ST. XAVIER'S COLLEGE (AUTONOMOUS)

Palayamkottai - 627 002

Recognized as "College with Potential for Excellence" by UGC)

(Accredited by NAAC at "A++" Grade with a CGPA of 3.66 in IV Cycle)

M.Sc. PHYSICS

SYLLABUS

(w. e. f. June 2023)

Programme Outcome

St. Xavier's College (Autonomous), Palayamkottai aims at the holistic development of the individual. At post –graduation, a student of science of our college should be able to,

- Apply theoretical knowledge of principles and concepts of physics to practical problems.

- Demonstrate ability to plan undertakes and report on a programme on original work including the planning and execution of experiments the analysis of interpretation of experimental results.

- Identify, formulate, research literature survey and analyze complex problems reaching substantiated conclusions using the principles of physical mathematical and bio medical sciences.

- Have specific skills in planning, conducting advanced experiments, recording and analyzing the data and draw the relevant conclusions from it.

- Having problem solving ability to meet out social issues such as energy crisis.

- To prepare to take up challenges as globally competitive physicists/ researchers in diverse areas of theoretical and experimental physics.

- Develop scientific communication skills both written and oral for specialized and non-specialized audience.

- To prepare the students to successfully compte for employment in research, teaching and commercial sector.

Programme Specific Outcomes

At the completion of the M.Sc., programme in Physics the students must be empowered to

1. Face the challenges of constantly evolving science world honing their ability
2. Apply and formulate the solutions of emerging scientific problems
3. Pursue Higher studies in physics
4. Handle any scientific equipments by providing hands on experience with practical instruments
5. Face competitive exams like NET/SET as the course papers designed based on the NET syllabus
6. Have the finer dimensions of physics by providing foundations for transparencies of scientific knowledge at specialization level
7. To be inspired and oriented for research activities
8. Develop their employability skills by equipping students with multi practical dimensions

M.Sc PHYSICS PROGRAMME PATTERN

(With Effect from June 2023)

Sem	Part	Status	Sub. Code	Title of the Paper	Hrs	Cdt
I	A	Core– 1	23PPHC11	Mathematical Physics	6	4
		Core– 2	23PPHC12	Classical Mechanics and Relativity	6	4
		Core– 3	23PPHC13	Linear and Digital ICs and Applications	6	4
		Core– 4	23PPHC14	Practical–I Electronics–I	4	2
	B	EC– 1	23PPHE11	Communication Electronics / Astrophysics	4	4
		EC– 2	23PPHE12	Practical–II General Physics–I	4	2
					30	**20**
II	A	Core– 5	23PPHC21	Statistical Mechanics	6	5
		Core– 6	23PPHC22	Quantum Mechanics –I	6	5
		Core– 7	23PPHC23	Condensed Matter Physics	6	5
	B	EC– 3	23PPHE21	Medical Physics / Solar Energy Utilization	4	3
		EC– 4	23PPHE22	Practical–III Electronics–II	4	2
		SEC– 1	23PPHS21	Practical–IV General Physics–II	4	2
					30	**22**
III	A	Core- 8	23PPHC31	Quantum Mechanics –II	6	5
		Core- 9	23PPHC32	Electromagnetic Theory	6	5
		Core- 10	23PPHC33	Nuclear and Particle Physics	6	5
		Core- 11	23PPHC34	Practical-V Microprocessor 8086	4	2
	B	EC- 5	23PPHE31	Microprocessor 8086 and Microcontroller / Material Physics and Processing Techniques	4	5
		SEC- 2	23PPHS31	Practical-VI Microcontroller 8051	4	2
		Internship	23PPHI35	Carried out in summer vacation at the end of Sem II	-	2
					30	**26**
IV	A	Core- 12	23PPHC41	Spectroscopic Techniques	6	5
		Core- 13	23PPHC42	Numerical Methods and Computer Programming	6	5
		Project	23PPHC43	Project with Viva-Voce	10	5
	B	EC- 6	23PPHE41	Physics of Nano Science and Technology / Atmospheric Physics	4	5
		SEC- 3	23PPHS41	Practical-VII Numerical Methods using C	4	2
		Extension Activiies	–	STAND (Student Training and Action for Neighbourhood) Development	-	1
					30	**23**
				ADDITIONAL COMPULSORY COURSES		
I PG		Value Added	23PPHVA1 / 23PPHVA2	Application Of Physics In Problem Solving / Quantum Computing		**3**
II PG		ECC	23PPHEC1 / 23PPHEC2 / 23PPHEC3 / 23PPHEC4	Energy Physics / Characterization of Materials / Introduction to Particle Physics / Laser Physics		**3**
					120	**97**

Abbreviations and Meanings:

PPH - PG Physics, C – Core, EC(E) - Elective Course, SEC(S) - Skill Enhancement Course, ECC(EC) - Extra Credit Course, CC - Certificate Course (Value Added Course), I – Internship, CO - Course Outcomes, K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create**.**

INDEX OF THE CURRICULUM

MATHEMATICAL PHYSICS
(Course Code: 23PPHC11)

Semester I	Core 1	Hours 6	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 Remember the linear vector space and also able to write operators in different coordinate system (K1)
CO2 Understand the meaning of quantization and path integrals (K2)
CO3 Apply the concepts Gradient, Divergence and Curl in orthogonal curvilinear and their typical applications in physics(K3).
CO4 Solve the analytical function in complex variable and use complex variable for solving the definite integrals (K4)
CO5 Evaluate the concepts of Fourier and Laplace transforms and its applications (K5)
CO6 To acquire the knowledge of differential equations and apply it in mathematical techniques in various fields (K6)

UNIT I : LINEAR VECTOR SPACE (18 Hours)

Basic concepts – Definitions– examples of vector space – Linear independence – Scalar product– Orthogonality – Gram–Schmidt orthogonalization procedure – Direct sum and invariant subspace – orthogonal transformations and rotation– Inner product

Beta Function – Symmetry properties – Evaluation – Transformation – Gamma Function – Evaluation – Transformation – Relation between Beta and Gamma Function.

UNIT II : COMPLEX ANALYSIS (18 Hours)

Review of Complex Numbers –de Moivre's theorem–Functions of a Complex Variable– Analytic functions– Harmonic Functions– Complex Integration– Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula –Taylor's Series – Laurent's Expansion– Zeros and poles – Cauchy Residue theorem - Application: Potential theory – (1) Electrostatic fields and complex potentials – Parallel plates, coaxial cylinders and an annular region (2) Heat problems – Parallel plates and coaxial cylinders

UNIT III : MATRICES (18 Hours)

Types of Matrices and their properties, Rank of a Matrix –Conjugate of a matrix – Adjoint of a matrix – Inverse of a matrix –Hermitian and Unitary Matrices –Trace of a matrix–Transformation of matrices – Characteristic equation – Eigen values and Eigen vectors –Cayley–Hamilton theorem –Diagonalization

UNIT IV : FOURIER TRANSFORMS & LAPLACE TRANSFORMS (18 Hours)

Definitions –Fourier transform – Properties of Fourier Transform – Infinite Fourier Sine and Cosine Transform – Derivative of Fourier Transform – Fourier Transform of a derivative – Fourier sine and cosine transform of derivatives – Applications.

