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 variables in the Hamilton-Jacobi equation, Action-angle variables 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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(For 2021-22 academic year onwards)

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

Paper code	Comp. code	Title of the paper	Internal Exam Marks	End Exam Max. Marks	End Exam Min. Marks	Total Max. Marks	Total Min. Marks	No. of credits
		Theory						
2.1	201	Statistical Mechanics	20	80	32	100	40	04
2.2	202	Quantum Mechanics-1	20	80	32	100	40	04
2.3	203	Integrated circuits & Analog modulation	20	80	32	100	40	04
2.4	204	MATLAB and Applications	20	80	32	100	40	04
		Practical						
2.5	205	General Physics – II	--	100	40	100	40	04
2.6	206	Electronics - II	--	100	40	100	40	04
Seminar			--	25	10	25	10	01
Total						**625**		**25**

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2.1: STATISTICAL MECHANICS

Unit I: ENSEMBLES **(13 Hrs)**

Concept of ensembles, Ensemble average, Microcanonical ensemble (MCE) –Thermodynamics in MCE – Entropy of an Ideal gas in MCE – Gibbs paradox – Sackur –Tetrode equation – Canonical ensemble (CE) – Thermodynamics in CE – Ideal gas in CE – Maxwell's velocity distribution – Equipartition energy theorem – Grand canonical ensemble (GCE) – Thermodynamics in GCE – Ideal gas in GCE – Fermi-Dirac and Bose-Einstein distribution functions from grand canonical partition function.

UNIT II: BOSE SYSTEMS **(10 Hrs)**

Equation of state for Ideal BE and FD gases – Photons – Planks distribution Law – Photons –Specific heat of solids – Einstein and Debye's theories – Bose Einstein Condensation – Liquid He – Two fluid model – Photons – Rotons – Super fluidity.

UNIT III : FERMI SYSTEMS **(11 Hrs)**

Ideal Fermi gas – Free electron model – electronic specific heat –thermionic emission – Pauli Paramagnetism – Landau diamagnetism – Boltzsman transport equation – Electrical conductivity – Thermal conductivity – Weiderman – Franzlaw – Non-equilibrium semiconductors – Electron-hole recombination- Classical Hall effect and Quantum Hall effect.

UNIT IV: FLUCTUATIONS AND PHASE TRANSITIONS **(14 Hrs)**

Fluctuations, Mean square deviation, fluctuations in ensembles, concentration fluctuations on quantum states, Classification of phase transitions, Vander Waal's equation of state, Maxwell's construction, Law of corresponding states, Clausius--Clapeyran equation, Critical exponents, Inequalities scaling hypothesis. Ising model, equivalence of Ising model to other models, solution to 1-D Ising model.

Text and reference books

1. Statistical Mechanics – **Agarwal & Melvin Eisner (New age International).**
2. Statistical Mechanics – **Kerson Huang(John Wiley & Sons)**
3. Statistical Mechanics –**R. K. Srivastava & J. Ashok (Prentice–Hall of India).**
4. Statistical Physics – **L. D. Landau & E. M. Lifshits (Pergamom)**
5. Statistical Mechanics –**D. A. McQuarrie (Harper & Row).**
6. Equilibrium statistical physics –**M. Plischke and B. Bergesen**
1. Modern theory of critical phenomena –**S. K. Ma**

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2.2: QUANTUM MECHANICS-1

UNIT I: BRA AND KET NOTATION **(10 Hrs)**
Principle of superposition. Bra and Ket vectors, linear operators. Hermitian operators. Eigen values and Eigen vectors of Hermitian operators. Complete set of states, Complete set of commuting operators. Continuous spectrum of Eigen values, Orthogonality.

UNIT II: REPRESENTATIONS **(12 Hrs)**
Properties of Dirac –Delta function. Orthogonal basis, Representation for Ket, Bra and operator, Wave functions as a representation of Ket, position and momentum representations, Poisson brackets, Quantum conditions, Equation of motion, Schrodinger, Heisenberg and Interaction pictures. Ehrenfest theorem. Harmonic oscillator problem in terms of creation and annihilation operators.

UNIT III: EXACTLY SOLVABLE PROBLEMS **(12Hrs)**
Spherically symmetric potentials in 3 dimensions, orbital angular momentum operator. Commutation relations, Eigen vectors and Eigen values of L^2 and L_z. Pauli spin operators. Hydrogen atom problem, vibrating rotator, rigid rotator and 1D harmonic oscillator.

UNIT IV: APPROXIMATE METHODS **(14Hrs)**
Time independent perturbation theory: Non-degenerate levels. Application to normal He atom and anharmonic oscillator. Degenerate levels-application to first order stark effect in hydrogen atom with n=2 and to normal Zeeman effect

Time dependent perturbation theory: Transition amplitude in first and second order, first order transition constant perturbation, Fermi golden rule, harmonic perturbation, Emission and absorption probabilities, Einstein A and B Coefficients.

Variation method, application to normal Helium atom.

Recommended Books:

1. Quantum Mechanics –**Ajoy Ghatak & S. Loknathan (Macmillan India Ltd).**
2. The principles of Quantum Mechanics – **P. A. M. Dirac(Oxford University Press)**
3. Quantum Mechanics –**L. L. Schiff (McGraw Hill)**
4. A Text Book of Quantum Mechanics – **P. M. Mathews & K. Venkatesam (Tata McGraw Hill)**

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2.3: INTEGRATED CIRCUITS & ANALOG MODULATION

UNIT I : OPERATIONAL AMPLIFIERS (IC741) AND APPLICATIONS (12 Hrs)

Difference amplifiers using BJT and types - Block diagram of typical Op-Amp - IC741 Op-Amp: Features, PIN out, Performance electrical parameters and ideal characteristics - Open and closed loop configurations - Inverting and Non-inverting amplifier. Applications of Op-Amps: Voltage follower – Adder, Subtractor, Differentiator and Integrator, Logarithmic and antilog amplifiers – Wien-bridge sine-wave generator – Square-wave and Triangle-wave generators.
Active Filters: Introduction – Low-pass, High-pass, Band-pass, Band-reject and All-pass first-order filters and their design

UNIT II: SPECIALIZED ICS:(IC555, IC565 & VOLTAGE REGULATORS) (12 Hrs)

IC555 timer - Description of functional diagram – Astable and monostable operations, Voltage-controlled oscillator, Schmitt trigger. Phase-locked loops – Operating principles - IC565 monolithic phase-locked loops – 565 PLL Applications: Frequency multiplier – Frequency shift keying demodulator.
IC Voltage regulators: Basics of voltage regulator -- IC Regulators (78xx, 79xx, LM317, LM337, 723)

UNIT III: 8085 MICROPROCESSOR (12 Hrs)

Evolution of Microprocessors - Intel 8085 Microprocessor – Architecture of 8085 microprocessor – Instruction cycle, Fetch Cycle, Execute cycle (Timing diagram), Machine cycle and clock states. Interrupts – Hardware and Software, Address space partitioning – Memory mapped I/O & I/O mapped I/O. Instruction set of 8085 microprocessor and its classification - Types of addressing modes - Programming of 8085 microprocessor: Addition (8 and 16 bit), 8 bit subtraction, multiplication and division - Finding the largest and smallest number in data array.

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UNIT IV: BASICS OF ANALOG MODULATION **(12 Hrs)**

Need for modulation - Types of modulation - **Amplitude Modulation:** Analysis of Amplitude modulation, Frequency spectrum of AM, modulation index, AM generation: Collector modulator, Balanced modulator, Detection of AM – Square-law diode detector. **Frequency Modulation:** Analysis of FM, Frequency spectrum of FM wave, Average power of FM wave, Working of simple frequency modulator, Varactor diode FM modulator, detection of FM waves: Balanced slope FM discriminator, **Phase modulation (PM):** Analysis and characteristics, Advantages of frequency modulation, AM and FM transmitters and radio receivers **(Block diagram approach).**

Recommended Books:

1. Op amps and linear Integrated Circuits – **Ramakanth A GayKwad** (PHI).
2. Linear Integrated Circuits - **Coughlin and Driscoll** (PHI, 2014).
3. Linear Integrated circuits – **Shail B. Jain & Roy Choudhury** (New Age International Publishers 2nd edition).
4. Linear Integrated circuits – **S.Salivahanan & V.S. Bhaaskaran** (Tata McGraw Hill).
5. Electronic Communication Systems-**G. Kennedy & Bernard Davis** (Tata McGraw Hill).
6. Principles of Electronic Communication Systems - **Louis E Freznel**, TMH.
7. Microprocessors: Architecture and Programming and Applications with 8085 - **Ramesh S. Gaonkar**, Penram Intl' Publishing.
8. Microprocessors and Microcomputers – **B. Ram**, TMH.
9. Introduction to Microprocessor – **Aditya P.Mathur** – TMH.

