, Quantum Mechanics, North Holland, 2014. 6. Richard P. Feynman, Robert B. Leighton, and Matthew Sands, The Feynman Lectures on Physics - Vol.3, Pearson Education, 1964. 7. L. Landau and E. Liftshitz, Quantum Mechanics, Pergamon 1965. 8. Leonard Susskind, Quantum Mechanics: The Theoretical Minimum, Penguin, 2015. 9. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.

1	**Title of the course** (L-T-P-C)	**Advanced Mathematical Methods of General Relativity** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	Exposure to Introductory Real Analysis, Linear Algebra and Calculus.
3	**Course content**	*Topology and Differential Geometry* Topological Spaces, Connected and Compact Spaces, Homeomorphisms, Manifolds, Orientability, Calculus on Manifolds, Vector and Tensor fields, Differential forms and their properties, Riemannian Geometry, Metric, Frames, Connection, Curvature, Torsion, Volume form, Isometries, Integration on Differential forms, Stokes Theorem, Laplacian, Homology and Cohomology, Fibre Bundles. *Differential Equations* Ordinary Differential Equations: First Order and Second Order Linear ODE`s, Series solutions, Frobenius method, Inhomogeneous Linear ODEs, Non-liner Differential Equations, Partial Differential Equations: First Order and Second Order Equations, Separation of Variables, Laplace and Poisson's Equations, Wave Equation, Heat-Flow and Diffusion Equations, Green`s functions: One Dimensional Problems, Problems in Two and Three Dimensions.
4	**Texts/References**	1. Differential Topology, Victor Guillemin, Allan Pollack, AMS Chelsea Publishing, (1974). 2. Introduction to Topology, Differential Geometry and Group Theory for Physicists, S. Mukhi and N., Wiley Eastern, Ltd. (1990). 3.Modern Differential Geometry for Physicists, Isham, World Scientific Lecture Notes in Physics, (2003). 4. Mathematical Methods for Physicists, G. Arfken, H. Weber, F. Harris, Elsevier, (2013). 5.Advanced Engineering Mathematics, E. Kreszig, Wiley, (2015).

1	**Title of the course** (L-T-P-C)	**Advanced Topics in Quantum Mechanics and Special Relativity** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	Exposure to Introductory Classical Mechanics and Quantum Mechanics.
3	**Course content**	Topics in *Quantum Mechanics* *Overview of Quantum Mechanics*: Waves and Particles, Wave packets, Uncertainty Principles, Schrodinger Equation, Operators and Observables, One-Dimensional Examples, Central Forces, Several Particle Systems, Approximation Methods, *Perturbation Theory*: Time independent and time dependent perturbation theory, *Scattering Theory*: General Features of Potential Scattering, Method of partial Waves, Integral Equation of Potential Scattering, Coulomb Potential, Scattering of Two Identical Particles, Approximation Methods, Absorption Processes and Scattering by Complex Potential. *Special Relativity* *Experimental Background*: Galilean Transformation, Michelson-Morley Experiment, Postulates of Special Relativity, *Relativistic Kinematics*: Lorentz Transformations, Addition of Velocities, Aberration and Doppler Effects, *Relativistic Dynamics*: Relativistic Momentum, Mass, Force Law and their Transformation Properties, *Relativity and Electromagnetism:* Transformation of electric and magnetic field, Field of uniformly moving charge and current- carrying wire, Forces between moving charges, Invariance of Maxwell`s equations. *Geometric Representation of Space-Time*: Spacetime Diagram, Simultaneity, Contraction, Dilation, Time order and space separation of events.
4	**Texts/References**	1. Modern Quantum Mechanics, J. Sakurai, J. Napolitano, Cambridge University Press, (2017). 2. Physics of Atoms and Molecules, B. Bransden, C. Joachain, Pearson (2003). 3. Introduction to Special Relativity, R. Resnick Wiley India, (2005). 4. Special Relativity, A. French, C R C Press, (2017).

1	**Title of the course** (L-T-P-C)	**Physics of Photovoltaics** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	NA
3	**Course content**	Basic principles of Photovoltaics- photons in, electrons out, Importance in the present world scenario; Fundamentals of photoelectric conversion: charge excitation, recombination, separation, conduction, and collection; Design of photovoltaic cells, electrical characterization parameters, material aspects; Solar cell technologies, emerging concepts, latest breakthroughs.
4	**Texts/References**	1. Jenny Nelson, "Physics of Solar Cells," 2ndedition, Imperial College Press, 2003. 2. P. Wurfel, "Physics of Solar Cells: From Principles to New Concepts," 2nd edition, Wile VCH, 2009. 3. L A Kosyachenko, "Solar Cells- New Approaches and Reviews", Intech Open, 2015.

1	**Title of the course** (L-T-P-C)	**Thin-Film Science and Technology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	NA
3	**Course content**	Basic definitions, importance of thin-film; Thin-film deposition methods: physical vapor deposition, chemical vapor deposition, atomic layer deposition, solution processed deposition, Epitaxy; Theory of nucleation & growth in thin films, defects, diffusion, methods of control and measurement of film thickness; Structural, optical, electrical and mechanical characterization of thin-films; Applications of thin films, examples of thin-film and devices: optical mirrors, transistors, solar cells, LEDs, displays, touchscreens, etc.
4	**Texts/References**	1. M Ogring, "The Material Science of Thin Films," 2nd edition, Academic Press, 2001. 2. A Goswami, "Thin Film Fundamentals," New Age International, 1996 3. A Wagendristel, Y Wang, "An Introduction to Physics and Technology of Thin Films", World Scientific, 1994.