Laplace transform – Properties of Laplace transform – Laplace transform of derivative of a function – Laplace transform of integrals – Laplace transform of periodic functions. – Inverse Laplace transform – Properties of Inverse Laplace transform – Applications.

UNIT V : DIFFERENTIAL EQUATIONS (18 Hours)

Linear differential equation of first order –Second order differential equation with constant coefficients – Power Series Solution: Legendre differential equation and functions – Generating function –Rodrigue formula – Orthogonality properties–Recurrence relations – Bessel's Differential equations– Generating functions –Orthogonality properties –Recurrence relations –Hermite polynomials – Generating function –Orthogonality properties – Recurrence relations.

BOOKS FOR STUDY:

1. Mathematical Physics, Sathyaprakash, Sulthanchand& sons, New delhi 2005
2. Mathematical Physics, B.S.Rajput, 20th Edition, PragatiPrakashan, 2008.
3. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
4. P.K. Chattopadhyay, 2013, Mathematical Physics (2^{nd} edition), New Age, New Delhi
5. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt.Ltd., India

BOOKS FOR REFERENCE:

1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw – Hill, New York 3.

WEB SOURCES

- www.khanacademy.org
- https://youtu.be/LZnRlOA1_2I
- http://hyperphysics.phy–astr.gsu.edu/hbase/hmat.html#hmath
- https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ

CLASSICAL MECHANICS AND RELATYIVITY
(Course Code: 23PPHC12)

Semester I	Core 2	Hours 6	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 To remember the concepts of Lagrangian and Hamiltonian formulation.(K1)
CO2 To illustrate the two body central force problems and its solutions and also about the solving ability of scattering theory.(K4)
CO3 To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. (K3)
CO4 To analyse the Hamiltonoan problems in detail and solve its various problems.(K4)
CO5 To access the theory of oscillations in detail with basis of free vibrations. (K5)
CO6 Creating basic ideas of theory of relativity and the concepts in relativistic mechanics.(K6)

UNIT I : PRINCIPLES OF CLASSICAL MECHANICS (18 HOURS)

Introduction–newtons law of motion –Mechanics of a single particle: conservation laws (linear momentum, angular momentum, work – energy theorem and conservation theorem) – mechanics of a system of particles – centre of mass – constraints – holonomic& non-holonomic constraints – generalized coordinates– Degrees of freedom(translation, rotation and vibration)–principle of virtual work and virtual displacement.

UNIT II : LAGRANGIAN FORMULATION (18 HOURS)

D'Alembert's principle –Lagrange's equations of motion for conservative systems from D'Alembert's principle–Applications: (i) newton's equation of motion from Lagrange's equations (ii) simple pendulum (iii) Atwood's machine.

UNIT III : HAMILTONIAN FORMULATION (18 HOURS)

Generalized momentum and cyclic coordinates – Phase Space – Hamiltonian(H) function and conservation of energy: Jacobi's integral– Hamilton's canonical equations of motion –applications: (i) one dimensional simple harmonic oscillator (ii) motion of particle in a central force field (iii) compound pendulum

UNIT IV : SMALL OSCILLATIONS (18 HOURS)

Euler's angles– Moments and products of inertia–Euler's equation of motion of a rigid body–general theory of small ossilations – transformation to normal coordinates – frequencies of normal modes – vibrations of a linear triatomic molecule.

UNIT V : RELATIVITY (18 HOURS)

Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum and acceleration in for vector notation and their transformations.

BOOKS FOR STUDY

1. J. C. Upadhyaya, Classical Mechanics, HimalayaPublshing. Co.New Delhi.
2. H. Goldstein, 2002, Classical Mechanics, 3rd Edition, Pearson Edu.
3. R. Resnick, 1968, Introduction to Special Theory of Relativity, Wiley Eastern, New Delhi.
4. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 1980.
5. N. C. Rana and P.S. Joag, Classical Mechanics – Tata McGraw Hill, 2001

BOOKS FOR REFERENCE

1. K. R. Symon,1971, Mechanics, Addison Wesley, London.
2. S. N. Biswas, 1999, Classical Mechanics, Books & Allied, Kolkata.
3. Gupta and Kumar, Classical Mechanics, KedarNath.
4. T.W.B. Kibble, Classical Mechanics, ELBS.
5. Greenwood, Classical Dynamics, PHI, New Delhi.

WEB SOURCES

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical–mechanics–j–c–upadhyay–2014–edition pdf–pdf–free.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8–09–classical–mechanics–iii–fall–2014/lecture–notes/
5. https://www.britannica.com/science/relativistic–mechanics

LINEAR AND DIGITAL ICs & APPLICATIONS
(Course Code: 23PPHC13)

Semester I	Core 3	Hours 6	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 To introduce the basic building blocks of linear integrated circuits (K1)
CO2 To teach the linear and non–linear applications of operational amplifiers (K2)
CO3 To introduce the theory and applications of PLL (K3)
CO4 To introduce the concepts of waveform generation and introduce one special function ICs. (K4)
CO5 To acquire the Exposure to digital IC‘s. (K5)
CO6 Create and design analog and digital circuits for practical use. (K6)

UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER (18 Hours)

Introduction, Classification of IC‘s, basic information of Op–Amp 741 and its features, the ideal Operational amplifier, Op–Amp internal circuit and Op–Amp. Characteristics.

UNIT II: APPLICATIONS OF OP–AMP (18 Hours)

LINEAR APPLICATIONS OF OP–AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters.
NON–LINEAR APPLICATIONS OF OP–AMP:Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.

UNIT III: ACTIVE FILTERS &TIMER AND PHASE LOCKED LOOPS (18 Hours)

ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL – introduction

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS (18 Hours)

VOLTAGE REGULATOR: Introduction, Series Op–Amp regulator, IC Voltage Regulators, D to A AND A to D CONVERTERS: Introduction, basic DAC techniques – weighted resistor DAC, R–2R ladder DAC, inverted R–2R DAC, A to D converters –parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications

UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS (18 Hours)

CMOS LOGIC:CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates.

COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four–bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7–segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154).

SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4– bit asynchronous binary counter (IC 7493).