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2.4: MATLAB AND APPLICATIONS

UNIT I: INTRODUCTION TO MATLAB (10 Hrs)

MATLAB Windows, On-line help, functions, MATLAB as a calculator, MATLAB operations: arithmetic operations rational operations, logical operations, variables, ,display formats, complex numbers, , Interactive Computations: : Matrices and Vectors, Creating vectors, Matrix manipulation, creating vectors, Matrix and array operations, Elementary math functions, Matrix functions, Vectorization, character strings.

UNIT II: PROGRAMMING IN MATLAB (12 Hrs)

Functions: command line functions, using Built – in functions, files, Loops, Branches and Control flow :IF-END,IF –ELSE-END,ELSE-IF,SWITCH CASE,FOR LOOPS,WHILE LOOPS, ,: saving and loading data.

Script files: M files, creating ,saving and executing, general structural of files, scope of variables, recursive functions, files In-put/Out-put, opening and closing files, writing formatted output files, reading formatted data from files, writing and reading binary files.

UNIT III: MATLAB - NUMERICAL METHODS (14 Hrs)

Linear Algebra, finding the solutions of linear systems: Gaussian elimination, finding eigen values and eigen vectors of Matrix, matrix factorization, Jacobi, Gauss-siedal method, Successive over relaxation methods, curve fitting: Polynomial curve fitting on the fly, Linear curve fitting, least squai- curve fitting, transcendental equations : Bisection ...ethod, Newton Raphson method, , Numerical integration by Trapezoidal rule, Simpson's 1/3 rule and Gauss's quadrature. Basic principles, Formulae –Algorithms.

UNIT IV: GRAPHICS USING MATLAB (12 Hrs)

Line styles, markers and colors, important plotting commands (line, lables, legend and tile commands), axis control, zoom in and zoom out , modifying plots with the plot editor , obtaining numerical values from graphs, 2-D plots and 3-D plots, Handle Graphics: object handles, objective properties and modifying the existing plot, saving plotting graphs.

Books Recommended:

1. MATLAB programming by **Rudrapratap.**
2. Programming in MATLAB by **Marc E. Hermitter (Thomson Brooks)**
3. Numerical Mathematical Analysis –**U. B. Scarborough (OXFORD & IBH publishing Co. Pvt. Ltd)**
4. Numerical Methods for Scientific and Engineering Computation –**M. K. Jain**
5. Computer Oriented Numerical Methods – **V. Rajaraman (PHI Pvt. Ltd)**
6. Numerical Methods, **E. Balaguruswamy (Tata McGraw Hill)**

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GENERAL PHYSICS – II LABORATORY

1. Michelson interferometer – Determination of wavelength, λ
2. Velocity of Ultrasonic waves in liquids using Interferometer.
3. Thermal expansion by Fizeau's method (Coefficient of linear expansion of Brass).
4. Study the elastic constants of glass by Cornu's interference method –elliptical and hyperbolic fringes.
5. Determination of Numerical aperture and loses in optical fiber.
6. Study the characteristics of Solar Cell.
7. MATLAB Programmes
   a) Fitting data straight-line.
   b) Solving a system of linear equations using Bisection and Gauss elimination Methods.
   c) Finding the eigen values and eigen vectors of a matrix.
   d) Evaluating the Integrals using Trapezoidal rule and Simpson's rule.

ELECTRONICS – II LABORATORY

PART-I: INTEGRATED CIRCUITS:

1. Operational Amplifiers (IC741) – Determination of CMRR, Slew-rate and output impedance.
2. Op-Amp (IC741): Frequency response of inverting and non-inverting amplifier.
3. Op-amp (IC741): Differentiator and Integrator – Observation of input and output waveforms and study the frequency response.
4. IC Voltage Regulators (78XX and 79XX) – To study the line and load regulation characteristics
5. IC555 timer – Monostable multivibrator: To construct and determination of pulse width.
6. IC555 timer – Voltage controlled oscillator: To construct and study the variation of frequency of the oscillation with applied voltage.
7. Amplitude Modulation
8. Frequency Modulation

PART-II: MICROPROCESSOR EXPERIMENTS:

1. Programs for data transfer, arithmetic and logical operations.
2. Programs for array operations – finding out the longest and smallest in a data array.

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3. Programs for arranging Hex. numbers in ascending and descending order.
4. Programs to find the square root, finding the sum of 'n' natural numbers and finding the sum of squares of the 'n' natural numbers.

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).
7. MATLAB programming by **Rudrapratap.**
8. Programming in MATLAB by **Marc E. Hermitter** (Thomson Brooks)

III-Semester (w.e.f. 2022-2023 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						
3.1 3.2	301 302	Quantum Mechanics -II Nuclear Physics	20 20	80 80	32 32	100 100	40 40	04 04
3.3A 3.3B 3.3C	303A 303B 303C	Solid state Physics: (Special - I) **(OR)** Electronics: (Special -) Microprocessor-8086 **(OR)** Nanoscience:(SPL) Materials Science - I	20	80	32	100	40	04
3.4A 3.4B 3.4C	304A 304B 304C	Solid state Physics: (Special - II) **(OR)** Electronics:(Special - II) Electronic Communication Systems **(OR)** Nanoscience - SPL- II	20	80	32	100	40	04
		Practical						
3.6	306	General Physics – II	--	100	40	100	40	04
3.7A 3.7B 3.7C	307A 307B 307C	Solid State Physics (Special-I) **(OR)** Electronics (Special-I) **(OR)** Nanoscience –I Practicals	-- -- --	100	40	100		04
		Seminar	--	25	10	25	10	01
		Total				**625**		**25**

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M.Sc. Physics III-Semester Theory

3.1 QUANTUM MECHANICS –II

Unit-I: **12Hrs**

Symmetry in Quantum Mechanics: Space and time displacements. Unitary displacement operator. Equation of motion. Symmetry and degeneracy. Matrix elements for displaced states. The group concept. Time displacement. Rotational symmetry. Infinitesimal rotation generators. **General Angular momentum**: Angular momentum operators. Eigen values of J^2 and J_z. Pauli spin operators. Matrix representation of J in |jm> basis. Addition of angular momenta and Clebsh- Gordon coefficients.

Unit-II : **12Hrs**

Scattering theory: The scattering cross-section. Wave mechanical picture of scattering – the scattering amplitude, Green's functions. Formal expression for scattering amplitude. The Born and Eikonal approximations. Partial wave analysis. Scattering amplitude in terms of phase shifts. Optical theorem. Exactly solvable problems – scattering by a square well potential, hard sphere and Coulomb potential.

Unit-III : **10Hrs**

Relativistic Quantum Mechanics: Klein- Gordon equation – plane wave solution – charge and current densities. Interaction with electromagnetic field for hydrogen like atom. Non-relativistic limit. Dirac equation. Dirac matrices. Plane wave solution and energy spectrum. Properties of Dirac spinors. Positive and negative energy states. Free Dirac particle in an external electromagnetic field. Spin-orbit interaction.

Unit-IV : **14Hrs**

Many Particle system: Identical particles, permutation operator, symmetrization, Slater determinant. Pauli exclusion principle. Central field approximation. Thomas Fermi statistical model. Evaluation of the potential. Hartree self consistent field – connection with variation method.

Molecular bonding: Bonding, anti-bonding and non-bonding orbitals. Fundamental principles of molecular orbital theory. LCAO approximation. Molecular orbital theory of hydrogen molecular ion and hydrogen molecule. Discussion of improved wave functions for H_2^+ ion; Valence bond theory of hydrogen molecule. Comparison of molecular orbital and valence bond theories.