1	**Title of the course** (L-T-P-C)	**Photonics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Optical radiation processes, conditions for the amplification of radiation, three- level and four-level lasers, resonators and cavity designs, electro-optic and acousto-optic modulators, Q-switching, mode-locking, practical laser systems till date, with their applications. Origin of nonlinearity, nonlinear optical interactions, intensity dependent refractive index, linear and nonlinear absorptions, nonlinear optical materials, sources based on nonlinear optical interactions and their applications, Intense- field nonlinear optics. Detectors and diagnostics, Spectroscopy techniques. Ray model and Wave model in fiber Optics, fiber parameters, Signal Distortion, Dispersion, nonlinear effects in fiber, Integrated Optics & Devices, fiber based systems, Photonic crystal fibers.
4	**Texts/References**	1. Saleh and Teich, "Fundamentals of Photonics," 2nd edition, Wiley-Interscience, 2012. 2. F. Graham Smith, "Optics and Photonics: An Introduction," 2nd edition, John Wiley & sons, 2007. 3. Orazio Svelto, "Principles of lasers", 5th edition, Springer Science & Business Media, 2010. 4. Robert W. Boyd, "Nonlinear Optics," 3rd edition, Academic Press, 2008. 5. (5) John A Buck, "Fundamentals of Optical Fibers," 2nd edition, Wiley-Interscience, 2004.

1	**Title of the course** (L-T-P-C)	**Atomic and Molecular Physics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	PH101 Quantum Mechanics and Applications
3	**Course content**	Recapitulation of quantum mechanics; One-electron atoms: energy levels, interaction with electromagnetic fields, transition rates, density of states, dipole approximation, Zeeman and Stark effects; Multi-electron atoms: Helium atom, central field approximation, Thomas- Fermi model of the atom, Hartree-Fock method, L-S and J-J coupling, interaction with external fields; Molecular structure: Born-Oppenheimer approximation, Electronic structure of molecules, Hydrogen molecule ion, molecular orbital (MO) theory, homo and hetero-nuclear diatomic molecules, electronic term symbols, valence bond (VB) theory of diatomic molecules, comparison of VB and MO theories; Molecular spectra: Rotational, Vibrational and Electronic spectra.
4	**Texts/References**	1. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain, Pearson Education, Ltd. (2003). 2. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, R. Eisberg and R. Resnick, John Wiley & Sons, Inc. (1985). 3. Atoms, Molecules and Photons, W. Demtroder, Springer-Verlag Berlin (2010). 4. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, McGraw Hill Education (2013). 5. Molecular Quantum Mechanics, P. Atkins and R. Friedman, Oxford University Press (2011). 6. Quantum Chemistry, I. N. Levine, Pearson (2016).

1	**Title of the course** (L-T-P-C)	**Special Theory of Relativity (2-1-0-6)**
2	**Pre-requisite courses(s)**	PH101, PH102
3	**Course content**	Experimental Background: Galilean Transformation, Michelson-Morley Experiment, Postulates of Special Relativity, Relativistic Kinematics: Lorentz Transformations, Addition of Velocities, Aberration and Doppler Effects, Relativistic Dynamics: Relativistic Momentum, Mass, Force Law and their Transformation Properties, Relativity and Electromagnetism: Transformation of electric and magnetic fields, Field of uniformly moving charge and current-carrying wire, Forces between moving charges, Invariance of Maxwell's equations. Geometric Representation of Space-Time: Spacetime Diagram, Simultaneity, Contraction, Dilation, Time order and space separation of events. Introduction to General Relativity.
4	**Texts/References**	Introduction to Special Relativity, R. Resnick Wiley India, (2005). Special Relativity, A. French, C R C Press, (2017).

1	**Title of the course** (L-T-P-C)	**Theory of Laboratory (2-1-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Vacuum Techniques: Production and measurement of vacuum, different type of vacuum systems and gauges, their working and limitations, techniques for production of ultra- high vacuum, applications of kinetic theory: theoretical background. Crystallography: Basic principles of powder X ray diffraction technique, single crystal X ray diffraction method and backscattered X ray Laue diffraction technique to investigate the single crystals. Electronics: Measurement techniques in electronics, use of different measuring devices, their scopes and limitations. Design, fabrication and testing of some circuits, Lock-in amplifier. Detectors: Study of different types of detectors. Photographic detectors, optical detectors, X ray detector.
4	**Texts/References**	Introduction to Solid State Physics - C Kittel, 7th ed., John Wiley (2005). Electronic Principles, A. Malvino and D. Bates, McGraw Hill Education 7th Edition (2017).

1	**Title of the course** (L-T-P-C)	**Research Project in Physics** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	The student can do a project with any faculty in the Department of Physics. The topic of the project could be chosen through discussion between the student and the faculty.
4	**Texts/References**	None

1	**Title of the course** (L-T-P-C)	**Advanced Mathematical Physics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Vector & Tensor Analysis; Matrix Analysis; Complex Variables– Complex integrals & applications: Geometrical representations of *w* = *f(z)*: Conformal Transformations; Schwarz– Christoffel Transformation; Solutions to Dirichlet and Newmann problems; Applications to fluid flow, electrostatics and heat flow; Differential equations – Ordinary differential equations and Partial differential equations, including Sturm-Liouville Theory, Separation of Variables, Laplace and Poisson Equations, Wave Equation, Heat-flow, Green's functions; Group Theory –Subgroups and Classes, Group representations, Characters, Physical applications, Infinite groups, Irreducible representations of SU(2), SU(3) and O(3); Special Functions – Neumann and Hankel functions, Bessel, Hermite, Laguerre, Legendre, Hypergeometric and Confluent hypergeometric functions, Chebyshev polynomials; Integral transforms - Fourier transforms and Laplace transforms; Integral Equations – Neumann Series; Hilbert-Schmidt Theory; Probability and Statistics.
4	**Texts/References**	1.George B. Arfken and Hans J. Weber, Mathematical methods for physicists, Academic Press Inc., 6th Edition, 2005 2. I.A. Gradshteyn, I.M. Ryzhik, Sixth Edition, Academic Press, 2000. 3. M. Abramowitz and I. A. Stegan, Handbook of Mathematical Functions, Dover Publications, INC., New York, 1965. 4. E. Kreyszig, Advanced Engineering Mathematics, Wiley India, 8th Edition, 2008.