BOOKS FOR STUDY:

1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt.Ltd.,NewDelhi,India
2. Ramakant A. Gayakwad, (2012), OP–AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, NewDelhi.
3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
4. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
5. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog),

BOOKS FOR REFERENCE:

1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi
4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
5. Integrated Electronics, Millman&Halkias, Tata McGraw Hill, 17th Reprint (2000)

WEB SOURCES

- https://nptel.ac.in/course.html/digital circuits/
- https://nptel.ac.in/course.html/electronics/operational amplifier/
- https://www.allaboutcircuits.com/textbook/semiconductors/chpt–7/field–effect controlled–thyristors/
- https://www.electrical4u.com/applications–of–op–amp/
- https://www.geeksforgeeks.org/digital–electronics–logic–design–tutorials/

COMMUNICATION ELECTRONICS
(Course Code: 23PPHE11)

Semester I	Elective 1	Hours 4	Credits 4

Course Outcomes: At the end of the course the students must be able to

- **CO1** To comprehend the transmission of electromagnetic waves thorough different types of antenna (K1)
- **CO2** To acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth (K2)
- **CO3** To gain knowledge in the generation and propagation of microwaves (K3)
- **CO4** To acquire knowledge about radar systems and its applications and also the working principle of colour television (K4)
- **CO5** To learn the working principle of fiber optics and its use in telecommunication (K5)
- **CO6** To understand the general theory and operation of satellite communication systems (K6)

UNIT I: ANTENNAS AND WAVE PROPAGATION (12 HOURS)

Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna- directional high frequency antennas-UHF and Microwave antennas- - Sky wave-ionosphere –Effect of Earth's magnetic field – Extraterrestrial communication – ground wave propagation.

UNIT II: ANALOG AND DIGITAL MODULATIONS (12 HOURS)

Pulse Modulation- Pulse code modulation– Pulse time modulation- Pulse position modulation–Pulse width modulation–Digital carrier systems – Modulation schemes – Amplitude Shift Keying, Phase Shift Keying (PSK), Frequency Shift Keying (FSK)– Advantages and disadvantages of digital communication.

UNIT III: SATELLITE COMMUNICATION (12 HOURS)

Kepler's First, Second and Third laws – Orbits – Geostationary satellites – Satellite system parameters – Power systems – Attitude control – Satellite station keeping – Antenna look angles – Determination of elevation angle – Limits of visibility – Frequency plans and polarization — Uplink power budget calculations – Downlink power budget calculations – Overall link budget calculations.

UNIT IV: OPTICAL FIBER (12 HOURS)

Importance of optic fiber- propagation of light wave in optical fiber- acceptance angle and acceptance cone of a fiber- numerical aperture- Principles of Light Transmission in a Fiber - Losses in Fibers – Dispersion - Light Sources for Fiber Optics, Photo-detectors, Fiber-optic Communication Link.

UNIT V: MOBILE COMMUNICATION (12 HOURS)

Need for Mobile communication – Requirements of mobile communication – History of mobile communication – Properties of wireless medium – Radio propagation – Reflection,

scattering and diffraction in propagation – Propagation coverage calculations –Cellular structure – Frequency reuse – Mobile internet– Working of mobile IP

BOOKS FOR STUDY:

1. Electronic Communications, Dennis Roddy, John Coolen, Fourth edition, Pearson, (2014).
2. Wireless and mobile communication, T.G.Palanivelu, R.Nakkeeran, Prentice Hall India.
3. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.

BOOKS FOR REFERENCE

1. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998
2. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.
3. Taub and Schilling, principles of communication systems, second edition, Tata McGraw Hill (1991).

WEB SOURCES

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. http://web.ewu.edu/
5. http://nptel.iitm.ac.in/

ASTRO PHYSICS
(Course Code: 23PPHE11)

Semester I	Elective 1	Hours 4	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 To impart knowledge on the physical universe and its evolution. (K1)
CO2 To make the student to understand fundamental principles and techniques of astronomy and astrophysics. (K2)
CO3 To make the student to study electromagnetic radiation from stars, atomic spectra and classification of stars. (K3)
CO4 To provide information about the properties and the evolution of stars. (K4)
CO5 To render information about astronomical instrumentation. (K5)
CO6 To apply the concepts and relations in understanding the galaxies (K6)

UNIT I : OBSERVATIONAL ASTRONOMY (12 HOURS)

The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multi wavelength)

UNIT II : PROPERTIES OF STARS (12 HOURS)

Brightness (luminosities, fluxes and magnitudes); colours (black body radiation, the Planck, Stefan–Boltzmann and Wien's laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman &Balmer series etc, Doppler effect); Hertzprung–Russell diagram; the main sequence (stellar masses ,binary systems, Kepler's laws, mass–luminosity relations); distances to stars (parallax, standard candles, P–L relationships, ms–fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).

UNIT III : THE LIFE AND DEATH OF STARS (12 HOURS)

Energy source (nuclear fusion, p–pchain, triple–alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure hydro static equilibrium, equation of state);evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants(white dwarfs, neutron stars, black holes, degeneracy pressure, Swarszchild radius, escape velocities).

UNIT IV : GALAXIES (12HOURS)

Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter ; active galaxies and quasars.

UNIT V : COSMOLOGY (12 HOURS)

Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (black body radiation);big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox)

BOOKS FOR STUDY

1. Zeilik & Gregory, Introductory Astronomy & Astrophysics,4th edition (Saunders College Publishing)
2. Morison,I.,Introduction to Astronomy and Cosmology, (Wiley)
3. Kutner,M.L., Astronomy: A Physical Perspective (Cambridge University Press)
4. Green,S.F. & Jones, M. H., An Introduction to the Sun and Stars (Cambridge University Press)

BOOKS FOR REFERENCE

1. Jones, M.H. & Lambourne,R.J.A.,An Introduction to Galaxies & Cosmology (Cambridge University Press)
2. Carroll,B.W. & Ostlie, D.A., An Introduction to Modern Astrophysics (Pearson)
3. Shu,F.H.,The Physical Universe, An Introduction to Astronomy, (University Science Books)
4. Motz,L. & Duveen, A., The Essentials of Astronomy, (Colombia University Press)

ELECTRONICS I
(Course Code: 23PPHC14)

PRACTICALS – I (Any Eight experiments)

Semester I	Core 4	Hours 4	Credits 2

List of Experiments:

1. SCR characteristics
2. IC 555 timer–Schmitt trigger
3. Network analysis the venin and Norton
4. BJT –amplifier
5. Instrumentation amplifier – Op amp
6. Average amplifier – Op amp
7. Differential amplifier (Transistor) – common mode gain, Differential mode gain & CMRR
8. Weins Bridge oscillator– Op amp
9. Pulse and astable Multivibrator – Op amp
10. Solving simultaneous equation– Op amp
11. Triangular wave generator
12. Active filter

GENERAL PHYSICS I
(Course Code: 23PPHE12)

PRACTICALS – II (Any Eight experiments)

Semester I	Elective 2	Hours 4	Credits 2

List of Experiments:

1. Determination of Rydberg's constant – Hydrogen spectrum
2. Determination of elastic constant – Elliptical fringes
3. XRD – Indexing of X–Ray diffraction pattern
4. Determination of elastic constant – Hyperbolic fringes
5. Determination of the wavelength using He-Ne laser
6. Determination of Solar constant
7. Spectrometer Cauchy's constant
8. Spectrometer i–d curve
9. Determination of Planck's constant using LED
10. Determination of refractive index of different liquids using spectrometer
11. Determination of fiber optic loss
12. Diffraction of light using double slit experiment

