M.Sc. (Physics) I - Semester Syllabus under CBCS pattern
(For 2021-22 academic year onwards)

I-Semester (w.e.f. 2021-2022 academic year)

Paper code	Comp. code	Title of the paper	Internal Exam Marks	End Exam		Total Max. Marks	Total Min. Marks	No. of credits
				Max. Marks	Min. Marks			
		Theory						
1.1	101	Mathematical Physics	20	80	32	100	40	04
1.2	102	Classical Mechanics	20	80	32	100	40	04
1.3	103	Solid State Physics	20	80	32	100	40	04
1.4	104	Analog and Digital Electronics	20	80	32	100	40	04
		Practical						
1.5	105	General Physics – I	---	100	40	100	40	04
1.6	106	Electronics - I	---	100	40	100	40	04
Seminar			--	25	10	25	10	01
Total						**625**		25

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1.1: MATHEMATICAL PHYSICS

UNIT I: LEGENDRE AND BESSEL DIFFERENTIAL EQUATIONS (12 Hrs)

Legendre differential equation and Legendre functions, Generating function of Legendre polynomials, Rodrigues formula for Legendre polynomials, orthogonal property of Legendre polynomials, recurrence formula. Power series solution equation –Bessel functions of First and Second kind –Generating function – Orthogonality – Neumann functions – Hankel functions –modified Bessel functions – Spherical Bessel functions - Recurrence relations.

UNIT II: LAGUERRE AND HERMITE DIFFERENTIAL EQUATIONS (12 Hrs)

Laguerre differential equations and polynomials, Generating function for Laguerre polynomials, recurrence relation, Rodrigues formula for Laguerre polynomials, orthogonality property. Hermite differential equation and polynomials, Generating function for Hermite polynomials. Integral formula for Hermite polynomial, Recurrence formula, Rodrigues formula, orthogonality of Hermite polynomials.

UNIT III: VARIABLE FUNCTIONS (12Hrs)

Hypergeometric equation, Hypergeometric functions, Differentiation of hyper geometric function and its integral representation, linear transformations, representation of various functions in terms of hyper geometric functions, confluent hyper geometric functions, representation of various functions in terms of hyper geometric functions. Beta and gamma functions: symmetry property, evaluation and transformation of Beta function, evaluation of gamma function, transformation of gamma function, relation between beta and gamma functions. Evaluation of integrals using Beta & gamma functions.

UNIT IV: FOURIER AND LAPLACE TRANSFORMATION (12Hrs)

Integral transforms, Fourier transforms and their properties, Convolution theorem for Fourier transforms, Parseval's theorem, Simple applications of Fourier transforms .Evaluation of integrals, solution of boundary value problems. Laplace transforms and their properties, Laplace transform of derivatives and integrals, Laplace transform of periodic functions, initial and final value theorem, Laplace transform of some special functions, inverse Laplace transforms, Convolution theorem.

Recommended Books:

1. Mathematical methods for Physicists – **Geroge B. Arfken & H.J.Weber (Academic Press)**
2. Mathematical methods in Physics and Engineering – **L. A. Pipes**
3. Mathematical Physics –**Satyaprakash (S. Chand)**
4. Mathematical Physics – **B. D. Gupta (Vikas Publishing House Pvt. Ltd).**

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1.2: CLASSICAL MECHANICS

UNIT I: LAGRANGIAN FORMALISM **(10 Hrs.)**

Mechanics of a system of particles, constrains of motion, generalized coordinates, Hamilton's variational principle and Lagrange equations, Lagrangian of a free particle and a system of particles with interaction, Lagrange's equations from D'Alembert's principle, velocity dependent forces, dissipative function, generalized momentum, conservation of momentum, cyclic coordinates and conservation of energy.

UNIT II: HAMILTONIAN FORMALISM **(12 Hrs.)**

Hamiltonian and it's physical significance, Hamilton's equations, Hamilton's equations in different coordinate systems. Example: Harmonic Oscillator, motion of a particle in central force field, charged particle in an electromagnetic field. Compound pendulum, Routh's procedure, the Routhian, Poisson brackets, angular momentum and Poisson brackets, a modified variational principle, canonical transformations, Poissons brackets and canonical transformations..