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Recommended Books:

1. Quantum Mechanics - ***L.I. Schiff***., McGraw Hill, New York.
2. A Text Book of Quantum Mechanics - ***P.M. Mathews and K. Venkatesan***, TMH.
3. Quantum Mechanics - ***A.K. Ghatak and S. Lokanathan***, *MacMillan*
4. Introduction to Molecular Orbital Theory – ***Turner,*** PHI..
5. Molecular structure and Spectroscopy-***G. Aruldas***, PHI.
6. A text book of Quantum Mechanics-***G.Aruldas***, PHI.
7. Quantum Mechanics – ***Max Born***
8. Quantum Mechanics Concepts and Applications by ***Nouredine Zetili,*** Wiley,Ed.,2021
9. An Introduction to Quantum Mechanics, ***P.T.Mathews*** Mc Graw Hill Publishing Company,1974

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3.2 NUCLEAR PHYSICS

Unit-I : **12Hrs**

Properties of Atomic Nucleus: Theories of Nuclear Composition- Proton-Electron, Proton-Neutron, Neutron-Positron and Antiproton-Neutron. Binding Energy, Semi-empirical Mass Formula (nuclear stability), Quantum Numbers for individual nucleons, Quantum Properties of nuclear states, Nuclear Angular Momentum. Nuclear Magnetic Dipole moment with determination methods, Classical Multipole Moments for point charges, Electric Quadrupole Moment, Potential well, Quantum Statistics.

Radioactivity and Isotopes: Fundamental laws of Radioactivity, Dosimetry, measurements ofdecay constants, Radioactive dating, natural radioactive series, Isotopes, their separation and uses.

Unit-II : **14Hrs**

Nuclear Forces: Deuteron-properties nuclear force, Number of excited S-states, Range and depth of potential, excited states of the deuteron. Neutron-Proton scattering at low Energies - scattering length, phase shift, spin dependence, coherent scattering, shape independent effective range theory, Proton-Proton scattering at low energies. Similarity between (*nn*) and (*pp*) forces, non-central forces - experimental evidence for the existence of non-central forces, general form of this force, its properties, ground state of the deuteron, *n-p* scattering below 10 Mev, High energy n-p and p-p scattering, Meson theory of nuclear forces.

Unit-III: **12Hrs**

Nuclear Fission and Fusion: Nuclear fission-Types of fission, distribution of fission products, Neutron emission in Fission. Fissile and Fertile materials, spontaneous fission, Deformation of liquid drop; Bohr and Wheeler's theory, Quantum effects, Nuclear Fusion and thermo nuclear reactions, controlled thermonuclear reactions - Hydrogen bomb, different methods for the production of fusion reactions.

Unit-IV: **10Hrs**

Introduction to Elementary Particles: Introduction, Classification of Elementary Particles, Particle Interactions - Gravitational, Electromagnetic, strong and weak, Conservation laws, Invariance under charge, parity, C.P., time and C.P.T.; Lepton and Baryon number. Elementary particle symmetries – SU(2) and SU(3) symmetries. Quarks.

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Recommended Books:

1. Nuclear Physics - ***D.C.Tayal***, Himalaya Publishing House.
2. Introductory Nuclear Physics - ***Kenneth S Krane***, John Wiley.
3. Elements of Nuclear Physics - ***M.L.Pandya and R.P.S.Yadav***, Sarika Offset Press, Meerut.
4. Atomic and Nuclear Physics - ***Shatendra Sharma***, Pearson Education.
5. Nuclear Physics - ***R.P.Roy and B.P.Nigam***, New Age International Ltd**.**

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3.3A. SOLID STATE PHYSICS - SPECIAL - I

Unit-I : **10Hrs**

X-ray Crystallography-Experiments: Small Angle X-ray Scattering (SAXS), Debye –Waller factor, Rotating crystal method, Weissenbery method, accurate determination of lattice parameters, systematic errors, graphical extrapolation method, Ball-milling method.

Unit II : **12Hrs**

Crystal structure determination: Factors affecting intensities, Calculation of structure factors of some simple structures, obtaining structure factors from measured intensities. Fourier analysis of electron density – electron density sections and projections. The phase problem, Patterson synthesis, isomorphic replacement and heavy atom methods, structure refinement by least squares method. Limitations of X-ray diffraction – advantages of neutron diffraction. Applications of neutron diffraction to hydrogen containing structures and magnetic structures.

Unit-III : **13Hrs**

Dielectrics: Static dielectric constant of solids, dielectric polarization, polarizability and dielectric constant, various contributions to the Polarizability. The local electric field – Clausius Mossotti relation. Dielectric response of an ionic crystal – difference between static and high frequency dielectric constants. Dielectric in an alternating field, the complex dielectric function, dielectric constantand dielectric loss, Debye's equations, dielectric dispersion, electronic polarisability and optical absorption, Ionic polarization and infrared absorption.

Unit-IV : **13Hrs**

Ferroelectricity: Characteristic properties and classification of ferroelectrics, spontaneous polarization, phase transition and temperature variation of dielectric constant. Behaviour of some representative ferroelectrics like KH_2PO_4, Rochelae salt and $BaTiO_3$. Theoretical aspects: Dipole theory of ferroelectrics, Thermodynamic theory of ferroelectrics, and Ionic displacement of ferroelectrics. Ferroelectric catastrophe. Domain structure of ferroelectrics: Description of domain structure, Domains and hysteresis, display of hysteresis loop and methods for observation of domain structure. Applications of ferroelectrics, Anti-ferro electricity.

Recommended Books:

1. Introduction to X-ray Crystallography – ***Woolfson***, Vikas, New Delhi.
2. Crystal structure analysis – ***M J Burger,*** John Wiley & Sons.
3. Solid State Physics – ***A J Dekker***, MacMillan.

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4. Basics of X-ray diffraction and its applications - ***K. Ramakanth Hebbar,*** I.K.International Pub. House.
5. X-ray diffraction procedures - ***Klug and Alexander,*** Wiley Easter Ltd.
6. Atomic properties of Solids –***D.B.Sirdeshmukh,L.Sirdeshmukh, K.G.Subhadra*** Springer
7. Nanoscience and Nanotechnology –***B.S.Murthy and P. Shanker*** etal.
8. Solid State Electronic Devices, ***B.G.Streetman***,Edition7th,2018,Pearson Education India
9. Elementary Solid State Physics,***M.Ali Omar***,1993,Addison-Wesley
10. Solid State Physics, ***M.A.Wahab***,Edition:3rd ,2020,Narosa Publishing House.
11. Electrons in Solids,***Richard H.Bude***,Edition 3rd ,1992 Elsevier,
12. Solid State Physics by ***R.K,Puri V.K Babbar*** Edition:1st 2017,S.Chand

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3.3B. Electronics Special –I (Microprocessor- 8086)

UNIT- I : **10Hrs**

INTEL 8086 Architecture - Bus Interface Unit (BIU), Execution Unit, Pin Description, External Memory Addressing, Bus cycles, Important companion chips: Intel 8284A, Intel 8286/8287.Intel 8282/8283, Maximum mode Bus cycles, 8086 System configuration, Memory interfacing, Minimum Mode System Configurations - Interrupt Processing, Direct Memory Access, Compatibility between the 8088, 80186 and 80286.

UNIT-II: **12Hrs**

Programming of 8086 - Addressing modes of 8086, Instruction Set of 8086 – Data transfer Instructions - Arithmetic instructions – Logical instructions – Shift and Rotate Instructions, Adjustment Instructions, Flag related instruction control Transfer Instructions, Process control Instructions, Level of programming, ,Flowchart Assembly language program development tools, Variables and constants used in assemblers, Assembler directives, Procedures and macro, Interrupts of personal computers, Hand coding of assembly language programs , Examples of 8086 assembly language programs.

UNIT-III **12Hrs**

Data Transfer Schemes and Peripheral interfaces –Parallel transmission – Programmed IO – Interrupt driven IO – Direct memory access (DMA) – Serial Transmission – Universal Synchronous Asynchronous Receiver Transmitter (USART) -8251. – pin diagram – Block diagrams of 8251. 8251– control word – 8251 interfacing in I/O mapped I/O.
Parallel I/O methods, Programmable Peripheral Interface (8255A), key board / displaying Interface (8579), Priority interrupts Controller (8259A), DMA Controller (8237) Programmable interval Timer (8254), Interface of DAC 0800.

UNIT-IV **14Hrs**

Intel 80x86 family of processors -INTEL 80186, Pins and signals of 80186, Architecture of 80186, INTEL 80286, Pins and signals of 80286, Architecture of 80286, Real address mode of 80286, Protected virtual address mode of 80286, INTEL 80386, Pins and signals of 80386, Architecture of 80386 microprocessor. Registers of 80386 microprocessor, Operating modes of 80386 microprocessor, INTEL 80486 microprocessor, Pins and signals of 80486, Architecture of 80486, Pentium microprocessor, Pins and signals of Pentium microprocessor, Architecture of Pentium processor, Advanced Pentium processors.

