AUS PG Physics syllabus structure (NEP-2020)

Paper Code	Credit	Paper Name	Course Type
Semester I			
PHY 501	4	Group A: Mathematical Methods Group B: Electromagnetic Theory	Disc C
PHY 502	4	Group A: Classical Mechanics Group B: Quantum Mechanics	Disc C
PHY503	3	General Laboratory	Laboratory
PHY504	3	A: Numerical computation using Scilab (through SWAYAM) B: Learning Electronics through software	ID C, Skill Enhancement Course
PHY505	3	A: Atmospheric Physics B: Physics at Nanoscale C: Basic Astronomy	ID C
PHY506	3	Compulsory Community Engagement	CCEC
PHY 507	NIL	Orientation	
Semester II			
PHY551	4	Group A: Solid State Physics Group B: Electronics	Disc C
PHY552	4	Atomic, molecular and laser physics	Disc C
PHY553	3	Electronics Laboratory	Laboratory
PHY554	3	A: Numerical Analysis and Computer Programming B: Biomedical Imaging Instrumentation	ID C, Skill Enhancement Course
PHY555	3	Value Based Course (through SWAYAM)	ID C
PHY556	3	Apprenticeship/Project	Disc
Semester III			
PHY601	4	Advanced Mathematical Physics	Disc C
PHY602	4	Advanced Quantum Mechanics	Disc C
PHY603	4	A: Particle Physics B: Astrophysics I C: Theory of solids D: Non-linear optics	Disc E
PHY604	4	A: Relativistic quantum field theory B: Lab on Astrophysics I C: Lab on theory of solids D: Lab on non-linear optics	Disc E (Th/Lab)

PHY605	4	Research Project	Part I
Semester IV			
PHY651	4	Statistical Mechanics	Disc C
PHY 652	4	Nuclear and Particle physics	Disc C
PHY 653	4	A: High Energy Physics B: Astrophysics II C: Condensed Matter Physics D: Laser Spectroscopy	Disc E
PHY 654	8	Research Project	Part II

Abbreviations:

Disc C: Disciplinary Core

Disc E: Disciplinary Elective

ID C: Interdisciplinary Course

SEMESTER I

Course: PHY 501

Marks: 100 (Internal Assessment 30; Final: 70) **Credit: 4**
(All units carry equal marks of 14. Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

Group A
MATHEMATICAL METHODS

Course Objectives: The primary objective is to teach the students some basic mathematical methods that will be used in many of the other courses in the M.Sc. Syllabus.

Unit I: Linear Vector Space:
Linear vectors, Inner product, norm, Schwarz inequality, Linear operators and their matrix representations, eigenvalues and eigenvectors, Cayley-Hamilton theorem, adjoint of a linear operator, Hermitian or self-adjoint operators and their properties, unitary operators, Ortho-normal basis– discrete and continuous. Diagonalization.

Tensor analysis: Basics of tensor algebra, Christoffel's symbols, geodesic, Riemannian Christoffel's symbol, covariant curvature tensor, Bianchi identity.

Unit II Complex analysis:
Analytic functions, Cauchy integral theorems, Taylor and Laurent series, residue theorem and complex integrations.

Integral transforms: Laplace transform and inverse Laplace transform. Fourier transform. Convolution. Solution of differential equations with the help of Laplace and Fourier transform.

Expected outcome: The students are expected to be familiar with the basic mathematical techniques that are essential for subsequent courses.

References:
1. S D Joglekar, Mathematical Physics: The Basics, Universities Press.
2. Murry R Speigel, Vector Analysis, Mc Graw Hill
3. Murry R Speigel, Complex variables, Mc Graw Hill
4. A W Joshi, Matrices and tensors in physics, New Age International
5. G B Arfken et al, Mathematical Methods for Physicists, Academic Press

Group B

ELECTROMAGNETIC THEORY

Course Objectives: The primary objective is to introduce some aspects of electromagnetic theory along with special relativity theory.