STATISTICAL MECHANICS
(Course Code: 23PPHC21)

Semester II	Core 5	Hours 6	Credits 5

Course Outcomes : At the end of the course the students must be able to

- **CO1** To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics (K1)
- **CO2** To identify the relationship between statistic and thermodynamic quantities(K2)
- **CO3** To comprehend the concept of partition function, canonical and grand canonical ensembles (K3)
- **CO4** To grasp the fundamental knowledge about the three types of statistics (K4)
- **CO5** To get in depth knowledge about phase transitions and fluctuation of thermodynamicproperties that vary with time (K5)
- **CO6** To understand the importance of Ising theory and it's applications (k6)

UNIT I : THERMODYNAMICS (18 HOURS)

Postulates of thermodynamics - Connection between statistics and thermodynamics – Energy and first law of thermodynamics - entropy and second law of thermodynamics – Clausius-Clapeyron equation - principle of increase of entropy – thermodynamic potentials – thermodynamic equilibrium – Nernst's heat theorem – consequences of third law – chemical potential.

UNIT II : STATISTICAL MECHANICS AND ENSEMBLES (18 HOURS)

Foundations of statistical mechanics - Specification of states of a system -Ensembles - Micro canonical ensemble - Phase space – ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox- - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Thermodynamic properties of monoatomic and diatomic ideal gas.

UNIT III : CLASSICAL AND QUANTUM STATISTICS (18 HOURS)

Phase space - Density matrix - Liouville's theorem - Statistics of ensembles - Maxwell-Boltzmann statistics – Bose-Einstein statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy – Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation- - Einstien's theory of specific heat - Debye's theory of specific heat capacity.

UNIT IV : REAL GAS, ISING MODEL AND FLUCTUATIONS (18 HOURS)

Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena –Fluctuations in ensembles – Probability of random walk in one dimension - Brownian motion - Langevin's theory - The Fokker-Planck equation

UNIT V : PHASE TRANSITIONS (18 HOURS)

Phase Equilibrium - Gibb's phase rule –Triple point –Vanderwall's equation - I and II order Phase transitions -Ehrenfest'sequations – Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

BOOK FOR STUDY:

1. SatyaPrakash, 2008, Statistical Mechanics, KedarnathRamnath, New Delhi
2. Francis W Sears and Gerhard L. Salinger , Thermodynamics, kinetic theory and statistical thermodynamics, 3rd edition, Narosa Publishing house.
3. S. K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
4. B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
5. J. K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
6. F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw -Hill, New York.
7. M. K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill New York.

BOOK FOR REFERENCE

1. Pathria, 1996, Statistical Mechanics, 2nd edition, Butter WorthHeinemann, New Delhi.
2. L. D. Landau and E. M. Lifshitz, 1969, Statistical Physics, Pergamon Press, Oxford.
3. K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London
4. W. Greiner, L. NeiseandH.Stoecker, Thermodynamics and Statistical Mechanics, Springer Verlang, New York.
5. A. B. Gupta, H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.

WEB SOURCES

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

QUANTUM MECHANICS - I
(Course Code: 23PPHC22)

Semester II	Core 6	Hours 6	Credits 5

Course Outcomes: At the end of the course the students must be able to

CO1 To develop the physical principles and the mathematical background important to quantum mechanical descriptions (K1)

CO2 To describe the propagation of a particle in a simple, one–dimensional potential (K2)

CO3 To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three–dimensional potential (K3)

CO4 To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature(K4)

CO5 To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation (K5)

CO6 To develop quantum mechanical models for classical problems in physics (K6)

UNIT I : BASIC FORMALISM (15 HOURS)

Interpretation of the wave function – Time dependent Schrodinger equation – Timeindependent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation

UNIT II : ONE DIMENSIONAL AND THREE–DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS (15 HOURS)

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential –Hydrogen atom – Rigid rotator

UNIT III : GENERAL FORMALISM (15 HOURS)

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation –Momentum representation – Unitary transformation – Symmetry transformation– Space inversion: Parity conservation- time reversal

UNIT IV: APPROXIMATION METHODS (15 HOURS)

Time independent perturbation theory for non–degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – WKB approximation – Connection formulae (no derivation) – Validity of WKB method – Application to simple harmonic oscillator.

UNIT V: ANGULAR MOMENTUM (15 HOURS)

Angular momentum operators-Angular momentum commutation relations-General angular momentum –Eigen values of J^2 and J_z - Angular momentum matrices - Spin angular momentum – Addition of angular momenta – Clebsh Gordan Coefficients .

BOOKS FOR STUDY

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition (37th
2. Reprint),Tata McGraw–Hill, New Delhi,2010.
3. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
4. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
5. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand&Co., New Delhi, 1982.
6. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.
7. SatyaPrakash, Swati Shaluja, Quantum Mechanics, KedarNath Ram Nath& Co Publishers, Meerut, India.

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1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.
4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.

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1. http://research.chem.psu.edu/lxjgroup/download_files/chem565–c7.pdf
2. http://www.feynmanlectures.caltech.edu/III_20.html
3. http://web.mit.edu/8.05/handouts/jaffe1.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_ 1.pdf
5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

CONDENSED MATTER PHYSICS
(Course Code: 23PPHC23)

Semester II	Core 7	Hours 6	Credits 5

Course Outcomes: At the end of the course the students must be able to

- **CO1** Remember and determine different crystal structures of materials and Provide in–depth knowledge of structure of solids. (K1)
- **CO2** Understand the knowledge on the theory of lattice vibration and correlate it with material thermal Properties. (K2)
- **CO3** Apply the knowledge level from theoretical physical subjects towards the understanding of basic properties of solid state matter. (K3)
- **CO4** Analyse the magnetic properties of material and predict magnetic properties of atoms and molecules based on their electronic configurations. (K4)
- **CO5** Evaluate the applications of superconductors in the cryogenics and industry. (K5)
- **CO6** Create the basic knowledge and also give an overview of current problems within the field of condensed matter/materials science mainly on functional materials. (K6)

UNIT I : CRYSTAL PHYSICS (18 HOURS)

Types of lattices – Miller indices – Symmetry elements and allowed rotations – Simple crystal structures – Atomic Packing Factor– Crystal diffraction – Bragg's law – Scattered Wave Amplitude –Common crystal structures : NaCl, CsCI, ZnS and Diamond – Packing density –hcp and ccp; Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals: Diffraction Conditions – Laue equations –Brillouin zone – Structure factor – Atomic form factor – Inert gas crystals – Cohesive energy of ionic crystals –Madelung constant.