Recommended books:

1. The 8086 Microprocessor: Programming & Interfacing the PC - By Kenneth J. Ayala a. Penram International Publishing, 1995.

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2. Microprocessor 8086, Architecture, programming and Interfacing- Sunil Mathur, PHI Learning PVT. LTD, NEWDELHI
3. The Intel Microprocessors 8086/8088, 80186/80188, 80286,80386,80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, Architecture, Programming, and Interfacing - By Barry B. Brey, 6th Ed., PHI / PEA, 17th Reprint, 2003.
4. Advanced Microprocessors and Interfacing - By Badri Ram, TMH, 2nd Reprint 2002
5. The 8088 and 8086 Microprocessors - Programming, Interfacing, Software, Hardware and Applications - By Walter A Triebel and Avtar Singh, PHI, 4th Ed., 2002.
6. Yu Cheng Lin and Glenn A. Gibson, "Microcomputer systems: The 8086/8088 Family Architecture, Programming and Design", PHI,1992.
7. A NagoorKani ,8086 Microprocessor and its applications, McGraw-Hill, Second edition.
8. RS Goankar, Microprocessor Architecture, Programming and Applications with 8086, Wiley Eastern Edition.

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3.3C. Nanoscience -SPL (Materials Science –I)

Unit-I: **12Hrs**

Imperfections and Dislocations in solids: Classification of Materials, Point defects, line defects, plane defects and volume defects. Surface imperfections**.** . Geometry of dislocations-Edge and Screw dislocations ,Mixed dislocations, Burgers vector and Burgers circuit, stress field of dislocation, force on dislocation, Forces between dislocations, Interaction of dislocations, Elastic energy of dislocations, Movement of dislocations, slip vector and slip plane. Tilt and twist dislocation.

Unit-II : **10Hrs**

Diffusion in solids and Phase transformations: Diffusion: Diffusion Phenomena**,** Laws of diffusion, effect of temperature and concentration on diffusion, Kirckendall effect and mechanism of diffusion, Atomic model of diffusion.

Phase transformations: Obstacles to phase transformations, Nucleation and growth, Nucleation kinetics, Growth and the overall transformation kinetics.

Unit-III : **12Hrs**

Elastic Behaviour of Materials- Atomic model of elastic behaviour, anelastic behaviour and relaxation process, viscoelastic behaviour, plastic deformation, stress-strain curves, plastic deformation by slip, shear strength of perfect and real crystals,effect on the stress to move a dislocation, Multiplication of dislocations, effect of grain size, solute atoms and precipitate particles on dislocation motion., Creep,Mechanisms of creep, Creep resistant materials.

Unit-IV: **14Hrs**

Dielectric and Magnetic materials: Dielectrics: polarization and dielectric constant, dielectric loss, mechanism of polarization, frequency dependence, polarizability in condensed state, dielectric strength, eletrostriction, piezoelectricity, pyroelectric materials, applications of dielectric materials.

Magnetic materials: Classification of magnetic materials, soft and hard magnetic materials, materials for magnetic recording, properties of magnetic materials, domain and magnetization process, magneto striction (cubic and poly crystals), magneto resistance, magneto static energy, hysteresis and its significance, soft and hard ferrites, applications of ferrites.

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<u>Recommended Books:</u>

1. Materials Science –**Raghavan,PHI**.
2. Material Science and Engineering by **RALLS COURTNEY WULFF**
3.Materials Science and Engineering –**C.M.Srivastava**
4.Materials Science and Engineering –**W.D.Calister,** JohnWiley and sons Inc.
5.Materials Science-**I.P.Singh**, Jain Brothers, New Delhi.

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3.4A SOLID STATE PHYSICS – SPECIAL -II

Unit-I: **14Hrs**

X-ray studies of Defects: Point defect estimation from densities obtained by X-ray methods, Activation energies of defect formation in metals and ionic crystals by X-ray method. Defect parameters from line profile analysis, stacking fault energies, dislocation densities, X-ray topography –various geometries and contrast mechanisms, Berg-Barrett method, Long method. Applications in study of dislocations and crystal growth phenomena.

Diffraction from periodic structures: General theory of Diffraction, periodic structures and the Reciprocal Lattice, The Scattering conditions for periodic structures, Structure Factor, methods of structure analysis, Diffraction experiments with various particles, X-ray interferometry and X-ray topography.

Unit-II: **12Hrs**

Ferromagnetism: Quantum theory of para magnetism, Weiss molecular field, exchange interaction Heissenberg model, Spin waves, Dispersion relation, Bloch T 3/2 law, Band model theory of ferromagnetism, crystal anisotropy (incubic crystals) and magnetic striction, Ferromagnetic domains, Thickness and energy of the Block walls, Observation of domain patterns.

Antiferromagnetism: Molecular field theory of the two sub lattice model, Neel temperature. Antiferromagnetic spin waves, Dispersion in relation. Qualitative treatment of super exchange interaction in MnO.

Ferrimagnetism: Molecular field theory of ferrimagnetisms.

Unit-III **12Hrs**

Electrical Transport Properties of Insulators : Hopping conduction; Temperature variation of electrical conductivity; Seebeck coefficient; Polarons- small polaron band conduction; large polaron band conduction; small polaron hopping conduction; Mott transitions; Ionic Conductivity; Supersonic Conductivity- structure, defects and conductivity.

Unit-IV : **10Hrs**

Plasmons, Polaritons, Polarons and Excitons : Dielectric function of the electron gas, plasmons, electrostatic screening, poloritons – LST relation. Electron –Electron interaction, Electron-Phonon interaction, polarons, Optical reflectance, Kramers-Kronig relation, Excitons-Frenkel excitons, weakly bound (Mott-Wannier) excitons. Raman effect in crystals.

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Recommended Books:

1. Physical properties of crystals J.F.Nye.
2. Physics of crystals S.Bhagavantam and S.Radhakrishna,
3. X-ray Studies of defects in single crystals by Auleytner.
4. Applied X-rays by Clarke.
5. X-ray Diffraction by polycrystalline materials by Peiser,Rooksby and Wilson.
6. Solid State Physics by Kittle.
7. Solid State Physics by Dekker.
8. SolidState Physics -M.A. Waheb
9. SolidState Physics- Kachava,
10. Principles of the Solid State-H.V. Keer
11. Intermediate theory of crystalline solids -Animalu
12.SSP-An Introduction to Principles of Materials Science-Harald Ibach l Hans Luth/
I3.G. F. Bacon: Neutron Diffraction, 2nd edn. (Oxford Univ. Press, Oxford 1962)
14.Solid State Physics - Ashcroft and Mermin.
15.The Oxford Solid state Basics- Steven H. Simon.

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3.4B: Electronics – Special – II (Electronic Communication Systems)

Unit-I: **12Hrs**

Pulse Modulation Systems: Introduction - Pulse amplitude modulation (PAM), Natural sampling, Flat-top sampling, PAM Modulator circuit, Demodulation of PAM Signals, PAM Demodulator circuit.

Pulse Code Modulation (PCM), Quantization of signals, Quantization error, Electrical representation of binary signals, PCM system, Equalization, Companding, Time division Multiplexing (TDM) of PCM signals - Synchronous & Asynchronous TDM, Bandwidth of PCM system; Delta Modulation (DM) system, Limitations of DM, Differential PCM.

Unit-II: **11Hrs**

Data Transmission Techniques: Introduction, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) system, Phase Shift Keying (PSK) system, Quadrature Phase Shift Keying (QPSK), QPSK Transmitter and Receiver, Differential Phase Shift Keying (DPSK), DPSK Transmitter and Receiver, Baseband signal receiver, Probability of error, Optimum filter, Matched filter, Correlator.

Unit-III: **14Hrs**

Optical Fiber Communication: Introduction, Total internal reflection, Acceptance angle, Numerical aperture, Optical Fiber construction, Optical Fiber Configurations, Optical Fiber Classifications – Single-mode step-index, multi-mode step-index, single-mode graded-index and multi-mode graded-index fibers; Losses in Optical fibers – Absorption, Scattering, dispersion and radiation losses; Modal dispersion-Types, Coupling or Splice losses, Optical sources – Homojunction and Heterojunction LEDs, Lasers – Types, Characteristics and Basic laser construction; Light Detectors – PIN diodes, Avalanche Photodiode (APD); Optical Fiber Communication system (Block diagram).