UNIT I: Relativistic Electrodynamics: Concept of invariant interval, four vectors, Lorentz transformation in four-dimensional space, Electromagnetic field tensor, Maxwell equation, Lagrangian of an uncharged particle and $E = mc^2$, Lagrangian of a charged particle, Lorentz force.

Motion of a charged particle in electromagnetic field: Uniform E and B fields, non-uniform fields, diffusion across magnetic fields, time-varying E and B Fields.

Unit II: Radiation: Radiation from an accelerated point charge, Retarded potentials, Lienard-Wiechert potentials, field of a system of charges at large distances. Dipole radiation, Quadrupole and magnetic dipole radiation.

Unit III: Scattering: Coulomb collision due to a harmonically bound charge, Thomson scattering, Rayleigh scattering, Mie Scattering and phase function formulation – consideration of a large particle. Other scattering formulations (expressions only): T-matrix, Discrete Dipole Approximation.

Expected outcome: The students are expected to get familiarized with basic ideas of electromagnetic radiation and scattering and also to be able to perform relativistic calculations using four vectors.

Text Books:

1. J.D. Jackson, Classical Electrodynamics, Wiley Eastern, 1989.
2. Griffiths, Introduction of Electrodynamics, Prentice Hall.
3. L.D. Landau & EM Lifshitz, The classical theory of fields, Butterworth Heinemann Ltd. Oxford.

Reference Books:

1. Berestetkii, Lifshit, Pitaevski, Quantum Electrodynamics, Pergaman Press.
2. Miah M.A.W, Fundamentals of Electromagnetic, Tata Mc Graw Hill.
3. Cook DM, Theory of Electromagnetic Fluids, Prentice Hall.
4. Lorrain &Corson, Electromagnetic field and waves, Freeman & Company Sanfrancisco.

Course: PHY 502

Marks: 100 (Internal Assessment 30; Final: 70) **Credit: 4**
(All units carry equal marks of 14. Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

Group A
CLASSICAL MECHANICS

Course Objectives: The primary objective is to teach the students Classical Mechanics at a level more advanced than what they have learnt in B.Sc. This is a course which forms the basis of Physics of many areas of Physics.

Unit I: Lagrangian and Hamiltonian Formulation: Constraints and their classification, generalized co-ordinates, D'Alembert's principle, Lagrange's equations of motion of the, Simple applications of the Lagrangian formulation, Central Force Problem: equations of motion for the orbit, classification of orbits, conditions for closed orbits, the Kepler problem.

Generalized momenta, Legendre transformation and the Hamilton's equations of motion. Cyclic coordinates and conservation theorems, Hamiltonian of a particle in a central force field, simple harmonic oscillator, charged particle in an Electromagnetic field, derivation of Hamilton's equations from Variational principle.

Unit II: Canonical Transformation: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of Poisson brackets (anti-symmetry, linearity and Jacobi identity), Poisson brackets of angular momentum, Noether's theorem The Hamilton-Jacobi equation, Linear harmonic oscillator using Hamilton-Jacobi method.

Unit III:
Motion in non-central reference frames: Motion of a particle in a general non-inertial frame of reference, notion of pseudo forces, equations of motion in a rotating frame of reference, Coriolis force.
Rigid bodies: Degrees of freedom of a free rigid body, Euler's equations of motion for a rigid body.
Small oscillations: Types of equilibria, Lagrange's equations of motion, normal modes and normal frequencies, examples of (i) normal modes and normal frequencies of a linear symmetric, tri-atomic molecule (ii) oscillations of two linearly coupled plane pendula.