UNIT III: HAMILTON-JACOBI THEORY **(13Hrs.)**

The Hamilton-Jacobi equation for Hamilton's principle function, the harmonic oscillator problem, Hamilton-Jacobi equation from Hamilton's characteristic function, separation of vari. les in the Hamilton-Jacobi equation, Action-angle v iables in a system of one degree of freedom, action –angle variables for completely separable systems. The Lepler problem in action-angle variables, Hamilton-Jacobi theory – Application to geometrical optics and wave mechanics.

UNIT IV: SMALL OSCILLATIONS AND NORMAL MODES **(13 Hrs.)**

Potential energy and equilibrium, stable, unstable and neutral equilibrium, one-dimensional oscillator, two coupled oscillators: solution of the differential equations, normal coordinates and normal modes, kinetic and potential energies in normal coordinates, general theory of small oscillations, secular equation and eigen value equation. Solution of the eigen value equation, small oscillations in normal coordinates, examples: two coupled pendulum, double pendulum, vibrations of a linear triatomic molecule

Books Recommended:

1. Classical Mechanics of Particles and Rigid Bodies – **Kiran C. Gupta (New Age International Publishers)**
2. Classical Mechanics by **Aruldas**
3. Classical Mechanics by **Goldstein (Narosa Publishing House)**
4. Classical Mechanics by **JC Upadhyaya (Himalaya Publishers)**
5. Classical Mechanics by **Satya Prakash.**

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1.3: SOLID STATE PHYSICS

UNIT I : BONDINGS IN SOLIDS AND X-RAY DIFFRACTION (12Hrs)

Types of crystal bindings: London theory of Vander Waal forces, Cohesive energy of inert gas in solids,Ionic crystals, Madelung constant, Covalent Crystals. X-ray diffraction by crystals, X-ray powder diffractometer, Principle of electron diffraction, modern electron diffraction set-up, .principle of neutron diffraction, Neutron diffractometer.

Non-crystalline solids – Monatomic amorphous materials, Radial distribution function and Structure of vitreous Silica.

UNIT II: LATTICE VIBRATIONS (12Hrs)

Elastic vibrations of continuous media, group velocity and phase velocity. Vibrations of monoatomic and diatomic linear lattice; concept of phonon experimental determination of dispersion relations, inelastic scattering of neutron by phonons. Infrared absorption by ionic crystals. Thermal expansion and thermal conductivity – Normal and Umklapp processes.

UNIT III: BAND THEORY OF SOLIDS (10Hrs)

Bloch theorem, Kronig penny model, effective mass, distinction between materials, insulators and semiconductors; concept of a hole. Motion of electrons in a three dimensional lattice, constant energy surface and Brillouin Zones. Concentration of electrons and holes in an instrinsic semiconductor, model for an impurity semiconductor.

UNIT IV: MAGNETISM (14Hrs)

Langevin's theory of diamagnetism, Quantum theory of paramagnetism, the rare-earth ions, iron group ions; quenching of orbital angular momentum. Ferromagnetism: Characteristic behaviour of ferromagnetic materials, spontaneous magnetization, Curie-Weiss law and hysteresis, interpretation in terms of the exchange integral, temperature dependence of spontaneous magnetization, Saturation magnetization at absolute zero. Ferromagnetic domains, anisotropy energy, transition between domains. Origin of domains, coercive force and hysteresis, concept of magnons.

Recommended Books:

1. Introduction to Solid State Physics –**C. Kittel (Jhon Wiley & Sons)**
2. Solid State Physics – **A. J. Dekker (Machmillan student editions)**
3. Solid State and Semiconductor Physics –**J. P.Mc kelvy (Krieger publications)**
4. Principles of Solid State Physics – **R. A. Levy (Academic Press)**
5. Elements of Solid State Physics –**J. P. Srivastava (Prentice-Hall of India)**
1. Quantum theory of Magnetism – **W. Nolting and A. Ramakanth, Spinger**

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1.4: ANALOG AND DIGITAL ELECTRONICS

UNIT I : AMPLIFIERS **(12 Hrs)**

Transistor biasing – Operating point, Bias stability, Types of biasing methods, Feedback concepts, Feedback topologies and classification, Analysis of RC coupled CE amplifier: low, mid and high frequency response, Bode plot, Emitter follower - Frequency response, Darlington pair - cascade connection, Large signal amplifiers: classification – Class A, Class B - Pushpull amplifier – Harmonic distortion – Class AB amplifier – Class C tuned amplifier.