Unit-IV: **11Hrs**

Transmission Lines: Introduction, Primary line constants, Phase velocity and line wavelength, Characteristic impedance, Propagation coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage Standing Wave Ratio(VSWR), Slotted-line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart.

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Recommended Books:

1. Communication Systems – ***R.P. Singh and S.D. Sapre,*** TMH
2. Principles of Communication Systems – ***H. Taub, D. L. Schilling, Goutam Saha*** (3^{rd} edition), TMH
3. Optical Fiber Communication – **Gerd Keiser,** 4^{th} edition, TMH
4. Electronic Communication Systems – ***Wayne Tomasi***, 5^{th} edition, Pearson Education
5. Electronic Communications – ***Dennis Roddy and John Coolen***, 4^{th} edition, Pearson Education.
6. Electronic Communication System – ***G. Kennedy.***

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3.4C. Nanoscience –SPL -I

Unit-I: **12Hrs**

Introduction and Electrical Transport in Nanomaterials: Introduction to nanomaterials, Band structure. Density of states of nanostructures. Electron transport in nanostructures. Various conduction mechanisms in 3D (bulk), 2D (thin film) and low dimensional systems-Thermionic emission, Field enhanced thermionic emission (Schottky effect), Field assisted thermionic emission from traps (Poole-Frenkel effect), Arrhenius type thermally activated conduction, Variable range hopping conduction, Polaron conduction.

Unit-II: **12Hrs**

Quantum mechanical concepts at Nanoscale: Introduction, Size effects in smaller systems: Pre-quantum, Quantum behaviour of nanometric world. Applications of Schroedinger equation: Iinfinite potential well a confined particle in 1D, Potential step: Reflection and Tunneling: Quantum leak, Penetration of barrier, Potential box: Trapped particle in 3D: Nanodot, Electron trapped in 2D plane: Nano sheet, Electron moving in 1D: Nanowire/rod/belt. Quantun confinement in nanomaterials.

Unit-III: **12Hrs**

Synthesis of Nanomaterials - Physical methods: Factors Affecting Synthesis of Nanomaterials, Top-down and Bottom-up approaches, Mechanical methods: Ball Milling, Melt Mixing, Methods based on Evaporation: Physical Vapour Deposition with Consolidation, Ionized cluster Beam Deposition, Laser Vapourization (Ablation), Laser Pyrolysis, Sputter Deposition, Chemical Vapour Deposition (CVD), Electric Arc Deposition. Molecular Beam Epitaxy (MBE). Nanolithographic Techniques: Introduction, Lithography using Photons (UV-VIS, Laser or X-rays), Lithography using Particle Beams.

Unit-IV: **12Hrs**

Synthesis of Nanomaterials - Chemical methods: Colloids and colloids in solutions. Growh of Nanoparticles – Synthesis of metal nanoparticles by colloidal routes, Synthesis of semiconductor nanoparticles by colloidal routes, Langmuir Blodgett (L-B) method, Sol-Gel method - Advantages, Disadvantages and Applications, Microemulsion method, **Biological methods**: Introduction to biomaterials. Synthesis using micro-organisms, synthesis using plant extracts.

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Recommended Books:

1. Introduction to Nanoscience and Nanotechnology – K.K. *Chatopadhyay and A.N. Benerjee*, PHI
2. Nanotechnology: Principles and Practices – *Sulabha K Kulkarni.* Capital Publishing Company, New Delhi.
3. Nanostructured Materials and Nanotechnology – *Hari Singh Nalwa*. AP.
4. Nanostructures and Nanomaterials-Synthesis, Properties and Applications – *Cao, Guozhong.*
5. Nano structures an Nanomaterials: Synthesis,properties and Application by Guozliong Cao,Imperial College Press(2004).
6. Introdction to Nanotechnology, By Charles P.Poole,Jr and Frank J.Owens,Willey India (2006).
7. An Introduction to Microeletromechanical Systems Engineering by Nadim Maluf,Artech House Publishers,2004
8. Nanomaterials Synthesis Properties and Applications, by Alen.S.Edelstein and Robert C.Cammarata,1998.

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M.Sc. Physics III Semester Practicals

3.6. General Physics-II Laboratory

1. Determination of ‘g’ factor using ESR spectrometer.
2. Analysis of square wave, clipped sine wave, saw tooth wave using Fourier analysis.
3. To study the characteristics of a given photo conductive cell and the spectral response.
4. To study the characteristics of G M counter and to find out its operating voltage.
5. Verify the inverse square law for γ-rays using G M counter.
6. Using G.M counter find the operational voltage by Least square fitting method.
7. Determination of energy gap of an intrinsic semiconductor by Four Probe Method.
8. Determination of e/m of an electron using helical method.

3.7A Solid State Physics Special – I Laboratory

1. Determination of co-efficient of thermal conductivity of a single crystal.
2. Determination of the ferromagnetic Curie temperature of monel metal.
3. Determination of paramagnetic susceptibility using Guoy balance.
4. Indexing of Laue pattern.
5. Indexing of a Debye-Scherrer film – Accurate determination of lattice constant using least squares method.
6. Determination of lattice constant using symmetric focusing camera.
7. Determination of lattice constant using X Ray Diffractometer.

3.7B Electronics Special - I Labaratory

Part-I: Communication Systems

1. Study of sampling techniques- a) Natural, b) Sample and Hold, c) Flat top sampling.
2. To study Pulse amplitude modulation and Demodulation – IC 555 timer.
3. To study Pulse width Modulation and demodulation – IC555 timer.
4. To study Pulse Position Modulation and demodulation – IC555 timer.
5. To study Pulse Code Modulation and demodulation – IC555 timer.
6. To study Amplitude shift keying (ASK) Technique.
7. To study Phase shift keying (PSK) Technique.
8. To study Frequency shift keying (FSK) Technique.

Part-II: Experiments with MATLAB

1. To verify Nyquist sampling theorem for over sampling and under sampling.
2. To study the Pulse Width Modulation (PWM) and demodulation.
3. To study the Pulse Position Modulation (PPM) and demodulation.

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M.Sc. Physics III Semester Practicals

4. To find scatterplot of M symbols in PSK.
5. To study the FSK modulation and demodulation.
6. To determine the signal-to-noise ratio (SNR) for PCM coded PSK and FSK.

Part-III: Microprocessor 8086 Experiments:
(Assembly Language Programming and Interfacing with 8086 -)

1. Programs for data transfer, arithmetic and logical operations.
2. Programs for array operations – finding out the largest and smallest in a data array.
3. Programs for arranging hex. numbers in ascending and descending order.
4. Programs to find the square root, finding the sum of 'n' natural numbers and finding the sum of squares of the 'n' natural numbers.
5. Program to convert digital signals to analog signals (DAC) – conversion of digital to DC voltages (-5 V to +5V) using DAC-0800.
6. Programs to generate waveforms viz., square, saw tooth and triangular using DAC.
7. Program to generate tones of different frequencies.
8. Program to demonstrate stepper motor control.

3.7C. Nanoscience -I Practicals

1. To determine the resistivity of a graphite sample using four probe method
2. To study the Curie temperature of a ferromagnetic material.
3. To study the magneto resistance behavior of Ge crystal at room temperature.
4. Determination of lattice constant using XRD.
5. Sol-Gel synthesis of nanoparticles
6. Synthesis of Silver metal nanoparticles by chemical route.
7. Synthesis of Copper oxide nanoparticles.
8. Grain size estimation using XRD and AFM.