Expected Learning Outcomes: Students will be equipped for advanced and specialized courses. The student learns to deal with particle mechanics at an advanced level and to learn the foundations of the classical theory of fields

Text Books:

1. Goldstein, Classical Mechanics Narosa Publishing, Delhi
2. Landau & Lifshitz, Course of theoretical Physics, Vol-10, Oxford University, Press
3. Joag & Rana, Classical Mechanics, Mc Graw Hill

Reference Books:

1. Berger, Classical Mechanics A modern Perspective, Mc Graw Hill International
2. Awqhmare, Classical Mechanics, Prentice Hall
3. Sommer field, Lectures on theoretical Physics. Vol-I, Academic Press, NY 1952
4. Hestness, New foundations for classical Mechanics, Kluwer Academic Publisher
5. R. Resnik, Introductions of Relativity, Wiley Eastern 1967
6. Corben & Stehle, Classical Mechanics, Wiley NY 1974
7. Einstein, The meaning of relativity 5th Ed. Princeton University Press
8. K. Fock, Theory of space time and Gravitational 2nd Ed., Peragon 1964
9. Schwartz, Introduction on to special relativity, Mc Graw Hill, 1968

GROUP B
QUANTUM MECHANICS

Course Objective: To discuss (i) the mathematical machinery needed for the study of quantum mechanics (ii) representations of general formalism of quantum mechanics in discrete and continuous basis systems, and (iii) formalism of angular momenta which is a prerequisite for studying the molecular, atomic and nuclear systems.

UNIT I: Review of wave-particle duality and its consequences.
Schrodinger’s equation, Stationary states, potential well problems – harmonic oscillator, step potential problems – Tunnel effect, hydrogen atom.
Postulates of Quantum Mechanics, Introduction of Hilbert space, Dirac’s bra and ket algebra, Observables and operators, Eigenvalues and eigenvectors of a harmonic operator, Orthonormal basis.
Generalized uncertainty principle, uncertainty relation of energy-time, states with minimum uncertainty product.

UNIT II: Matrix representation of Observables and states, Determination of eigenvalues and eigenstate for observables using matrix representations, Change of representation and unitary transformations, Representation in continuous basis: Coordinate and momentum representations. Connection between position and momentum representations. Harmonic oscillator problem by operator method.
Symmetries and conservation laws. Angular momentum algebra, Orbital angular momentum, matrix representation of angular momentum, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients.

Expected outcome: Students will learn the mathematical tools and concepts needed for understanding the general formalisms of quantum mechanics and how to use them to study the microphysical systems.

References:

1. R.L.Liboff, Introductory Quantum Mechanics, Pearson Education (2006)
2. L.I. Schiff, Quantum Mechanics, Mc Graw Hill (1998)
3. A.K. Ghatak and S. Lokanathan: Quantum Mechanics, Macmillan (2000)
4. D J Griffiths, Introduction to Quantum Mechanics, Cambridge (2018)
5. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1990)
6. E. Merzbacher, Quantum Mechanics, John Wiley & Sons (1999).
7. Satya Prakash, Advanced Quantum Mechanics, Kedar Nath (1990)
8. V.K. Thankappan, Quantum Mechanics, New Age Intl. Pub (1996)
9. S. Gasiorowiz, Quantum Mechanics, Wiley (1995)
10. P M Mathews and S Venkateswan, Quantum Mechanics, Tata McGraw Hill (1976
11. N Zettili, Quantum Mechanics, John Wiley (2001)
12. John L Powell and B Crasemann, Quantum Mechanics, Narosa (1991).

Course: PHY 503
GENERAL LABORATORY

Marks: 100 (Internal Assessment 30; Final: 70) **Credit: 3**

Course Objectives: Aims at performing some basic experiments in physics to observe and study some physical phenomena by students.