1	**Title of the course** (L-T-P-C)	**Research Seminar** **(2-0-0-4)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	NA
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Photonics: Fundamentals and Technology (2-1-0-6)**
2	**Pre-requisite courses(s)**	Electrodynamics, Fundamentals of Optics
3	**Course content**	Laser Technology: Optical radiation processes, conditions for the amplification of radiation, three level and four level lasers, resonators and cavity designs, practical laser systems till date, with their applications. Nonlinear Optics and Devices: Origin of nonlinearity, nonlinear optical interactions, intensity dependent refractive index, linear and nonlinear absorptions, nonlinear optical materials, sources based on nonlinear optical interactions and their applications. Attoscience, Ultrafast Optics and Spectroscopy: High-harmonic generation, Attosecond pulse generation and technology, detectors and diagnostics, Spectroscopy techniques and applications. Fiber Optics: Ray model, Wave model, fiber parameters, Signal Distortion, Dispersion, nonlinear effects in fiber, Integrated Optics & Devices, fiber based systems. Photonic crystal fibers.
4	**Texts/References**	1. Saleh and Teich, “Fundamentals of Photonics,” 2nd edition, Wiley-Interscience, 2012. 2. F. Graham Smith, “Optics and Photonics: An Introduction,” 2nd edition, John Wiley & sons, 2007. 3. Orazio Svelto, “Principles of lasers”, 5th edition, Springer Science & Business Media, 2010. 4. Robert W. Boyd, “Nonlinear Optics,” 3rd edition, Academic Press, 2008. 5. John A Buck, “Fundamentals of Optical Fibers,” 2nd edition, Wiley-Interscience, 2004.

1	**Title of the course** (L-T-P-C)	**Advanced Atomic and Molecular Physics** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	Introductory Quantum Mechanics.
3	**Course content**	Recapitulation of quantum mechanics; One-electron atoms: Schrodinger equation, energy levels, interaction with electromagnetic fields, transition rates, density of states, dipole approximation, Zeeman and Stark effects; Multi-electron atoms: Helium atom, central field approximation, Thomas-Fermi model of the atom, Hartree-Fock method, L-S and J-J coupling, interaction with external fields; Molecular structure: Born-Oppenheimer approximation, Electronic structure of molecules, Hydrogen molecule ion, Approximate molecularorbital (MO) theory, homo and hetero-nuclear diatomic molecules, electronic term symbols, valence bond (VB) theory of diatomic molecules,comparison of VB and MO theories; Molecular spectra: Rotational, Vibrational and Electronic spectra; Introduction to molecular dissociation.
4	**Texts/References**	1. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain, Pearson Education, Ltd. (2003). 2. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, R. Eisberg and R. Resnick, John Wiley & Sons, Inc. (1985). 3. Atoms, Molecules and Photons, W. Demtroder, Springer-Verlag Berlin(2010). 4. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, McGraw Hill Education (2013). 5. Molecular Quantum Mechanics, P. Atkins and R. Friedman, Oxford University press (2011). 6. Quantum Chemistry, I. N. Levine, Pearson (2016).

1	**Title of the course** (L-T-P-C)	**Molecular Spectroscopy** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Review of atomic and molecular physics: One- eletron atom and muti-electron atom, energy levels, Transition probabilities and cross- sections, Lifetime, Line broadening mechanisms, Central field approximation, L-S and j-j coupling schemes, interaction with external fields, Born-Oppenheimer approximation, Hydrogen molecule ion, Electronic structure of diatomic molecules and extension to simple polyatomic molecules,electronic term symbols, Selection rules. Electromagnetic radiation and its interaction with matter. Absorption and emission of radiation. Electromagnetic spectrum and different forms of spectroscopy. Rotational Spectroscopy: Linear, symmetric rotor, spherical rotor and asymmetric rotor molecules, Rotational infrared, millimeter wave and microwave spectra, Rotational Raman spectroscopy. Vibrational Spectroscopy: Diatomic molecules, Polyatomic molecules, infrared spectra, Raman spectra, Ro-vibrational spectroscopy, Anharmonicity. Electronic Spectroscopy: electronic transition, energy of electronic transition, the Franck-condon principle,X-ray and photoelectron spectroscopy,Auger electron spectroscopy.
4	**Texts/References**	1. Modern Spectroscopy, J. M. Hollas, John Wiley & Sons, Inc. 2. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, McGraw Hill Education. 3. Molecular Spectroscopy, Ira N Levine, John Wiley & Sons, Inc. 4. Molecular Quantum Mechanics, P. Atkins and R. Friedman, Oxford University press. 5. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain, Pearson Education, Ltd. (2003).