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IV-Semester (w.e.f. 2022-2023 academic year)

Paper code	Comp. code	Title of the paper	Internal Exam Marks	End Exam Max. Marks	End Exam Min. Marks	Total Max. Marks	Total Min. Marks	No. of credits
		Theory						
4.1	401	Electromagnetic Theory and Optics	20	80	32	100	40	04
4.2	402	Molecular and Resonance Spectroscopy	20	80	32	100	40	04
4.3A 4.3B 4.3C	403A 403B 403C	Solid State Physics: (Special – III) **(OR)** Electronics: (Special -III) Microcontrollers **(OR)** Nanoscience SPL (Materials Science – II)	20	80	32	100	40	04
4.4A 4.4B 4.4C	404A 404B 404C	Solid State Physics: (Special –IV) **(OR)** Electronics:(Special -IV) Satellite and Mobile Communication **(OR)** Nanoscience -SPL -II	20	80	32	100	40	04
		Practical						
4.6	406	General Physics – II	--	100	40	100	40	04
4.7A 4.7B 4.7C	407A 407B 407C	Solid State Physics (Special-I) **(OR)** Electronics (Special-I) **(OR)** Nanoscience -II Practicals	--	100	40	100	40	04
		Seminar	--	25	10	25	10	01
		Total				**625**		**25**

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M.Sc. Physics IV-Semester Theory

4.1. ELECTROMAGNETIC THEORY AND OPTICS

Unit-I : **14Hrs**

Electromagnetic Potentials: Introduction to electrostatics and magnetostatics – Electrodyanamics: emf – electromagnetic induction – Maxwell's equations in differential and integral forms - Retarded potentials – Radiation from moving point charge and oscillating dipoles – Linear antenna – Radiation resistance – electric quadrupole radiation - Lienard – Wiechert potentials. General wave equation – Propagation of light in isotropic dielectric medium – Dispersion – Propagation of light in conducting medium - skin depth – Reflection and refraction at the boundary of a dielectric interface – Fresnel's equations – Propagation of light in crystals - Double refraction.

Unit-II : **10Hrs**

Waveguides: - Introduction, rectangular wave guide, transverse magnetic (TM) modes, transverse electric (TE) modes, wave propagation in the guide, power transmission and attenuation in wave guide resonators, Transverse magnetic (TM) and Transverse electric (TE) waves in circular guides.

Unit-II: **14Hrs**

Electromagnetic waves and Fibre Optics: Monochromatic plane waves in vacuum and non-conducting media,energy and momentum of electromagnetic waves,propagation through linear media,reflection and transmission at normal incidence, oblique incidence, the modified wave equation, monochromatic plane waves in conducting media, reflection and transmission at a conducting surface.

Fiber Optics: Fiber Optics Total internal reflection - Optical fiber modes and configuration – Single mode fibers – Graded index fiber structure – Fiber materials and fabrication – Mechanical properties of fibers – Fiber optic cables – Attenuation – Signal distortion on optical wave guides - Erbium doped fiber amplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system - Applications of optical fibers in communication and medicine.

Unit- IV: **10Hrs**

Non-Linear Optics: Basic Principles – Origin of optical nonlinearity - Harmonic generation – Second harmonic generation – Phase matching condition – Third harmonic generation – Optical mixing – Parametric generation of light – Parametric light oscillator – Frequency up conversion

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– Self focusing of light - Guided wave optics - Pulse compression - Optical solutions.

Recommended Books:

1. Introduction to Electrodynamics – ***D.J.Griffiths***, PHI.
2. Electrodynamics – ***B.B.Laud***, New Age International..
3. Lasers and Non linear optics – ***B.B.Laud***, New Age International.
4. Optical Electronics – ***Ajay Ghatak and Tyagarajan,*** Cambridge.
5. Electrodynamics – ***Jordan*****,** PHI.
6. Electrodynamics – ***Jackson,*** TMH.
7. Introduction to Modern Optics, ***G. R. Fowels***, 2012
8. Lasers and their Applications, ***M.J. Beesly, Taylor and Francis*****,** 1976
9. Optics, E. Hecht, ***Addison Wiley***, 1974
10. Optical Fiber Communications, ***G. Keiser*****,** McGraw Hill Book, 2000

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4.2. MOLECULAR AND RESONANCE SPECTROSCOPY

Unit-I: **14Hrs**

Molecular symmetry: Symmetry operations, Molecular point groups, Matrix representations of symmetry operations of a point group, Reducible and irreducible representations, Character tables for C_{2v} and C_{3v} point groups. Symmetry species of point groups, Normal modes of vibration and their distribution into symmetry species of a molecule, Infrared and Raman selection rules.

Microwave and Infrared spectroscopy: Rotation of molecules, Rotational spectra of polyatomic molecules- Linear, symmetric top and asymmetric top molecules, Diatomic vibrating-rotator, Breakdown of the Born-Openheimer approximation, Vibrations of polyatomic molecules, Rotation-vibration spectra of polyatomic molecules, Instrumentation of Infrared and Fourier Transform Infrared (FTIR) spectrometer.

Unit-II: **12Hrs**

Raman spectroscopy: Molecular polarizability, Quantum theory of Raman scattering, Pure-rotational Raman spectra, Vibrational Raman spectra, Rotational fine structure, Vibrations of Spherical top molecules, Structure determination from Raman and Infrared spectra, Instrumentation of Raman Spectrometer.

Electronic spectroscopy: Electronic spectra of diatomic molecules-Vibrational coarse structure, Franck-Condon principle, Dissociation Energy, Rotational fine structure of Electronic–vibration transitions.

Light Sources and Detectors: Synchrotron Radiation source, Dye Laser, Thermal Detectors, Photomultiplier Tube and Photodiode, Charge Coupled Detector (CCD), Identification of functional group.

Unit-III: **10Hrs**

Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, Resonance condition, Classical theory and Bloch's equations, Relaxation processes-spin-lattice and spin-spin relaxations, chemical shift, NMR instrumentation, NMR Imaging.

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Electron spin resonance: Principles of ESR, Conditions for resonance, Spin Hamiltonian, Hyperfine structure, ESR spectra of Hydrogen atom, CH_3 radical and Benzene anion, Instrumentation of ESR spectrometer.

Unit-IV: **12Hrs**

Nuclear Qudrupole Resonance (NQR) Spectroscopy: Quadrupole nucleus, Principle of Nuclear quadrupole resonance (NQR), Half integral and Integral spins, Studies on chemical and hydrogen bonding and solid state applications, NQR spectrometer Instrumentation.

Mossbauer Spectroscopy: Recoilless emission and absorption of gamma rays. Isomer shift, Quadrupole interaction, Magnetic hyperfine interaction. Applications - Determination of electronic and molecular structure, Crystal symmetry and magnetic structure, Instrumentation of Mossbauer spectrometer.

Recommended Books:

1. Chemical applications of group theory **– F. A. Cotton**
2. Fundamentals of molecular spectroscopy **- *Colin N. Banwell and Elaine,*** TMH.
3. Molecular structure and spectroscopy - ***G Aruldhas,*** PHI.
4. Introduction to Molecular spectroscopy **- *Gordon M. Barrow,*** McGraw Hill.
5. Spectroscopy – Vol 1 and 2 **– *B P Straughan and S Walker,*** Chapman & Hall.
6. Principles of Magnetic resonance **– *C P Slitcher,*** Harper & Row NY J W Hill.
7. Electron Spin Resonance – ***Wertz and Bolton.***
8. Introduction to Mossbauer Spectroscopy – ***Ed by May L.***
9. Nuclear Quadrupole resonance spectroscopy **– *Das T P and Hahn E L.***
10. Laser Spectroscopy**- W. Demtroder.**

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4.3A. SOLID STATE PHYSICS – (SPECIAL – III)

Unit-I : **12Hrs**

Free electron theory of metals –Outstanding properties of metals**,** Electrical D.C conductivity, A.C conductivity and thermal conductivity, free electron concentration, properties of a degenerate Fermi gas at 7 >0^0 K, Free electron gas at 0^0 K, energy of electron gas at 0^0K Richardson –Dushman equation and experimental verification.

Unit-II : **12Hrs**

Energy bands and Fermi surface: Tight binding approximation, Wigner-Seitz approximation. deHaas-Van Alphen effect, cyclotron resonance, magneto resistance, Giant magneto resistance (GMR) and Colossal magneto resistance (CMR) materials and their applications – Spintronic devices.

Unit-III : **11Hrs**

Superconductivity–I: Experimental survey – occurrence of superconductivity, effect of magnetic field - Meissner effect , Type I, Type II super conductors, energy gap, Specific heat, isotope effect, Thermodynamics of the transition (I and II order) - entropy, specific heat, thermal conductivity, flux quantization supercurrents, vortex state.

Unit-IV : **13Hrs**

Super conductivity–II: London's equation, penetration depth, coherence length. Ginzburg – Landau theory – G- L equations. Single particle tunneling (N-I-N) (S-N-S), (S-I-S) Josephson tunneling – DC Josephson effect, DC- SQUID. Electron-phonon interaction –Cooper instability – Cooper pairs. BCS theory (Qualitative – ground state, results of BCS theory). High T_c superconductivity. Applications of superconductivity.