1. Experiments with Michelson Interferometer: Determination of wavelength, small difference in wavelength, etc.
2. Experiments with Fabry-Perrot Interferometer: Determination of wavelength, small difference in wavelength, etc.
3. Study of Zeeman Effect and determination of e/m of electron.
4. Determination of wavelengths of spectral lines using Constant Deviation Spectrometer.
5. Analysis of elliptically polarized light using Babinet Compensator.
6. Determination of refractive index or thickness of a thin film using Jamin's Interferometer.
7. Study of Hall Effect (general model)
8. Determination of velocity of ultrasonic wave liquid using Ultrasonic Interferometer.
9. Determination of velocity of ultrasonic wave in liquid by study of diffraction of light by the wave.
10. Determination of Stefan's Constant.
11. Determination of Plank Constant using photo cell.
12. Determination of Dielectric Constant (general model).
13. Study of plateau of a Geiger –Muller counter and carry out statistical analysis of the data.

Expected outcome: The students performing the experiments will experience results that justify theoretical understanding of Physics.

NB: The list of experiments should be considered as suggestive of the standard. and are subject to availability of equipment. The teachers are authorised to either add or delete experiments whenever necessary.

Course PHY 504
(SKILL ENHANCEMENT COURSE, IDC)

Marks: 100 (Internal Assessment 30; Final: 70) Credit: 3

(Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

A: Numerical computation using Scilab

Course Objectives: Aims at teaching students various aspects of the computational software Scilab and training them in writing codes for numerical scientific computation and simulation.

Course to be conducted by Spoken Tutorial, IIT-B through SWAYAM.
Syllabus: https://onlinecourses.swayam2.ac.in/aic20_sp38/preview

+N.B.

The Spoken Tutorial Project is funded by the National Mission on Education through Information and Communication Technology (ICT), launched by Ministry of Education, erstwhile Ministry of Human Resources and Development, Government of India. Spoken tutorial courses are available on SWAYAM.

Course outcomes: The students are expected to have thorough familiarity with Scilab and write codes for various numerical computations and simulations.

B: Learning Electronics through software

Course Objectives: (a) learning electronics through software fill the gaps between the theoretical and practical approach of understanding electronic devices. Through this software students can achieve the knowledge about the working of electronic devices without going to the laboratory. (b) To develop the skills of the students in designing and analyzing the electrical/electronic circuit.

Unit I: **Marks: 15**

Introduction to MultiSim, characteristics curve of a Diode, different types of rectifier circuit, clipper and clamper circuit, power supply, characteristics curve of a transistor (BJT/FET), single/two stage RC coupled amplifier using the given transistor, frequency response of the given amplifier, oscillator. Boolean expression, logic gates and verifies its truth table by MultiSim. Design Adder, subtractor, multiplexer, decoder, demultiplexer, flip-flops, counters and shift register using MultiSim.

Unit II: **Marks: 20**

Lab based on Unit I.

Unit III: **Marks: 15**

P-N junction model and diode working principle, I-V characteristics of solar cell, Equivalent circuit of solar cell, Fill factor, Fabrication process of semiconductor grade silicon, single crystalline silicon. Thin film deposition techniques, Thin film solar cell: amorphous silicon, Physics of bulk hetero junction solar cells, Perovskite solar cell, Photophysics of perovskite solar cell, fabrication process, stability, morphology optimization, Single crystal perovskite solar cell.

Unit IV: **Marks: 20**

Numerical simulation of solar cell by SCAPS 1-D program: Homo junction and hetero junction solar cell (Si-solar cell, perovskite solar cells).

Expected Learning Outcomes: Expected Learning Outcomes: Students will be able to design, develop, analyze, and model electronic circuits using proprietary/free software.

Texts/ References:

1) Electronic Principles (SIE), Albert Malvino, David J. Bates, McGraw Hill Education; 7th edition (1 July 2017). ISBN: 978-0070634244.
2) Electronics Devices and Circuit Theory Boylestad, Robert L. Pearson Publication, New Delhi, 2015. ISBN: 978-8131727003
3) Solar Cells: Operating Principles, Technology and System Applications, Martin A Green, Prentice Hall, 1981, ISBN-13: 978-0858235809.
4) Solar Cell Device Physics, Stephen J. Fonash, Academic Press, 2009, ISBN 978-0-12-374774-7.