1	**Title of the course** (L-T-P-C)	**Remote Sensing** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Introduction, Electromagnetic radiation, Interaction of electromagnetic radiation with atmosphere, Effects of Atmosphere- Scattering, Absorption, Atmospheric window, Energy interaction with surface features, Spectral reflectance of earth objects and land covers, Resolution concepts, Satellites, orbits and missions. Remote sensing system: Physical basis of signatures: Reflective optical region (multispectral and hyperspectral), thermal IR region and microwave region. Sensors: Historical development, Resolutions, Opto-mechanical electro-optical sensors, across track and along track scanners, multi spectral scanners, characteristics of different types of platforms, medium and high resolution missions, Data products and characteristics. Data analysis: Sources of errors, scene, sensor and atmospheric causes, Corrections: geometric and radiometric, visual and digital interpretation, elements of interpretation, interpretation keys, digital analysis and classification, Image formation, visualization: image enhancement, filters, Image classification: unsupervised and supervised, thematic mapping, accuracy assessment. Applications of Remote Sensing.
4	**Texts/References**	1. Introduction to Remote Sensing, J.B Campbell, Taylor & Francis. 2. Physical Principles of Remote Sensing, W.G. Rees, Cambridge University Press. 3. Fundamentals of Remote Sensing, George Joseph & C Jeganathan, Universitiy Press, India 4. Introductory digital image processing: a remote sensing perspective, John R. Jensen, Prentice Hall. 5. Remote sensing and image interpretation, T. M. Lillesand, R. W. Kiefer, and J. W. Chipman, Wiley.

1	**Title of the course** (L-T-P-C)	**Superconductivity and Magnetism** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**Superconductivity:** Overview, types of superconductors, electrodynamics and thermodynamics of superconductors, elements of Ginzburg-Landau theory and BCS theory; Fluxoid quantization; Josephson tunnelling; applications of superconductivity; SQUID, recent discoveries on superconductors. **Magnetism:** Classification of magnetic materials, localized and itinerant magnetism, various types of exchange interactions- direct, super, RKKY and DM, magneto-crystalline anisotropy energy, shape anisotropy, domains, domain walls and magnetization process, magnetism in thin films and fine particles; basics of spin dependent scattering/spin- polarized transport; magneto-transport effects, basics of magnetic recording, Hall effect, spintronics and spintronic devices.
4	**Texts/References**	Superconductivity, Superfluids and Condensates- J F Annet, Oxford Master Series (2004), Superconductivity- C Poole, H Farach and R Creswick, R Prozorov, Elsevier (2014), Introduction to Superconductivity, M. Tinkham Ed. McGraw-Hill Inc. (1996). Magnetism in Condensed Matter - Stephen Blundell, Oxford Master Series (2001), Magnetism and Magnetic Materials – J. M. D. Coey, Cambridge University Press (2012) Physics of Ferromagnetism - S. Chikazumi, Oxford University Press (1997), Introduction to Spintronics - S. Bandyopadhya and M. Cahay, CRC press (2020), Introduction to Solid State Physics - C Kittel, 7 th ed, John Wiley (2005)

1	**Title of the course** (L-T-P-C)	**Quantum Computation** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Exposure to PH101 – Quantum Mechanics and Applications MA102 - Linear Algebra
3	**Course content**	Introduction to Classical Computation: The Turing Machine –The Church-Turing thesis, Universal Turing Machine, Probabilistic Turing machine; Circuit model of computation – Binary arithmetics, Elementary logic gates, Universal classical computation; Computational complexity – Complexity classes, Chernoff bound; Energy and information – Maxwell's demon, Landauer's principle, Extracting work from information; Reversible computation – Toffoli and Fredkin gates, billiard ball computer. Framework of Quantum Mechanics: The Dirac notation and Hilbert Space, Dual Vectors, Operators, Spectral Theorem, Functions of operators, Tensor Products, Schmidt Decomposition theorem; The state of quantum system, time-evolution of a closed system; composite systems, measurement, mixed states and general quantum operations. Quantum Computation: The quantum circuit model, Quantum Gates – 1-qubit gates, Controlled-U gates; Universal Sets of Quantum Gates, Implementing measurements with quantum circuits. Quantum communications: Super dense coding, Quantum Teleportation. Quantum Algorithms: Probabilistic versus quantum algorithms, Phase Kick-Back, Deutsch algorithm, Deutsch-Jozsa Algorithm, Simon's Algorithm, Grover's quantum search Algorithm. Quantum computational Complexity Theory and lower bounds: computational complexity, Black-Box Model, General Black-box lower Bounds, Polynomial Methods, Block Sensitivity. Quantum Error Corrections: Classical error corrections – The error model, encoding, error recovery, Fault tolerance, Quantum error correction, Three- and nine-qubit quantum codes, Fault tolerant quantum computation. Quantum Computation with physics systems
4	**Texts/References**	1. Quantum Computation and Quantum Information, M. A. Nielsen & I. L. Chuang, 10th Edition, Cambridge University Press, NY, USA (2011). 2. An introduction to Quantum Computing, P. Kaye, R. Laflamme and M. Mosca, Oxford University Press, (2010). 3. Preskill's lecture notes on Quantum Information and Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229/ 4. Principles of Quantum Computation and Information (Vol.-1), G. Benenti, G. Casati, and G. Strini, World Scientific, 2004. 5. Classical and Quantum Computation, A. Yu. Kitaev, A. H. Shen, and M. N. Vyalyi, Americal Mathematical Society, 2002 6. Quantum Coputation and Quantum Communication-Theory and Experiments, M. Pavicic, Springer, 2006. 7. Quantum Computer Science, N. D. Mermin, Cambridge, 2007. 8. Lectures on Quantum Information, Edited by D. Bruss and G. Leuchs, Wiley-VCH Verlag, 2007