UNIT II : TYPES OF BONDING, LATTICE DYNAMICS (18 HOURS)

Crystal bindings: Ionic bond– covalent bond– molecular bond– Hydrogen bond– metallic bond–Vanderwaal's bond–Binding energy of crystals–polaron–vibrations of one dimensional monoatomic and diatomic linear lattices -Group and phase velocities – Quantization of lattice vibrations – Phonon momentum – Inelastic scattering by phonons – Debye's theory of lattice heat capacity – Thermal Conductivity –Umkalapp processes.

UNIT III : THEORY OF METALS AND SEMICONDUCTORS (18 HOURS)

Classical free electron theory of metals – Electric and thermal conductivities – Wiedemann–Franz law – Band theory of solids – Bloch theorem –Kronig–Penney model – Semiconductors – Fermi distribution function – Intrinsic carrier concentration – Temperature Dependence – Mobility and conductivity in semiconductors – Hall effect – Fermi surface – Construction of Fermi surface in metals (SC, BCC & FCC lattices) – De-Hass-van Alphen effect.

UNIT IV : MAGNETISM (18 HOURS)

Important terms in magnetism – Classification of magnetic materials – Classical Theory of diamagnetism (Langevin theory) – Quantum theory of paramagnetism–Hund's rule– Theories of ferromagnetism – Weiss exchange field – Curie point – Heisenberg's

theory of ferromagnetism (Quantum approach) – Domain theory – Bloch wall – Antiferomagnetism– Neel temperature.

UNIT V : SUPER CONDUCTIVITY (18 HOURS)

Effect of magnetic fields –Meissner effect – Critical field – Critical current – Entropy and heat capacity – Energy gap – Type I and II Superconductors. London equation – Coherence length – Isotope effect – Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory– Single particle tunneling –Josephson tunneling– DC and AC Josephson effects – High temperature Superconductors – SQUIDS.

BOOKS FOR STUDY:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India Pvt. Ltd. , New Delhi, 2004.
2. Rita John, Solid State Physics, Tata McGraw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid–State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid State Physics – Principles and Applications, Pearson, 1999.

BOOKS FOR REFERENCE:

1. M. Tinkham, Introduction to Superconductivity, Tata Mcgraw Hill, New Delhi, 1996.
2. S.O. Pillai, Problems and Solutions in Solid State Physics, New Age international Publishers, New Delhi, 1994.
3. J. S. Blakemore, 1974, Solid state Physics, 2nd Edition, W.B. Saunder, Philadelphia
4. H. M. Rosenburg, 1993, TheSolidState, 3rd Edition, OxfordUniversity Press, Oxford.
5. J. M. Ziman, 1971, Principles of the Theory of Solids, CambridgeUniversity Press, London.
6. C. Ross–Innes and E. H. Rhoderick, 1976, Introduction to Superconductivity, Pergamon, Oxford.

MEDICAL PHYSICS
(Course Code: 23PPHE21)

Semester II	ELECTIVE 2	Hours 4	Credits 3

COURSE OUTCOMES:

- **CO1** Learn the fundamentals, production and applications of X-rays (K1)
- **CO2** Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI (K2)
- **CO3** Apply knowledge on Radiation Physics(K3)
- **CO4** Analyse Radiological imaging and filters(K4)
- **CO5** Assess the principles of radiation protection(K5)
- **CO6** Create and develop instruments(K6)

K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyse; K5 - Evaluate; K6 - Create

UNIT I : X-RAYS AND TRANSDUCERS (12 HOURS)

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer

UNIT II : BLOOD PRESSURE MEASUREMENTS (12 HOURS)

Introduction –sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

UNIT III : RADIATION PHYSICS (12 HOURS)

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – KERMA – Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Geiger Counter – Scintillation Counter

UNIT IV : MEDICAL IMAGING PHYSICS (12 HOURS)

Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Gamma Camera (Only Principle, Function and display)

UNIT V : RADIATION PROTECTION (12 HOURS)

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

BOOKS FOR STUDY:

1. Dr.K.Thayalan ,Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology: - LippincotWilliams and Wilkins, 1990.
3. FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
4. D. J. Dewhurst, An Introduction to Biomedical Instrumentation, 1st ed, Elsevier Science, 2014.
5. R.S. Khandpur, Hand Book of Biomedical Instrumentations, 1st ed, TMG, New Delhi, 2005.

BOOKS FOR REFERENCE:

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, František Vítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
4. K. Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
5. John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

WEB SOURCES

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2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
5. https://www.modulight.com/applications-medical/

SOLAR ENERGY UTILIZATION
(Course Code: 23PPHE21)

Semester II	ELECTIVE 2	Hours 4	Credits 3

Course Outcomes: At the end of the course the students must be able to

CO1 To impart fundamental aspects of solar energy utilization. (K1)
CO2 To give adequate exposure to solar energy related industries (K2)
CO3 To harness entrepreneurship skills (K3)
CO4 To understand the different types of solar cells and channelizing them to the different sectors of society (K4)
CO5 To develop an industrialist mindset by utilizing renewable source of energy (K5)
CO6 Create and develop photovoltaic devices (K6)

UNIT I : HEAT TRANSFER & RADIATION ANALYSIS (12 HOURS)

Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.

UNIT II : SOLAR COLLECTORS (12 HOURS)

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.

UNIT III : SOLAR HEATERS (12 HOURS)

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.

UNIT IV : SOLAR ENERGY CONVERSION (12 HOURS)

Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process- texturization, diffusion, Antireflective coatings, metallization.

UNIT V : NANOMATERIALS IN FUEL CELL APPLICATIONS (12 HOURS)

Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage.

BOOKS FOR STUDY:

1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.
2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", McGraw-Hill, 2010.
3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems", Academic Press, London, 2009
4. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

BOOKS FOR REFERENCE:

1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)
2. Solar energy thermal processes – John A.Drife and William. (1974)
3. John W. Twidell& Anthony D.Weir, 'Renewable Energy Resources,2005
4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013
5. Duffie, J.A., Beckman, W.A. , "Solar Energy Thermal Process", John Wiley and Sons,2007.