Course PHY 505
(AILF, IDC)

A: ATMOSPHERIC PHYSICS

Marks: 100 (Internal Assessment 30; Final: 70) Credit: 3

(All units carry equal marks of 14. Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

Course Objectives: *The course is designed to train students with both deep understanding of the fundamental laws of physics that govern weather and climate as well as practical tools and skills in a broad range of applications.*

Unit I: Introduction to Atmosphere & Atmospheric observations

Origin and Composition of the Atmosphere Distribution of Pressure and Density, Ionosphere, Atmospheric Electric field Magnetosphere, Distribution of Temperature and Winds, Atmosphere as a Fluid and Fluid Continuum, Physical Laws, Overview and Importance of Meteorological Observation, Measurement of Temperature and Humidity, Measurement of Wind and Power, Measurement of Precipitation, Modern Meteorological Instruments, Surface and Upper Air Observational Network, Satellite Observation. Basics of Atmospheric

Unit II: Atmospheric Thermodynamics and Radiation

Intensity of radiation : Blackbody radiation , Shortwave and long wave radiation, Irradiance, Kirchoff's law, The solar constant, Radiation balance and emission temperature ; A simple model of the greenhouse effect ; Beer's law; Schwarzschild's equation; Some applications of Schwarzschild's equation, Remote sensing of temperature; Radiative heating and cooling rates, Radiative transfer: Radiation pencils vs. photon showers, Conservation of intensity , Application to blackbody radiation

Radiative equilibrium, Convection: The parcel's equation, Potential, Stability of temperature profiles to vertical displacements of air parcels; Radiative-convective equilibrium: Stability of the radiative equilibrium temperature profile, The Tropopause; Dynamical effects of moisture: Thermodynamics of moist air: Entropy of cloudy air, Dry and moist adiabatic lapse-rates, Radiative-convective equilibrium and the real world, Sloping convection .

Unit III: Clouds and Precipitation

Atmospheric Aerosols, Nucleation of Water Vapour Condensation, Droplet growth in Warm clouds, Formation of cloud by Collision and Coalescence, Formation and Growth of Ice Crystals in Cold clouds, Mechanisms of Cloud Formation and Cloud Seeding, Role of Clouds and Precipitation products in Charge Separation

Unit IV: Atmospheric Motion & Boundary Layer

Equations of motions: Forces acting on a parcel of air, Material, Rotating frame of reference, Coriolis and centrifugal, Mass conservation; Scale analysis of the equation of motions: Vertical momentum equation, Horizontal momentum equation, The thermal wind relation

The vorticity view: The geostrophic flow, vorticity and divergence,

Predicting the vorticity of the flow, Dynamics of rotating fluids, Kelvin's identity, the vorticity equation, Rossby waves.

Unit V: Weather, Climate and large scale circulations

Weather and climate; definition and significance of climatology. Elements of weather and climate; their causes. Climate control. Major climatic zones of the world. Air masses and fronts: concept, classification and properties.

Atmospheric disturbances: tropical and temperate cyclones; thunderstorms and tornadoes.

Concepts of climate change: Climatic variability and climate change, consequences of Climate change, global warming, Causes and consequences of Global Warming, Ozone hole. Sea level rise, greenhouse gases. Response of the atmosphere to a sudden doubling of CO_2 , Climate change in realistic models and observations.

Climates of Indian region, Spatial and temporal patterns of climate parameters in India. Effect of El Nino& La Nina, Indian Ocean dipole on Indian climate.

Indian Monsoon- pre monsoon, southwest monsoon and northeast monsoon.

Expected outcome: Attending the course, the student should be able to describe the basic structure of the Earth's atmosphere and the climate system, understand the basic processes and dynamics. They should be able to grasp the issues related to climate change in a deeper level . This will also serve as basics if anyone wishes to take up meteorology as carrier option.