1	**Title of the course** (L-T-P-C)	**General Relativity and Cosmology (4-0-0-8)**
2	**Pre-requisite courses(s)**	Special Relativity, Classical Mechanics
3	**Course content**	Overview of Special Relativity: Minkowski Metric, Lorentz Transformations, Spacetime Diagrams, Vectors, Dual Vectors and Tensors on Flat Spacetime, Tensor Manipulations, Maxwell's Equations in Tensor Notation, Classical Field Theory, Manifolds: Equivalence Principle, Gravitation as Spacetime Curvature, Definition of manifold, Vectors, Dual Vectors and Tensors on Manifolds, Metric Tensor, Tensor Densities, Differential Forms and Integration of Manifolds, Curvature: Covariant Derivative, Connection, Christoffel Symbol, Parallel Transport, Geodesics, Riemann Curvature tensor, Symmetries of Riemann Tensor, Binachi Identity, Ricci Tensor, Riemann Tensor, Symmetries and Killing Vectors, Maximally Symmetric Spaces, Geodesic Deviation, Tetrad and Non-Coordinate Basis, Spin- Connection, Cartan Equation, Gravitation: Minimum Coupling Principle, Physics in Curved Spacetime, Einstein Equations, Newtonian Limit, Lagrangian Formulation and Einstein-Hilbert Action, Energy-Momentum Tensor, Energy-Conditions, Black Holes: Spherical Symmetry, Schwarschild Solution, Birkoff`s Theorem, Geodesics in Schwarschild Spacetime, Tests of General Relativity, Event Horizon, Black Hole, Singularity, Maximal Extension and Kruskal Coordinates, Penrose Diagram, Formation of Black Holes, Relativistic Stars, General Black Holes (Charged and Rotating), Gravitational Radiation: Linearized Gravity, Gauge Transformations, Degrees of Freedom, Newtonian Fields and Photon Orbits, Gravitational Wave Solutions, Production of Gravitational Waves, Energy Loss due to Gravitational radiation, Detection of Gravitational Waves. Cosmology: Homogeneity and Isotropy, Robertson-Walker Metric, Friedman Equations, Solutions for Matter, Radiation and Cosmological Constant Dominated Universes, Redshifts and Distances, Gravitational Lensing, Our Universe, Inflation.
4	**Texts/References**	1.Spacetime and Geometry: Introduction to General Relativity, Pearson, S. Carroll (2016). 2.Gravitation and Cosmology, S. Weinberg, Wiley (2008). 3.A First Course on General Relativity, S. Schutz, Cambridge University Press (2009). 4.General Relativity, R. Wald, University of Chicago Press, (1984).

1	**Title of the course** (L-T-P-C)	**Quantum Information Theory** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Introduction to Quantum Information and Computation
3	**Course content**	Advanced entanglement theory (GM, GGM, newly proposed measures etc). Quantum Correlation Beyond Entanglement (Quantum Discord, Geometric discord, Work-Deficit etc). Resource theory in QI (Entanglement, Quantum Coherence, Reference Frame, Asymmetry etc). Continuous variable quantum information. General evolution and Decoherence theory. Open quantum systems; Master equations, Markovian and Non-Markovian, Various measure of non markovianity. Quantum Thermodynamics. Advanced topics in quantum channels. Quantum information and condensed matter systems. Beyond quantum mechanics – No signaling theories.
4	**Texts/References**	1. Quantum Theory: Concepts and Methods, A. Peres, Springer, 1995 2. Quantum Computation and Quantum Information, M. A. Nielsen & I. L. Chuang, 10th Edition, Cambridge University Press, NY, USA (2011). 3. Quantum Information Theory, M. M. Wilde, Cambridge University Press, 2nd edition, 2017. 4. Lectures on Quantum Information, Edited by D. Bruss and G. Leuchs, Wiley-VCH Verlag, 2007.

1	**Title of the course** (L-T-P-C)	**Quantum Optics** **(4-0-0-8)**
2	**Pre-requisite courses(s)**	Linear Algebra (finite-dimensional vector spaces, matrices, eigenvectors and eigenvalues, linear maps, etc.), Introductory & Advanced Quantum Mechanics.
3	**Course content**	**Elementary Quantum Systems & Operator Algebra:** The Oscillator in the Heisenberg Picture and its Energy-Eigenvalue problem; Physical interpretation of number, creation, and annihilation operations – Bosons and Fermions; Transformation function from N to q representation for Oscillator; The Coherent States; Spin Operators. Some General Operator Theorems; Ordered Boson Operators and its algebraic properties; Characteristic functions – Wigner Distribution function; Wick's Theorem for Boson operators. Definition of Entropy. **Quantization of Electromagnetic Field:** Potential theory for the classical EM field; Canonical communication relation; Pure states and statistical mixtures; Time development of quantum optical systems; Interaction of quantized field with atom; Quantum degrees of first and second- order coherence. **Single/Multimode/Continuous mode quantum optics:** Single- mode field operators; Number states; Coherent States; Chaotic light; The squeezed vacuum; Squeezed coherent states; Beam splitter input-output relations; Multimode states; Continuous-mode field operators; photon bunching and antibunching; Photon pair states; Homodyne detection. **Interaction between light and a two-level atom**: The Jaynes-Cummings model interaction and the corresponding Hamiltonian - its solution and the expression for the population inversion; the experimental developments; the classical and quantum signatures-collapses and revivals.
4	**Texts/References**	1. Quantum Statistical Properties of Radiation, William H. Louisell, Wiley Classics Library Edition (1990). 2. The Quantum Theory of Light, Rodney Loudon, Oxford University Press, New York (2000). 3. Quantum Optics, O Scully and S Zubairy, Cambridge University Press (1997). 4. Quantum Optics, DF Walls and Grad J Milburn, Springer (2010). 5. Quantum Optics: An Introduction, M.Fox, Oxford University Press(2007). 6. Fundamentals of Quantum Optics, John R Klauder and E C G Sudarshan, Dover Publications Inc. (2006). 7. Introductory Quantum Optics, C. Gerry and P. Knight, Cambridge University Press (2004). 8. Optical Coherence and Quantum Optics, Leonard Mandel, Cambridge University Press (1995). 9. Quantum Optics, Girish S. Agarwal, Cambridge University Press (2012).