ELECTRONICS II
(Course Code: 23PPHE22)

PRACTICALS – III (Any Eight experiments)

Semester II	Elective 3	Hours 4	Credits 2

1. BCD adder/Course traction
2. Verification of demorgan's law–Karnaugh map
3. BCD to 7 segment display
4. Shift registers–serial in and out, parallel in and out
5. Up–down counter
6. Mod counter
7. Ring counter
8. Binary adder and Course traction
9. Multiplexer, Demultiplexer,
10. Encoder and decoder
11. Parity Generator / Checker
12. ALU operations (74181)

GENERAL PHYSICS EXPERIMENTS II
(Course Code : 23PPHS21)

PRACTICALS – IV (Any Eight experiments)

Semester II	Elective 4	Hours 4	Credits 2

1. Conductivity of thin films – Four probe method
2. Magnetic susceptibility measurements – Guoy's method
3. Determination of magnetoresistance of a semiconductor
4. Dielectric constant of crystals – Parallel plate capacitor method
5. Dielectric constant of liquids using Colpitts oscillator
6. Magnetic susceptibility – Quincke's method
7. Measurement of Hall voltage and Hall coeffecient – Hall Probe apparatus
8. Measurement of dielectric constant – LCR METHOD
9. Band gap determination – Four Probe method
10. Conductivity of semiconductor crystal – Two probe method
11. Determination of dielectric loss using CRO
12. Determination velocity of sound – Ultrasonic Interferometer

QUANTUM MECHANICS - II
(Course Code: 23PPHC31)

Semester III	Core 8	Hours 6	Credits 6

Course Outcomes: At the end of the course the students must be able to

- **CO1** To develop the theory and the properties of angular momenta, both orbital and spin(K1)
- **CO2** To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Born approximation. (K2)
- **CO3** To explain Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field(K3)
- **CO4** To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts(K4)
- **CO5** To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions(K5)
- **CO6** Develop the concepts related to Bosons(K6)

UNIT I : PERTURBATION THEORY (18 HOURS)

Time dependent perturbation theory – First order perturbation –Second Order perturbation – Harmonic perturbation – Transition to continuum states – Transition probability –Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Application of time dependent perturbation theory to Semi classical theory of radiation – Selection rules.

UNIT II : SCATTERING THEORY (18 HOURS)

Scattering cross section – Scattering amplitude – Partial waves –Scattering by a central potential: Partial wave analysis- optical theorem- Scattering length- The Born approximation – Scattering by screened coulomb potential – Validity of Born approximation- Yukawa potential –Laboratory and centre of mass coordinate systems.

UNIT III : RELATIVISTIC QUANTUM MECHANICS (18 HOURS)

Klein – Gordon Equation Particle in a Coulomb field – Dirac Equation for a free particle- Dirac Matrices – Covariant form of Dirac Equation - Negative Energy States – Antiparticles – Spin of the Dirac particle – Magnetic Moment of an Electron

UNIT IV : IDENTICAL PARTICLES AND SPIN (18 HOURS)

Indistiguishable particles-Particle exchange operator-Symmetric and antisymmetric wave functions- Pauli's exclusion principle - Spin angular momentum–spin matrices for electron - commutation relations - Pauli Eigen values and Eigen functions - Electron spin functions- Spin matrices and Eigen functions – Density operator and density matrix - spin functions for two electrons and three electrons.

UNIT V : CLASSICAL FIELDS AND SECOND QUANTIZATION (18 HOURS)

Classical field equation: Lagrange form – Hamiltonian form –Quantization of the field – The N-representation-System of Bosons – Creation and Annihilation operators – System of fermions – The Klein Gordon field.

BOOKS FOR STUDY

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw–Hill, New Delhi,2010.
2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. NouredineZettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017
6. SatyaPrakash, Swati Shaluja, Quantum Mechanics, KedarNath Ram Nath& Co Publishers, Meerut, India.

BOOKS FOR REFERENCE

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition,Oxford University Press, London, 1973.
2. B.K.Agarwal&HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics,1stedition,I.K.International Publishing house Pvt.Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970

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2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf
4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf
5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

ELECTROMAGNETIC THEORY
(Course Code: 23PPHC32)

Semester III	Core 9	Hours 6	Credits 6

Course Outcomes: At the end of the course the students must be able to

- **CO1** Remember the fundmentals of Maxwell equations(K1)
- **CO2** Understand the electric and magnetic fields(K2)
- **CO3** Apply the theory to solve problems in electromagnetic field(K3)
- **CO4** Analyze the behaviour in Electromagnetic waves(K4)
- **CO5** Evaluate the electrostatic boundary value(K5)
- **CO6** Develop the knowledge about wave guides(K6)

UNIT I : ELECTROSTATICS (18 HOURS)

Electric charge-Coulombs Law-Electric field-Electrostatic potential-Gauss Law-Applications of Gauss Law-Electric dipole-Mutipole Expansion of Electric fields-Poissons Equation-Laplace Equation-Polarization-Field outside a dielectric medium-The Electric filed inside a Dielectric-Gauss Law in Dielectric-The Electric displacement-Electric susceptibility and dielectric constant

UNIT II : MAGNETOSTATICS (18 HOURS)

Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

UNIT III : MAXWELL'S EQUATION (18 HOURS)

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution-Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

UNIT IV : WAVE PROPOGATION (18 HOURS)

Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole

UNIT V : POTENTIALS AND FIELDS (18 HOURS)

The potential formulation-Scalar and Vector Potentials-Gauge Transformation-Coulomb Gauge and Lorentz Gauge-Lorentz force law in potential form-continuous distributions-retarded potentials-Jefimenko's equations-point charge-LienardWiechert potentials.

BOOKS FOR STUDY:

1. D. J. Griffiths, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S.Chand& Co., New Delhi

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1. W. Panofsky and M. Phillips, 1962, Classical Electricity and Magnetism, Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, Electromagnetics with Applications, 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, Principles of Electrodynamics, Books and Allied, Kolkata.
4. P. Feynman, R. B. Leighton and M. Sands, 1998, The Feynman Lectures on Physics, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA.

NUCLEAR AND PARTICLE PHYSICS
(Course code: 23PPHC33)

Semester III	Core 10	Hours 6	Credits 6

Course Outcomes: At the end of the course the students must be able to

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion. (K1, K5)
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter. (K2, K3)
CO3	Use the different nuclear models to explain different nuclear phenomena(K3)
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force. (K3, K4)
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles. (K5)
CO6	Develop the standard model of elementary particles (K6)

UNIT I : PROPERTIES OF NUCLEUS AND NUCLEAR MODELS (18 HOURS)

Properties of Nucleus – General Properties – Size – Charge – Mass – Density – Spin – Magnetic moment – Forces –Nuclear Models – Liquid drop model: Weizsaker's semi empirical mass formula, –Bohr Wheeler theory of nuclear fission – Nuclear shell model: magic numbers- evidence for magic numbers – Predictions of Shell model – Collective model – Optical model.

UNIT II : NUCLEAR FORCES (18 HOURS)

Introduction – Deuteron – Properties of deuteron – Ground and Excited states – neutron-proton scattering at low energies – proton-proton scattering at low energies – Similarity between nn and pp forces – Meson theory of nuclear forces.

UNIT III : NUCLEAR DECAY (18 HOURS)

Theory of radioactivity – Law of radioactive disintegration – Half-life period – Mean life – Measurement of decay constants – Gamow's theory of alpha decay - The Neutrino hypothesis - Fermi's theory of Beta decay – Violation of parity conservation in Beta decay - Gamma emission: multipole radiation - internal conversion and nuclear isomerism.

UNIT IV : NUCLEAR REACTIONS AND NEUTRONS (18 HOURS)

Types of Nuclear reactions – Elastic, inelastic, radiative capture, disintegration, direct reactions – Compound nucleus - Reciprocity theorem – Neutron sources – Classification of neutrons – neutron diffusion- neutron current density – leakage rate – Fermi age equation – Four factor formula – Classification of nuclear reactors.