Reference Books:

1 P.K. Das, The Monsoons, National Book Trust, New Delhi, 1968.
2. E P Lydolph, The Climate of the Earth, Rowman and Allanheld, Totowa, N.J.
3. J R Mather, Climatology, McGraw-Hill, New York, 1974.
4. E T Stringer, Foundation of Climatology, Surjeet Publications, Delhi, 1982.
5. G T Trewartha, An Introduction to Climate, International Students edition , McGraw Hill, New York,1980.
6. Frederick K. Lutgens, The Atmosphere: An introduction to Meteorology,
7. Chandrasekhar, Fundamentals of Atmospheric Science.
8. Murry Salby, Fundamentals of Atmospheric Physics.
9. Wallace and Hobbs**,** Atmospheric Sciences: an introductory survey,.
10. John Marshall and Alan Plumb, Atmosphere, Ocean and Climate Dynamics: An introductory text,

B: PHYSICS AT NANOSCALE

Marks: 100 (Internal Assessment 30; Final: 70) Credit: 3

(All units carry equal marks of 14. Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

Course Objectives: To introduce knowledge on basics of nanoscience and the fundamental concepts behind size reduction in various physical properties. More specifically, the student will be able to understand the different properties of materials in reduced scales.

UNIT I: Fundamentals of nanomaterial and nanotechnology. Concept of strong and weak quantum confinement. Semiconductor, metal nanomaterials, and their properties. Many-Body Finnis and Sinclair (FS) potentials, Many-Body Embedded-Atom Model (EAM) potentials.

UNIT II: Concept of Top down and bottom up approaches, their advantages and disadvantages. Different synthesis techniques: Lithography, vapour deposition, laser deposition, sputtering, Molecular beam epitaxy, sol gel methods of preparation.

UNIT III: Different characterization techniques. UV/VIS/IR spectroscopy, Photoluminescence, X-Ray diffraction, Microscopy techniques (TEM, SEM, AFM).

UNIT IV: Swift ion irradiation. Phase transitions in nano systems: Gibbs phase rule, comparison of phase transitions between small and large systems. Phase transition in small systems: Evaporation of water, micellization, crystallization.

UNIT V: Applications of nano materials: Light emitting and detecting device. Filter, photo voltaic cell,gas sensor, antibacterial element, drug delivery system, use of carbon nanotubes.

Expected Learning Outcomes: The learner will be able to comprehend the significance of nanoscience and nanotechnology and its applications in various fields. The students will have in-depth knowledge on the behaviour of various class of materials in reduced dimensions.

Text books:

1. S. S. Nath, Synthesis of semiconductor quantum dots and their applications, LAP LAMBERT Academic Publishing AG & Co. KG, Germany, ISBN: 978-3-8383-6106-2, 2010.
2. V. Rajendran, B. Hillebrands, K. Saminathan, K. E. Geckeler, Ed., Synthesis and characterization ofNanostructured Materials, MacMillan Publishers, 2010.
3. G. Cao, Nanostructures and Nanomaterials, Imperial College Press, 2004.
4. G. A. Mansori: Principles of Nanotechnology, World Scientific, Chicago, 2005.
5. C. P. Poole and F. J. Owens, Introduction to Nanotechnology, Wiley Interscience: New Jersey, 2003.
6. P. J. F. Harris, Carbon Nanotube Science - Synthesis, Properties and Applications, Cambridge University Press: Cambridge UK, 2009.

Reference books:

1. G. Gope, D. Chakder, S. S. Nath, Preparation of quantum dots and their uses in electronics and optics,VDM Verlag Dr. Muller GmbH & Co. KG, Germany, ISBN: 978-3-639-20197-0, 2010.
2. K. Klabunde, Nanoscale Materials in Chemistry, Wiley Interscience: New York, 2001.
3. V. Rotello (Ed.): Nanoparticles: Building Blocks for Nanotechnology, Nanostructure Science andTechnology, Kluwer Academic/Plenum Publishers, New York, 2004.
4. P. M. Ajayan, L. S. Schadler, P. V. Braun, Nanocomposite science and technology, Willey-VCH, 2003.