UNIT II: OSCILLATORS AND OPTO-ELECTRONIC DEVICES **(12 Hrs)**

Oscillators: Principles of oscillations, Barkhausen criterion, Classification of Oscillators, Colpitts Oscillator, Hartley Oscillator, Phase-shift Oscillator, Wien Bridge Oscillator, Crystal Oscillator, Multivibrators: Astable, Monostable and Bistable multivibrators.

Opto-electronic devices: Radiative and non-radiative transition, Light dependent resistor (LDR), Photodiodes, phototransistors, Photovoltaic (Solar) cell materials, construction and operation of LED, Diode laser: Structure, working and factors affecting performance.

UNIT III: BOOLEAN ALGEBRA AND COMBINATIONAL LOGIC CIRCUITS **(12 Hrs)**

Boolean algebra -Laws and identities, De Morgan's theorems, Simplification of Boolean expressions using Boolean identities, Standard representation of Logic functions, canonical sum, canonical product, Logic simplification using Boolean algebra, Karnaugh maps (2, 3 & 4 variable).

Combinational Logic Circuits & Design: Adders, Subtractors, Decoders, Encoders, Multiplexers, Demultiplexers, Comparators, Parity Circuits, Three-state devices, designing combinational logic circuits.

UNIT IV : SEQUENTIAL LOGIC CIRCUITS **(12 Hrs)**

Flip-flops: SR, D, T, JK and JK Master-slave, Registers: Shift registers, SISO, SIPO, PISO and PIPO registers, Universal shift register (IC7496), Shift register counters - Ring counter, Johnson Counter- Asynchronous (Ripple) counter, Modulo-N counter, Synchronous counter, Up/Down Counters - ripple counter IC7493 - Decade counter IC7490 - working, Truth-table and timing diagrams.

Recommended Books

1. Integrated Electronics – **Millman & Halkias** (Tata McGraw Hill)
2. Electronic Principals – **Malvino & Bates** (Tata McGraw Hill 7th edition)
3. A first course in electronics – **Anwar Khan & Kanchan Dey** (PHI, 2006)
4. Electronic Devices and Circuits – **Bogart** (Pearson education)
5. Optoelectronics- an Introduction, **Wilson, J. F. B.Hawkes**,(PHI, 2003)
6. Fundamentals of Photonics. **B.E.A. Salesh; M.C.Teich**,(John Wiley,2nd edition,2012).
7. Digital Principles and Applications – **Malvino & Leach** (TMH)
8. Modern Digital Electronics – **RP Jain** (Tata McGraw Hill, 3rd edition)
9. Fundamentals of Digital Circuits – **Anand Kumar**(PHI)

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GENERAL PHYSICS – I LABORATORY

1. Determination of Rydberg's constant.
2. Newton's Rings – Determination of Poisson's ratio.
3. Verification of Beer –Lambert Law.
4. Specific heat of a Solid (cylindrical graphite sample).
5. Study the characteristics of LASER.
6. Determine the thickness of a thin sheet by using Fresnel Biprism
7. To determination of a lattice constant in a cubic crystal by using X-ray spectrum.
8. Determination of a wavelength of source by using Diffraction - single slit method

ELECTRONICS – I LABORATORY

1. Transistor RC-coupled amplifier: To construct and study the frequency response of single stage amplifier
2. Collector-coupled Astable multivibrator: To construct and determine the frequency of oscillation
3. To construct an Hartley oscillator using transistor and compare the frequency of oscillation with the theoretical value.
4. To construct a Colpitts oscillator using transistor and compare the frequency of oscillation with the theoretical value.
5. Emitter follower: To determine the voltage gain, input impedance and output impedance.
6. Digital experiments: a) Verification of DeMorgans Theorem. b) Construction and verification of half and full adder circuits
7. Realize the following flip-flops using NAND Gates: RS, JK, D & and JK-Master-Slave Flip-Flop.
8. Design and implement different mod counters (a) synchronous, (b) Asynchronous.

Recommended Books:

1. Advanced practical Physics – **Wornsop & Flint**
2. Advanced Practical Physics Vol.1 – **S P Singh** (Pragati Prakashan).
3. A Text Lab manual in Electronics – **Zbar** (Tata McGraw Hill).
4. Lab manual for Electronic Devices and Circuits – **David A Bell,** 4th Edition (PHI).
5. Linear Integrated Circuits – **Shail B. Jain & B. Ray Choudhury** (New Age International Publishers, 2nd edition).
6. Linear Integrated Circuits – **Shalivahanan & V S Bhaaskaran** (Tata McGraw Hill, 2008).

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