Semester I

Curriculum and Credit Framework for Undergraduate Programme of Physics Hons. (single Major) *w.e.f. 2024 (NEP 2020)*

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credits	Marks
				Th	Pr	T		
CC- 1	MCC101	Mathematical Physics I and Mechanics	Theory	4	0	2	4	50 (ESE-40, IA-7,CA-3)
SEC-1	SEC101	Digital System and Applications Skill	Theory	3	0	0	3	50 (ESE-40, IA-7,CA-3
MDC-1	MDC101	The Idea of our Universe	Theory	3	0	0	3	50 (ESE-40, IA-7,CA-3
GE1A (MIC)	MIC 101	Mathematical **Physics I and Mechanics**	Theory	3	0	0	4	50 (ESE-40, IA-7,CA-3

Th= Lecture, **T=** Tutorial, **Pr =** Practical, **CC -** Core Course, SEC=Skill enhancement course, MDC=Multi-disciplinary Course, IA= Internal Assessment, CA= Class attendance.

CC 1: Mathematical Physics-I and Mechanics (Credits: 04, Lectures 60)

The emphasis of this course is on application in solving problems of different physical systems of interest. The students are to be examined entirely on the basis of problems, seen and unseen.

Group-A (Mathematical Physics-I) Lectures 30

First Order and Second Order Differential equations:

First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronski an and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(7 Lectures)**

Vector Calculus:

***Recapitulation of vectors*:** Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (**5 Lectures**)

***Vector Differentiation*:** Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(6 Lectures)**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vectorfields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **(6 Lectures)**

Orthogonal Curvilinear Coordinates:
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(6 Lectures)**

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E.Harris.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Mathematical Physics-H.K.Dass
- Vector Analysis-Spigel
- Mathematical Physics-A Ghatak, Guha
- Mathematical Physics-A. B. Gupta

Group-B (Mechanics, Lectures 30)

The aim of this course is to study various classical dynamics systems. Students will learn different key concepts involving the description of a mechanical system by go through problem solving**.**

Fundamentals of Dynamics: Reference frames, Inertial frames; Review of Newton's Laws of Motion, Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in uniform gravitational field, Dynamics of a system ofparticles, Centre of mass, Principle of conservation of momentum, Impulse. **(5 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non- conservative forces. Law of conservation of Energy. **(2 Lectures)**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia.Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Kinetic energy of rotation. Motion involving both translation and rotation. **(5 Lectures)**

Elasticity: Stress and strain. Stress-strain curve. Hook's law and elastic moduli and the relations between them. Twisting torque on a cylinder or wire. Torsional rigidity. Bending of beam. Shearing force and the torque. Internal bending moment. Geometrical moment of inertia. Depression of horizontal beam. Cantilever. Beam supported on knife edges at the two ends and loaded at the middle. Depression due to shear. (**4 Lectures**)

Fluid Motion: Kinematics of Moving Fluids: critical velocity and Reynold's number. Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Corrections to Poiseuille's equation. Flow through capillaries in series and in parallel. **(2 Lectures)**

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.
Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global

positioning system (GPS). **(5 Lectures)**

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(4 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. **(3Lectures)**

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, PearsonEducation
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- General Properties of matter, Sengupta and Chatterjee.
- Classical Mechanics and General Properties of Matter-D.P. Roychowdhury and S.N. Maity
- Classical Mechanics, A.B. Gupta
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

SEC1: DIGITAL SYSTEMS AND APPLICATIONS SKILL:

Aim of the course is to enable the students to know the basic of digital circuit and helps to design the electrical circuit, networks and appliances through hand on mode

(Credits: 03, Lectures 45)

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(3 Lectures)**

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **(6 Lectures)**

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map **(6 Lectures)**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders **.(4 Lectures)**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(6 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop **(8 Lectures)**

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator **(3 Lectures)**

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **(4 Lectures)**

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **(5 Lectures)**

Reference Books:

Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw

- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Fundamental of Electronics-B. Ghosh
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

MDC-I

The Idea of our Universe (3 Credits, 45 Lectures)

The Astronomer's Universe: Astronomy and Physics, The olbers paradox (5 lectures)

The life of a star: The classification of stars, The Herzsprung-Russel diagram, The birth of a star, The main sequence, the red giant stars, white dwarfs, neutron stars, and black holes, super nova. A star as a thermonuclear reactor, Planetary systems. (8 lectures)

Our Galaxy and Beyond: Our Galaxy, External Galaxies, Quasi Tailors objects (QSO), High energy astro physics. (5 Lectures)

Theories of the Universe: Newtonian Cosmology, The expanding universe, Cosmological postulates, element synthesis in the "hot bigbang", The steady state theory. Other cosmological model (T LECTURES) (8 Lectures)

Gravitation: Newtonian gravitation, General theory of relativity, Mach's Principal, Is the gravitational Changing? (5 Lectures)

Universe the arrow of time: Reversible phenomenon, Thermodynamics and cosmology, the electromagnetic arrow of time, Why and arrow of time. (6 Lectures)

Nature of the universe: A confrontation between theory and observations, Test of Model of the universe by consistency, Test of models of the universe best on the distant parts of the universe. Observation from the nearby universe. The nature of QSO Shifts and unsolved problems. (8 Lectures)

Reference Book :

1. The structure of the universe-Joyanta Bishnu, Narliker, Oxford University Press.

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