C: BASIC ASTRONOMY

Marks: 100 (Internal Assessment 30; Final: 70) **Credit: 3**
(All units carry equal marks of 14. Two questions of equal marks will be set from each unit. Students require to answer one question from each unit.)

Course Objectives: Since this course is an open elective, with students from diverse background opting for it, the primary objective is to impart a basic knowledge about the oldest branch of physical science through a conceptual mode, relying less on mathematics and more on physical understanding. Since exciting new developments have been taking place in the astronomy of 20-th and 21-st centuries, with India playing crucial roles, the idea is to enable students to have a flavour of both historical and modern aspects so that they acquire a perspective of their place in the universe.

UNIT I: **Time and Co-ordinate System**
Spherical Trigonometry, the celestial sphere; the cardinal points and circles on the celestial sphere. Equatorial. ecliptic and galactic system of co-ordinates. Constellations and nomenclature of stars. Aspects of sky from different places on the earth. Twilight, Seasons, Sidereal, Apparent and Mean solar time and their relations.
Equation of time. Ephemeris and Atomic Times. Calendar. Julian date and heliocentric correction. precession, nutation and proper motion on the coordinates of stars.

UNIT II: **Astronomical Measurements and Telescopes**
Magnitude systems: apparent and absolute magnitudes, distance modulus, color index; Atmospheric extinction, *seeing* and scintillation.
Distances of stars from the trigonometric and moving cluster, parallaxes. Stellar motions. Variable stars as distance indicators.
Basic optics and optical telescopes, Detectors: photographic plate, Photo Multiplier Tube (PMT), Charge Coupled Device (CCD).

UNIT III: **Solar System**
Origin and evolution of the Solar System - Physical characteristics, Rotation, Sunspots. Inner planets, Jovian planets, Dwarf planets. Asteroids: classification, origin. Comets: Discovery and designation, physical nature, classification, origin. Meteors and Meteorites.

UNIT IV: **Stars and Our Galaxy**
Colour –magnitude relation, H R diagrams, Different spectral types of stars, Star formation in Molecular clouds, Stellar Evolution, End state of stars: Supernova, Neutron star and Black hole. Our Galaxy: milky Way, structure and morphology of our galaxy, Galactic rotation, Missing Mass problem.

UNIT V: **External Galaxies and Cosmology**
Normal Galaxies, Classification scheme for external galaxies, Hubble's law.
The origin and evolution of universe, Standard and Alternate cosmologies.

Expected Learning Outcomes: A historical perspective of the development of Astronomy. Conceptual understanding of basic principles involved. A flavour of current developments in this field and India's role in them. Appreciation of laws of nature that are discovered on Earth but which explain successfully distant cosmic objects and the universe as a whole.

Text Books:

1. Frank Shu,Physical Universe,
2. W.M.Smart, Text book of Spherical Astronomy.
3. Jay M. Pasachoff , Astronomy: From the Earth to the Universe(Sixth Edition).
4. A.E.Roy , Orbital Motion.
5. McCusky , Introduction to Celestial Mechanics.
6. K.D.Abhyankar, Astrophysics:Stars and Galaxies, Tata McGraw Hill Publication
7. G.Abell, Exploration of the Universe.
8. A.Unsold, New Cosmos.
9. B Basu, T Chatterjee, S N Biswas, Introduction to Astrophysics.

Course: PHY 506
Compulsory Community Engagement
Marks: 100 (Internal Assessment 30; Final: 70) Credit: 3

- Weekly 3 hours of community service to be undertaken by students under the supervision of mentors assigned by the department.
- Mentors may decide on the nature of community service the students will engage.
- Students require maintaining a log book of their activities undertaken in their entire period and submit the same to the department through their mentors/mentees.
- The evaluation method of the course may be discussed in the DMC.

Course: PHY 507
Orientation