1	**Title of the course** (L-T-P-C)	**Tunable Coherent Optical Devices** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Electrodynamics, Fundamentals of Optics
3	**Course content**	Tunable laser: Materials, Active medium (Solid- state, Fiber, semiconductor), Pump source, Spectral range, Time-scale, Development of systems. Quantum Cascade laser: Development and characteristics. Microstructured semiconductors and periodically-poled crystals: Fabrication and properties. Tunable systems based on nonlinear optical materials: Wide spectral coverage (Ultraviolet to Terahertz), all time scale. Applications: Trace gas sensing, exhaled breath monitoring, laser-tissue interaction.
4	**Texts/References**	1. Michael Bass, Handbook of Optics: Volume IV - Optical Properties of Materials, Nonlinear Optics, Quantum Optics, Third Edition (OSA, vol IV, 2010). 2. Majid Ebrahim-Zadeh and Irina T. Sorokina, eds., Mid-Infrared Coherent Sources and Applications (Springer, 2008). 3. Richard L. Sutherland, "Handbook of Nonlinear Optics," CRC Press, 2003 4. Robert W. Boyd, "Nonlinear Optics," 3rd edition, Academic Press, 2008.). 5. Orazio Svelto, "Principles of lasers", 5th edition, Springer Science & Business Media, 2010.

1	**Title of the course** (L-T-P-C)	**Molecular Dynamics Imaging: Methodologies and Applications** **3-0-0-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Charged particle imaging: History, fragment ion imaging, electron imaging, angular information of products, coincidence measurements. Recoil-Ion Momentum Spectroscopy: Imaging Spectrometers for Ions, Target Preparation, Target Preparation, Imaging Spectrometers for Electrons, New developments. Velocity Map Imaging: Newton spheres - concept, creation and analysis, experimental requirements, characterization of the surface patterns of Newton spheres. Velocity map imaging of photo-dissociation. Reconstruction methods: Symmetric distributions, Abel and Hankel inversion methods, Back-projection method, Iterative inversion, Basis set expansion method, Forward convolution. Time resolved imaging: 3-D imaging scheme, experimental schemes, Detector time calibration, Multi-particle detection. Applications: Kinematically complete imaging of molecular many-body fragmentation: coincident multi-particle detection and analysis, Photoelectron and photo-ion imaging with femtosecond pump-probe time clocking, Multiple Ionization and fragmentation in strong Laser fields.
4	**Texts/References**	1. Imaging in Molecular Dynamics: Technology and Applications, Benjamin J. Whitaker, Cambridge University Press, 2003. 2. Many-Particle Quantum Dynamics in Atomic and Molecular Fragmentation, J. Ullrich and V. P. Shevelko, Springer, 2003. 3. Quantum Control of Molecular Processes, M. Shapiro and P. Brumer, Wiley, 2012. 4. Ultrafast Phenomena in Molecular Sciences, R. de Nalda and L. Bañares, 2014.

1	**Title of the course** (L-T-P-C)	**Hydrogen Technology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Properties of hydrogen, global status of supply and demand, methods of hydrogen production, steam reforming. Advanced methods of steam reforming, partial oxidation, autothermal reforming, combined reforming, reforming using alternate energy sources. Hydrogen production from methane decomposition, from coal and biomass. Hydrogen separation and purification, thermochemical cycles for hydrogen production, fundamentals for electrolysis of water. Components of electrolytic cell, configuration of electrolyzer stack, different electrolyzer technologies, photoelectrochemical hydrogen production, technical and economic comparison of different production methods and global status, cost analysis. Introduction to hydrogen storage, underground hydrogen storage, fundamentals of hydrogen compression and expansion. Mechanical and non-mechanical hydrogen compressors; compressed hydrogen tank types and design considerations. Hydrogen liquefaction, liquid state hydrogen storage tanks, fundamentals of hydrogen storage in adsorption-based materials. Fundamentals and thermodynamics of absorption-based hydrogen storage, metal hydrides, types of metal hydrides, metal hydride-based systems design. Novel materials for solid state hydrogen storage; economics of storage; Long distance hydrogen transport via pipelines, ships and in form of LOHC; hydrogen transport via road; hydrogen refueling stations. Use of hydrogen in internal combustion engines, fuel cells, hydrogen sensing. Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status and future directions. Hydrogen for stationary power applications and for transport applications. Hydrogen for steel, cement, fertilizer, and other industries for decarbonization.
4	**Texts/References**	1. A.J. Appleby, F.R. Foulkes, “Fuel Cell Handbook,” Krieger Publishing Company, Malabar, Florida, 1993. 2. Agata Godula-Jopek, “Hydrogen Production: Electrolysis,” Wiley Online Library, 2015. 3. K. S. Dhathathreyan and N. Rajalakshmi, “Polymer Electrolyte Membrane Fuel Cell,” in Recent trends in Fuel cell science and technology, Eds. Anamaya Publishers, 2006. 4. Gupta, R. B., “Hydrogen Fuel: Production, Transport and Storage,” CRC Press, Taylor & Francis Group, 2009. 5. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B., “Hydrogen storage: state-of-the-art and future perspective. Netherlands,” European Communities, 2003. 6. N. Rajalakshmi, K. S. Dhathathreyan and Sundara Ramaprabhu, “Investigation of a novel metal hydride electrode for Ni-MH batteries,” Advances in Hydrogen energy, Kluver Academic/ Plenum Publishers, 2000. 7. N. Rajalakshmi and K.S.Dhathathreyan, “Hydrogen Energy Technologies”, in The New Energy Economy, published by World Institute of sustainable energy, 2005. 8. N.Rajalakshmi and K. S .Dhathathreyan, “Present Trends in Fuel Cell Technology Development”, in “Progress in Fuel Cell Research “ ed. Petr. V. Alemo, NOVA Publishers, USA, 2007. 9. Yasodhar Surabattula, R. Balaji, N. Rajalakshmi and K. Arul Prakash, “First and second law of thermodynamics - Analysis for Fuel cells,” Encyclopedia of Energy storage, Elsevier press, 2021.