Recommended Books:

1. Introduction to Solid State Physics **–** ***C Kittel,*** John Wiley & Sons.
2. Material Science and Engineering **–** ***W D Callister,*** John Wiley & Sons.
3. Solid State Physics **–** ***N. Ashcroft and N.D. Mermin,*** Thomson Books.
4. Solid State Physics: Structure and Properties of Materials – ***M.A.Wahab***, Narosa
5. Quantum theory of Magnetism – ***W. Nolting and A. Ramakanth***, Springer
6. Principles of Nanomagnetism – ***Alberto P. Guimaraes***, Springer
7. Fundamentals of Solid State Physics –Saxena Gupta -Saxena

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4.3B ELECTRONICS – SPECIAL – III (Microcontrollers and Applications)

Unit-I : **12Hrs**

Microcontrollers and Embedded Systems: block diagram of 8051. Architecture of 8051 – Pin assignments. Program counter and Data pointer –Flags and PSW – Internal RAM – Special function Registers – Register banks and stack – I/O ports and circuits – External Memory – Counters and Timers – Serial Data I/O, Interrupts.

Unit-II : **13Hrs**

Programming of 8051: Introduction, Addressing modes, instruction set and Assembly Language Addressing modes – Instruction set-Moving data – External Data moves, push and pop opcodes, Data Exchanges, Logical: Byte and Bit level operations Rotate and Swap operations, Arithmetic: Flags, Increment, Decrement, Addition, Subtraction, Multiplication and Division; JUMP and CALL Instructions: Jumps, Calls, subroutines, interrupts and returns. Programming examples.

Unit-III : **10Hrs**

Interfacing of peripherals to Microcontrollers: Interfacing of PPI 8255, LCD & Key Board with 8051. Interfacing of stepper motor, ADC, DAC and sensors with 8051. Interfacing to external memory.

Unit-IV : **13Hrs**

Other Microcontrollers: Atmel Microcontrollers, Architectural details and pin description of Atmel 89C51 and 89C2051 microcontrollers. Using flash memory devices Atmel 89CXX and 89C20XX. Applications of Atmel 89C51 and 89C2051 Microcontrollers: generation of sine, square and staircase ramp waves, PIC Microcontrollers: Overview and features, PIC16C6X/7X, FSR (file selection register), PIC Reset Actions, PIC oscillator connections, PIC memory organization.

Recommended Books:

1. The 8051 Microcontroller – ***Kenneth Ayala***, DELMAR CENGAGE learning.
2. The 8051 Microcontroller and Embedded systems using Assembly and C – ***M.A.Mazidi, J,G.Mazidi and R.D.McKinlay*** – PHI.
3. Microcontrollers – Theory and Applications - ***A.V.Deshmukh***, TMH.
4. Programming and customizing the 8051 Microcontroller – ***Myke Predko***, TMH.

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4.3C. Nanoscience (Materials Science –II)

Unit-I: **12Hrs**

Phase Diagrams: Laws of thermodynamic functions, concept of free energy, stability and metastability, relative stability of phases and phase rule and phase diagrams solid solutions, limited and unlimited solid solubility, interstitial and substitutional solid solutions, Hume Rothery rules, Unary and Binary phase diagrams(Lead-tin and Iron –carbon phase diagrams) phase diagrams, lever rule, homogeneous and heterogeneous nucleation, growth and transformation kinetics, microstructural changes during cooling and heating, applications of phase diagrams.

Unit-II: **14Hrs**

Ceramics and Composites –Introduction to ceramics, classification of ceramics, Ceramic structures-oxide structures, silicate structures, ceramic phase diagrams-two oxide systems,– Brittle fracture of ceramics–stress-strain behaviour of ceramics, micro-structure of ceramics, grain growth in ceramics**.** **Composite materials:** Definition of composite materials, Reinforcement in composite materials. Fibres, types of fibres, laminar composites. Design of composite materials. Metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon-carbon composites, hybrid composites. Applications of composites.

Unit-III: **12Hrs**

Polymers - Classification of Polymers, polymer molecules, chemistry of polymer molecules, molecular weight, structure of polymers, formation of free energy of polymer system, Flory – Huggins free energies, phase diagrams in polymer blends, thermoplastics and thermosetting polymers, mechanical behaviour polymers-stress-strain behaviour, viscoelastic deformation, strengthening of polymers, crystallization, melting and glass transition phenomenon in polymers, polymerization, manufacturing of polymers, applications of polymers.

Unit-IV: **10Hrs**

Luminescence and Luminescent materials - General consideration of Luminescence, excitation, absorption and emission process of luminescence, Co-ordinate diagram, energy level diagram, radiative and non-radiative processes. Different types of Luminescence – Electroluminescence and Photoluminescence – Color centres – different kinds of color centers in alkali halides.

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Recommended Books:

1. Materials Science –**Raghavan,PHI**.
2. Material Science and Engineering by **RALLS COURTNEY WULFF**
3. Composite materials **–S.C.Sharma**
4. Materials Science and Engineering –**W.D.Calister,** JohnWiley and sons Inc
5. Introduction to Ceramics –**W.D.Kingery,H.K.Bowen and D.R.Uhlmann**, John Wiley and Sons.
6. Solid State Physicsv-**A.J.Dekker**, Macmillan India Ltd., 2003
7. Introduction to Ferroic Materials –**V.K.Wadhawan**
8. Luminescent materials –**G.Blasse and C.Grabmaier**, Springer-Verlog,1994

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4.4A. SOLID STATE PHYSICS – SPECIAL -IV

Unit-I : **10Hrs**

The Electronic Band structure of Solids: General symmetry properties, The Nearly Free-Electron approximation, Examples of Band structures, The Density of states, extended, reduced and periodic zone schemes, Density of states in Non crystalline solids, Photoemission spectroscopy.

Unit-II : **12Hrs**

Band structures of selected metals and methods for calculating band structures: Alkali metals, Noble metals, Divalent simple metals, Trivalent simple metals, semi metals, transition metals, rare earth metals and alloys.

Methods for calculating band structure: Independent electron approximation, General features of Valence band wave functions, Cellular method, Muffin-Tin potentials, Augmented plane wave (APW) method, Green's function (KKR) method, Orthogonal plane wave (OPW) method and Pseudo potential method.

Unit-III : **14Hrs**

Nano-structures: Electronic structure of 0D and 1D systems: Quantized energy levels 545 semiconductor nanocrystals metallic dots discrete charge states, One-dimensional(1D) sub bands, spectroscopy of Van Hove singularities 1D metals-coulomb interactions and lattice couplings.

Electrical Transport in 0D and 1D: Coulomb oscillations, spin, Mott insulators and the Kondoeffect Cooper pairing in superconducting dots. Conductance quantization and the Landauer formula, two barriers in series-resonant tunneling, Incoherent addition and Ohm's Law, Localization, voltage probes and the Buttiker-Landauer formalism.

Vibrational and Thermal properties: Quantized vibrational modes, Transverse vibrations,Heat capacity and thermal transport.

Unit-IV : **12Hrs**

Measuring the Fermi surface and Surface effects: Effect of electric and magnetic fields on Fermi surfaces, Magnetoacoustic effect, Ultrasonic effect, Anomalous skin effect, The work

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function, contact potentials, Thermionic Emission, Low energy electron diffraction, field ion microscopy and electronic surface levels.

Recommended Books:

1. Physical properties of crystals J.F.Nye
2. Physics of crystals S.Bhagavantam and S.Radhakrishna
3. Solid State Physics –Charles Kittle
4. Solid State Physics –Dekker
5. Solid State Physics –Structure and properties of Materials M.A. Waheb Narosa
6. Solid State Physics –Kachava
7. Principles of the Solid State –H.V.Keer
8. Crytal growth from liquids –J.C.Brice, North Holland Publishers
9. Intermediate theory of crystalline solids – Animalu
10. An introduction to principles of materials science –Harald Ibach 1 Hans Luth.
11. Solid State Physics – Ashcroft and Mermin
12. The Oxford solid state basics –Steven H.Simon
13. Nano structured materials and Nanotechnolofy –Hari Singh Nalwa.
14. Luminescent materials – G.Blasse and C.Grabmaier, Springer –Verlog, 1994

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4.4B: Electronics (Special – IV): Satellite and Mobile Communication

Unit - I: **12Hrs**

Satellite Communication - I: History of Satellites, Kepler's laws, Principles of Satellite orbits and positioning, Satellite Height, Speed, Angle of inclination, Geo synchronous orbits, Position coordinates in latitude and longitude, Azimuth and elevation, Repeaters and Satellite Transponders, Frequency allocations for Transponder channels, Spectrum usage, Frequency Reuse, Satellite Subsystems – Attitude and Orbit Control Systems, Communication Subsystems, Channelization process - Multi channel Architecture, Power Subsystems; Telemetry, Command and Control Sub-systems.