UNIT V : ELEMENTARY PARTICLES (18 HOURS)

Classification of elementary particles – Types of particle interactions – Mesons, Leptons and Hyperons – Particles and antiparticles – Quantum numbers – Conservation laws - CPT – invariance under charge, parity and time reversal – Quark theory of nuclei – SU2 and

SU3 symmetry – baryon octet- meson octet- baryon decuplet – Gell Mann Okuba mass formula – Standard model of particle physics.

BOOKS FOR STUDY:

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011)
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996)
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968).

BOOKS FOR REFERENCE:

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973)
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002)
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001).
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

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2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia.org/article/Nuclear_Forces
3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/
4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

MICROPROCESSOR 8086 AND MICROCONTROLLER
(Course code: 23PPHE31)

Semester III	EC 5	Hours 4	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 Understand the internal architecture and organization of microprocessor 8086.(K1)
CO2 Access the various semiconductor memories and memory organisationof 8086.(K2)
CO3 Discuss the classification of interrupts and the internal architecture of 8259.(K3)
CO4 Analyse the various pheriperal devices and the architecture of 8255.(K4)
CO5 Gather knowledge about the architecture and instructions of micro controller 8051(K5)
CO6 Develop the knowledge about the basics of serial communication and interrupt registers.(K6)

UNIT I : ARCHITECTURE AND INSTRUCTION SET OF 8086 (12 HOURS)

Pins and signals – Architecture – Instruction and data flow – even and odd memory banks - Bus cycles and timing diagram – Addressing modes – Instructions affecting flags – Data transfer instructions – Arithmetic - Logical – String manipulation – Control transfer instructions – CALL and RETURN instructions – Unconditional and conditional jump instructions – Loop instructions- Software instructions – Processor controlled instructions .

UNIT II : MEMORY AND I/O INTERRUPS (12 HOURS)

Semiconductor memory - ROM, PROM, EPROM - Static RAM – Dynamic RAM – NVRAM – Memory organization – I/O structure of a typical microcomputer - Comparison of memory and I/O mapping I/O devices . Interrupts and its need – classification – sources - interrupts of 8086 – implementing interrupt scheme in 8086 – INTR and its expansion – programming interrupt controller – INTEL 8259 – Interfacing 8259 with 8086 – Functional block diagram of 8259 – Processing of interrupts by 8259.

UNIT III : PERIPHERAL DEVICES (12 HOURS)

Programmable peripheral devices - parallel data communication interface – parallel data transfer schemes – Programmable peripheral interface 8255 – INTEL 8255 – Pins – signals – internal block diagram – Interfacing 8255 with 8086 - DMA data transfer scheme – Serial data communication – Keyboard interface using ports .

UNIT IV : MICROCONTROLLER – 8051 (12 HOURS)

Microprocessor and Microcontroller - Overview of 8051 Family – Pin description of 8051 - Registers - Program Counter, ROM space, RAM space,Stack, PSW, SFR registers- Assembly Language Programming - Data Types and Directives- Addressing Modes - Jump Call Instructions - - Arithmetic and Logic Instructions – Bit Instructions - Time delay generations and Calculations

UNIT V : MICROCONTROLLER SFRS AND PROGRAMMING (12 HOURS)

Counter / Timer - Counter Programming - Basics of Serial Communication - RS232 Connections and ICs Max 232 - 8051 Serial Communication Registers - Serial Communication Programming - Interrupts - Interrupts Registers - Internal and External Interrupt Programming.

BOOKS FOR STUDY:

1. Nagoorkani, Microprocessor 8086 programming and interfacing –RBA Publications – 1 st Edition.
2. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded System, Pearson Publications, 13th Edition

BOOKS FOR REFERENCE:

1. A.P.Godse and D.A.Godse – Microprocessors and micro controllers – Technical Publications.
2. Barry Brey , Intel Microprocessor 8086/ 8088, 80186, 80286 , 80386 , 80486 ,Prentice Hall India ((1996)

MATERIAL PHYSICS AND PROCESSING TECHNIQUES
(Course code: 23PPHE31)

Semester III	EC 5	Hours 4	Credits 4

Course Outcomes: At the end of the course the students must be able to

CO1 Impart knowledge on various materials growth, synthesis and processing techniques (K1)

CO2 To learn the structural, morphology, and surface characterization techniques (K2)

CO3 Acquire the knowledge about the pressure gauges (K3)

CO4 Analyze the different growth techniques of thin films(K4)

CO5 Understanding the characteristics and types of plasma (K5)

CO6 Know about the principles and charcterisation of various instrumentation(K6)

UNIT I : CRYSTAL GROWTH (12 HOURS)

Significance of crystal growth-Naturally occurring crystal growth processes-Crystal growth processes in laboratory and industrial scale- Classification of crystal growth methods Growth from solutions - Nucleation: Homogeneous and heterogeneous, Solubility phase diagram–Saturation-Supersaturation- Metastable zone width-Slow evaporation and slow cooling methods, Growth from gel-Growth from flux-Growth from melt- Bridgeman-Stockbarger method-Czochralski pulling method- Growth from vapour-Sublimation method.

UNIT II : PLASMA PROCESSING (12 HOURS)

Basics of plasma: Introduction, Types of plasma; Properties of plasma; V-I characteristics; Advantages of plasma processing. Thermal plasma: Principles of plasma Structure of sprayed deposits, Plasma spheroidization- Plasma decomposition; Treatment ofhazardous wastes – Synthesis of ultrafine nano powders- Plasma melting and remelting - Nonthermal plasma: Glow discharge plasma, Plasma reactors for surface treatment: Corona& DBD atmospheric pressure surface treatment reactors.

UNIT III : VACUUMTECHNIQUES (12 HOURS)

Units and range of vacuum – Formulas for important quantities – Qualitative description ofPumping process – Surface processes and outgassing – Gas flow mechanism – Classification of pumps- Positive displacement pumps – Kinetic pumps – Entrapment pumps - Classification of pressure gauges - Total pressure gauges –Hydrostatic pressure gauges - Thermal conductivity gauges –Ionization gagues – Vacuum system : simple rotary, diffusion, turbo molecular, ultrahigh vacuum and cryo-pumped systems.