		10. EG & GT Technical Services Inc., “Fuel Cell Handbook,” sixth edition. US Department of Energy publication, 2002. 11. Global Hydrogen Review 2021, IEA (2020,2021,2022), Paris, https://www.iea.org/reports/global-hydrogen-review-2021 12. Fuel Cells and Hydrogen Production - Springer Link https://link.springer.com.
1	**Title of the course** (L-T-P-C)	**Third Generation Photovoltaics: Materials, Integration and Devices** **3-0-0-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Device Physics of Solar Cells: Principle of solar energy conversion, Shockley-Quisser limit- Single, Tandem and multi-junction solar cells, Solar cell modeling-optical and electrical. Dye Sensitized Solar Cells: Introduction, Fabrication of Dye Sensitized Solar Cells' Design of novel dye, Design of solid electrolytes materials, Counter electrode engineering. Organic Solar Cells: Introduction, Physics of Bulk Hetero junction (BHJ) Solar Cells, Morphology and charge separation in BHJ, Design of low band gap polymers, Novel architecture and limitations in BHJ. Perovskite Solar Cells: Fabrication of perovskite solar cells, Photophysics in perovskite solar cells, Stability in perovskite solar cells, Lead free perovskite solar cells. Photovoltaic system engineering, Thermo- Photovoltaic generation of electricity, Concentration and storage of electrical energy, Photovoltaics modules, system and application, Building integrated photovoltaic systems.
4	**Texts/References**	1. Zdyb, A. Third Generation Solar Cells, Routledge, 2023. ISBN 9781032052557 2. Green, M. Third Generation Photovoltaics- Advanced Solar Energy Conversion. Springer, 2006. ISBN: 9783540265634. 3. Ponseca, C. S., Emerging Photovoltaic Technologies- Photophysics and Devices, Jenny Stanford Publishing, 2019. ISBN:9781000021769 4. Jean, J., Brown, P. R., Emerging Photovoltaic Technologies, IOP Publishing, 2019. ISBN:9780750321525 5. Elseman, A. M., Solar Cells- Theory, Materials and Recent Advances, IntechOpen, 2021. ISBN:9781838810160

1	**Title of the course** (L-T-P-C)	**Silicon Photovoltaics** **3-0-0-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Status, Trends, and Challenges: Photovoltaics effect, Myths and history of Photovoltaics, PV Costs, Markets and forecasts, PV research and manufacturing, Global trends in performance and applications, Silicon progress and challenges, Thin film progress and challenges, Future of emerging PV technologies Introduction to semiconductor physics: Band structure, Optical absorption and doping; Semiconductor types: crystalline, multicrystalline, amorphous, thin-film; Transport phenomena: the p-n junction, Charge carrier dynamics in semiconductors; Current-voltage characteristics of solar cells, Loses- optical and recombination, Asymmetrical devices: Metal-semiconductor contacts and semiconductor surface; Solar cell operation: Solar spectrum; solar cell fundamentals; Theoretical limits of photovoltaic conversion, Thermodynamics and photovoltaic conversion; Effect of temperature and parasitic resistance. Solar modules: Module and circuit design, Identical and non-identical cells, Thermal consideration, Hot-spot heating, Environmental protections. Crystalline semiconductor solar cells: Description of the crystalline silicon photovoltaic technology from bulk crystal growth. Extension to III-V compounds solar cells. New Directions in Si PV Technology: Heterojunction technology; Passivated Emitter and Rear Cell (PERC); Tunnel Oxide Passivated Contact (TOPCon)
4	**Texts/References**	1. Honsberg, C., and S. Bowden. Photovoltaics: Devices, Systems and Applications CD-ROM. (A free online resource), 1999. 2. Wenham, S., M. Green, et al., eds. Applied Photovoltaics. 2nd ed. Routledge, 2006. ISBN: 9781844074013. 3. Solanki, C. S., Solar Photovoltaics- Fundamentals, Technologies And Applications, PHI Learning, 2009. ISBN:9788120351110 4. Shah, A., Solar Cells and Modules, Springer, 2020. ISBN:9783030464875 5. Satpathy, R. K., Pamuru, V., Solar PV Power, Design, Manufacturing and Applications from Sand to Systems, Elsevier, 2020. ISBN:9780128176276