Unit-II: **12Hrs**

Satellite Communication - II: Ground station, Antenna Subsystems, Receive **S**ubsystems - Receive ground control equipment, Transmitter Subsystems – Transmit ground control equipment, Power Subsystems, Telemetry and Control Subsystems, Satellite Applications - Communication satellites, Digital Satellite Radio, Surveillance satellites, Global Navigation Satellite Systems - Space segment, Control segment, GPS receivers - GPS Triangulation, GPS Applications.

Unit-III: **12Hrs**

Introduction to Cellular Mobile Systems: Limitations of conventional mobile telephone system - Spectrum efficiency considerations, Technology feasibility and affordability; Trunking efficiency, Basic Cellular System, Performance criteria – Voice quality, Service quality, Special features, Operation of Cellular Systems, Planning a Cellular System – Regulations, Engineer's role and Finding solutions:

Unit-IV: **12Hrs**

Elements of Cellular Mobile Radio System: General Description – Maximum number of Calls per Hour, Maximum number of frequency channels per cell, Frequency Reuse Channels – Frequency reuse schemes, Frequency reuse distance, Number of customers in the system, Co-channel interference reduction factor, Handoff Mechanism, Cell Splitting, Personal Communication System (PCS) – Standards, 1G, 2G, 3G and 4G.

Recommended Books:

1. Electronic Communication Systems - ***Wayne Tomasi,*** 5th edition, Pearson Education.
2. Principles of Electronic Communication Systems – ***Louis E. Frenzel*** (3rd Ed.) MGH

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3. Principles of Communication Systems – ***H. Taub, D. L. Schilling, Goutam Saha*** (3rd edition), TMH
4. Satellite Communications - ***Timothy Pratt, Charless Bostian, Jeremy Allnutt,*** 2nd edition, Wiley.
5. Electronic Communications **– *Dennis Roddy and John Coolen***, Pearson Education.
6. Mobile Cellular Communications – ***William C. Y. Lee,*** 2nd edition, MGH.
7. Mobile Communications **– *Jochen H. Schille***

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4.4C. NANOSCIENCE – II

Unit-I: **14Hrs**

Characterization Techniques for Nanomaterials: Commonly used analytical techniques for characterization of nanomaterials. Electron Microscopes - Interaction of Electrons with Solids, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Scanning Probe Microscopes (SPM) - Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Scanning Near-Field Optical Microscope (SNOM), Magnetic Force Microscope (MFM), X-ray diffraction techniques – Diffraction from different types of samples, Diffraction from nanoparticles, Magnetic Measurements – Vibrating Sample Magnetometer (VSM).

Unit-II: **10Hrs**

Properties of Nanomaterials: Mechanical properties, structural properties, Thermal properties, Electrical properties, Optical properties of metallic and semiconductor nanoparticles, Luminescence in semiconductor nanoparticles, Magnetic properties.

Unit-III: **12Hrs**

Carbon based Nanomaterials: Introduction to Carbon Clusters, Preparation and Characterization of Fullerenes and Graphene. Carbon Nanotubes (CNTs) – Types of Carbon nanotubes, Synthesis of Carbon nanotubes, Growth mechanism, Electronic Structure of Carbon Nanotubes, Properties and Applications of CNTs, Nanodiamond, Nanoelectronics – single electron transistor, molecular machine.

Unit-IV: **12Hrs**

Advanced Nanomaterials: Porous Silicon - Preparation: Electrochemical Etching method, Mechanism of pores formation, Properties and Applications of Porous Silicon. Aerogels - Types of Aerogels, Properties and applications of Aerogels. Zeolites- Synthesis, Properties and Applications. Ordered porous materials using micelles as templates. Self Assembled Nanomaterials - Inorganic and Organic molecules.

Recommended Books:

1. Nanostructured Materials and Nanotechnology – ***Hari Singh Nalwa***, AP.
2. Introduction to Nanotechnology – ***C.P. Poole Jr and F.J. Owens***, John Wiley and Sons Inc.

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3. Introduction to Nanoscience and Nanotechnology – ***K.K. Chattopadhyay and A.N. Benarjee,*** PHI.
4. Nanotechnology: Principles and Practices – ***Sulabha K Kulkarni***, Capital Publishing Company, New Delhi.
5. Instrumental Methods of Analysis –
6. Physical Principles of Electron Microscopy – ***Ray F Egerton***.

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4.6. General Physics-II Laboratory

1. Determination of susceptibility of a given salt using Quinke's tube method.
2. To study the characteristics of a given solar cell.
3. To verify Beer's law using spectrophotometer.
4. To determine the γ-attenuation coefficients for lead, copper, and aluminum using G M counter.
5. Analysis of hysteresis loop for a given ferromagnetic material and to determine its saturation magnetization, retentivity and co-ercivity.
6. Determination of numerical aperture of an optical fiber.
7. To study the characteristics of a given Laser Diode.
8. Analysis of an audio amplifier using optical fiber.
9. Resistivity measurement of thin slice conducting /non-conducting measurements using bottom surface method.

4.7A. Solid State Physics special-II Laboratory

1. Determination of the ferroelectric Curie temperature of $BaTiO_3$ Polycrystalline pellet.
2. Determination of the dispersion curves of monatomic and diatomic lattice analogs using Lattice Dynamic kit.
3. Estimation of colour centre density of X- ray irradiated alkali halide crystal using spectrophotometer.
4. Determination of photoelastic constants using Babinet compensator.
5. Determination of energy band gap of a semi-conductor thin film using spectrophotometer..
6. Determination of refractive index of a single crystal –Brewster angle method using He-Ne Laser.

4.7B. Electronics Special-II Laboratory
(Part-I: Microcontroller Experiments using 8051)

1. Program for multiplication of two Hexa decimal numbers.
2. 2. Program for division of two Hexa decimal numbers.
3. Programs to pick the smallest and largest numbers in a given set of numbers.
4. Programs for arranging given 'n' numbers in ascending and descending order.
5. Program for generation of specific time delay.
6. Program to interface a D A C and generate saw tooth, square and rectangular waveforms.
7. Program to flash an LED connected at a specified output terminal.

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8. Program to interface a stepper motor, rotate it in clockwise and anticlockwise through given angle steps.
9. Programming using Keil software.
    a) To pick the smallest among a given set of numbers.
    b) To pick the largest among a given set of numbers.
    c) To arrange a given set of numbers in an ascending order and descending order.
    d) To generate a rectangular waveform at a specified port terminal.

Part-II: Digital Communications:

1. Study of sampling techniques.
    a) Natural sampling.
    b) Sample and Hold.
    c) Flat top sampling.
2. Study of various sampling frequencies and Duty cycles.
3. Study of order of the low pass filter.
4. Study of TDM with different receiver and synchronization techniques.
5. Study of Pulse Code Modulation and Demodulation.
6. Study of various carrier modulation and demodulation techniques.
7. Study of Delta Modulation and demodulation.
8. (i) Study of continuously variable slope detector and modulation and demodulation (ii). Study of companding system .
9. (i) Study of pulse width modulation and demodulation.
   (ii) Study of pulse position modulation and demodulation.
10. Voice communication/Optical Fiber Communication.

4.7C. Nanoscience -II Practicals

1. To study the dielectric behavior of PZT ceramic by determining dielectric constant.
2. To prepare nanoparticles using Ball Milling.
3. DSC/DTA/TGA studies for the thermal analysis of materials
4. To draw the B-H loop of a ferromagnet.
5. Synthesis of CdS nanoparticles.
6. Synthesis of ZnO particles.
7. Synthesis of transition metal oxide nanoparticles by Solid-State Thermolysis.
8. Optical absorption of Silver nanoparticles by using UV-Vis Spectroscopy.
9. Synthesis of Carbon Nanotubes.

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