1	**Title of the course** (L-T-P-C)	**Waves, Oscillations and Optics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Linear oscillators. Coupled oscillators and normal modes with mechanical and electromagnetic examples. Inertia, restoring force and damping. Driven systems and resonance. The continuum limit. Waves and wave equations. Dispersion relations. Phase. Interference and diffraction. Wave packets. Impedance, reflection, absorption and transmission. Polarization. Geometrical optics. Brief introduction to nonlinearity.
4	**Texts/References**	1. Waves, Berkeley Physics Course (Vol 3), Frank S. Crawford Jr., McGraw Hill, 2017. 2. Vibrations and Waves, G. C. King, John Wiley & Sons, 2009 3. Optics, Principles and applications, K. K. Sharma, Elsevier (2006) 4. Optics, M. V. Klein and T. E. Furtak, Wiley (1986) 5. Principles of Optics, M. Born and E. Wolf, McMillan, 1974. 6. Introduction to Modern Optics, G. B. Fowles, Dover, 1975. 7. Fundamentals of Optics, F. Jenkins and H. White, McGraw Hill, 2017.

1	**Title of the course** (L-T-P-C)	**Numerical Methods** **2-0-2-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Representation of numbers. Round-off error. Condition and stability. Convergence. System of Linear Equations: Exact methods: Lower-Upper (LU) decomposition, Gauss-elimination methods without and with partial pivoting, Iterative methods: Gauss-Jacobi and Gauss- Seidal methods, Matrix norm Condition number and Ill-conditioning, Singular value decomposition, Matrices- Eigenvalues and eigenvectors. Non-linear Equations and Roots of Polynomials: Bisection method, Newton–Raphson's method, Direct Iterative method with convergence criterion. Numerical Interpolation and Curve Fitting: Lagrange, Hermite, cubic spline interpolation methods and discussion on associated errors, Curve fitting by least squares. Numerical Calculus: Integral Calculus:- General quadrature formula, Simpson's rules, Improper integrals, Gaussian quadrature formulae. Differential Calculus:- Numerical differentiation, Richardson Extrapolation, Monte Carlo Methods. Ordinary Differential Equations: Euler methods, Runge- Kutta methods and Numerov methods, second order differential equations, coupled differential equations, finite differences, eigen values via finite differences, Power method and eigenvalue problem. Partial Differential Equations: Numerical solutions, Finite difference representation, Elliptic equations.
4	**Texts/References**	• P L DeVries, J E Hasbun “A First Course in Computational Physics”, John Wiley, 2nd Edition, 2010. • Tao Pang, An Introduction to Computational Physics, Cambridge Univ. Press, 2nd Edition, 2006. • K E Atkinson, “An Introduction to Numerical Analysis”, Wiley 2nd Edition,2008. • S S Sastry, “Introductory Methods of Numerical Analysis”, Prentice Hall, 5^{th} Edition, 2012. • E W Cheney, D R Kincaid, “Numerical Mathematics and Computing”, Cengage Learning, 7th Edition, 2012.

1	**Title of the course** (L-T-P-C)	**Electronics** **2-1-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Network theorems; application to simple circuits. Semiconductor basics, diodes, p-n junction devices, transistors; biasing schemes; small signal amplifiers; feed-back theory; oscillators; power supply; wave shaping circuits. Bipolar junction transistor: configurations, small signal amplifier, oscillators; JFET and MOSFET: characteristics, small signal amplifier. OP-AMP: Differential amplifiers; Op-Amp (741) circuits (amplifiers; scalar; adder; subtractors; comparator; logarithmic amplifiers; etc.) Digital electronics : Logic gates, Boolean algebra, Karnaugh maps, flip flops, shift registers, adders, counters, ADC and DAC.
4	**Texts/References**	• J. Millman, C. C. Halkias, C. D. Parikh, Integrated Electronics, 2nd edition, McGraw Hill Education (2017). • A. P. Malvino, Electronic Principles, 7th edition, McGraw Hill Education (2017). • R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition, Prentice Hall (2013). • D. P. Leach, A. P. Malvino and G. Saha, Digital Principles and Applications, 8th edition, McGraw Hill Education (2014). • R. Gaekwad, Op-Amps and Linear Integrated Circuits, 4th edition, Prentice Hall of India (2015).

1	**Title of the course** (L-T-P-C)	**Electronics Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	The following is the proposed list of experiments/topics for this lab: ● Diode properties of transistor junctions ● Transistor as function generator ● Characteristics of field-effect transistor ● Half and full-wave rectifier ● RC-coupled amplifier ● Differential amplifier circuits ● Unregulated and regulated power supply ● Wein bridge oscillator using OP-Amp ● Op-Amp as adder/subtractor/integrator/differentiator ● MOSFET characteristics ● Universality of NOR/NAND gates ● Verification of De Morgan's theorem ● RC/ LR/ LCR circuit
4	**Texts/References**	• J. Millman, C. C. Halkias, C. D. Parikh, Integrated Electronics, 2nd edition, McGraw Hill Education (2017). • A. P. Malvino, Electronic Principles 7th edition, McGraw Hill Education (2017). • R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory 11th edition, Prentice Hall (2013). • D. P. Leach, A. P. Malvino and G. Saha, Digital Principles and Applications 8 th edition, McGraw Hill Education (2014). • R. Gaekwad, Op-Amps and Linear Integrated Circuits, 4th edition, Prentice Hall of India (2015).

1	**Title of the course** (L-T-P-C)	**Radiative Processes in Astrophysics** **3-0-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	• Electrodynamics (PH301T level course offered by Physics Dept or equivalent topics in PH426 - Special Theory of Relativity • Astrophysics (Elective PH404T offered by the Institute, Physics Dept or equivalent course)
4	**Texts/References**	Special Theory of Relativity and Astrophysics