UNIT IV : GROWTH TECHNIQUE OF THINFILMS AND NANOMATERIALS (12 HOURS)

Plasma arc discharge-sputtering-chemical vapour deposition-pulsed laser deposition-molecular beam epitaxy-Electrochemical deposition- SILAR method-Solid-State Reaction - Sol-Gel Technique - Hydrothermal growth - Ball Milling – Combustion synthesis – Sonochemical method - Microwave synthesis – Co precipitation

UNIT V : CHARACTERIZATION TOOLS (12 HOURS)

Working principles and instrumentation – XRD – XPS – AES- SIMS - RBS– LEED - AFM –SEM – STM

BOOKS FOR STUDY:

1. Maissel and Glange., 'Handbook of Thin Film Technology', McGraw Hill, First Edition, 1970
2. Roth ., 'Vacuum Technology', North Holland, Third Edition 1990
3. Pipko A, Pliskosky V, ' Fundamentals of Vacuum Techniques ',MIR Publishers First Edition, 1984
4. K. L. Chopra 'Thin Films Phenomena' McGraw Hill, First Edition 1969

BOOKS FOR REFERENCE:

1. D. K. Avasthi, A. Tripathi, A. C. Gupta, ' Ultra High Vacuum Technology', Allied Publishers Private Limited ,2002
2. Kasturi Lal Chopra, Suhit Ranjan Das ,Thin Film Solar Cells Plenum Press, New York, 1983
3. A.Chambers, R.K.Fitch and B.S.Halliday , 'Basic Vacuum Technology ' ,IOP Publishing Ltd, 2 ND Edition ,1998
4. P.V.Ananthapadmanabhan and N. Venkataramani 'Thermal plasma Processing' Pergamon materials series, Vol 2, 1999

MICROPROCESSOR 8086

(Course Code: 23PPHC34)

PRACTICALS – V (Any Twelve experiments)

Semester III	Core 11	Hours 4	Credits 2

List of Experiments:

1. Addition of two 16 – bit data
2. Subtraction of two 16 – bit data
3. Multibyte Addition of two hexa decimal numbers
4. Multibyte subtraction of two hexa decimal numbers
5. Sum of elements in an array
6. Multipication of two 16 – bit numbers
7. Division of 32 – bit by 16 –bit numbers
8. Addition of two BCD numbers
9. Subtraction of two BCD numbers
10. Smallest data in an array
11. Lardgest data in an array
12. Sorting an array in Ascending order
13. Sorting an array in descending order
14. Matrix Addition
15. Conversion of BCD to binary
16. Coversion of Binary to BCD
17. Interfacing LED's using 8255
18. Interfacing 4 x 4 keyboard

MICROCONTROLLER 8051

(Course Code: 23PPHS31)

PRACTICALS – VI (Any Twelve experiments)

Semester III	SEC 2	Hours 4	Credits 2

List of Experiments:

1. 6 - Bit Addition
2. 8 - Bit Course traction
3. 8 - Bit Multiplication
4. One's and Two's Complement
5. Setting bits in an 8 - bit number
6. Masking bits in an 8 - bit number
7. Arithmetic Operations
8. Sum of the elements in an array
9. Multiprecision Addition
10. 8 - Bit Division
11. ASCII to Decimal Conversion
12. Word Disassembly
13. Hex to Decimal Conversion
14. Decimal to Hex Conversion
15. Largest element in an array
16. Ascending order of an array
17. Stack and Course routines
18. Delay Loops

INTERNSHIP

Semester : IV **Sub. Code: 23PPHI35** **Credits: 2**

- All PG students will undergo internship during the summer holidays of the First year after completing II semester.
- Two credits will be given for internship.
- Minimum Days: 30
- Minimum working time per day: 3 Hrs. & Maximum working Time: 5 Hrs.
- The places of internship can be government offices, Panchayats, MP, MLA offices, private institutions, companies, production units etc.
- The HoD of the departments will give a letter of introduction to each student.
- The students will identify the company / institution for internship.
- The students will be divided equally based on the number of professors available in the departments. Each professor will serve as a guide to the assigned students.
- The students will finalize the institutions / companies for the internship in consultation with the guides.
- The students shall maintain a work diary which will be countersigned by the managers / authorities of the company in which the students do the internship on daily basis.
- The work diary, Work completion certificate obtained from the company and a comprehensive report on the learning outcomes will be submitted to the guides at the end of the internship.
- Viva will be conducted based on the experience of the internship in the month of August. The guide will be the internal examiner and another faculty from the same department will serve as the external examiner.

SPECTROSCOPIC TECHNIQUES
(Course code: 23PPHC41)

Semester IV	Core 12	Hours 6	Credits 5

Course Outcomes: At the end of the course the students must be able to

- **CO1** Remember the basics on characterization of Electromagnetic radiation(K1)
- **CO2** Understand the applications of microwave,IR,Raman spectroscopy(K2)
- **CO3** Apply the spectroscopic techniques to analyze different mechanism(K3)
- **CO4** Analyze and interpret the FTIR, Raman and Resonance spectrum(K4)
- **CO5** Evaluate linear ,vibrational and rotational motion of the molecules(K5)
- **CO6** Learn different spectroscopic techniques to analyse molecular structure (K6)

UNIT I : MICROWAVE SPECTROSCOPY (18 HOURS)

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules -Microwave Spectrometer- Instrumentation techniques – block diagram - Stark effect.

UNIT II : INFRARED SPECTROSCOPY (18 HOURS)

Vibrational energy of the diatomic molecule – vibrating diatomic molecule- Diatomic Vibrating Rotator-vibrations of polyatomic molecules-Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy

UNIT III : RAMAN SPECTROSCOPY (18 HOURS)

Theory of Raman Scattering - Classical theory - Quantum theory of Raman scattering-rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- .Mutual exclusion principle- Raman Spectrometer -Instrumentation technique and block diagram - FT Raman spectroscopy- SERS

UNIT IV : ELECTRONIC AND MOSSBAUER SPECTROSCOPY (18 HOURS)

Vibrational coarse structure-Vibrational analysis of band systems-Frank Condon principle-Rotational fine structure of vibration spectra-The Fortrat parabola-Dissociation-Pre Dissociation-Electronic angular momentum in diatomic molecules-Photo Electron spectroscopy-Recoilless Emission and Absorption-Experimental Techniques-Isomer shift-Quadrupole interaction-Application

UNIT V : RESONANCE SPECTROSCOPY (18 HOURS)

NMR – Magnetic properties of nuclei-Resonance conditions-NMR instrumentation-Relaxation process-Bloch Equations-Chemical shift-NMR Spectra of solids-Magnetic angle spinning NMR-Nuclear Quadrupole effects-NMR imaging

ESR-Principle of ESR-ESR Spectrometer-Fine and Hyperfine spectrometer-Double resonance in ESR.

BOOKS FOR STUDY:

1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers.

BOOKS FOR REFERENCE:

1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.

NUMERICAL METHODS AND COMPUTER PROGRAMMING
(Course Code: 23PPHC42)

Semester IV	Core 13	Hours 6	Credits 5

Course Outcomes: At the end of the course the students must be able to

- **CO1** Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations (K1)
- **CO2** Relate Simultaneous linear equations and their matrix representation (K2)
- **CO3** Understand,howinterpolationwillbeusedinvariousrealmsofphysicsand know to apply in some simple problems (K3)
- **CO4** Analyze the newton forward and backward interpolation (K4)
- **CO5** Assess the trapezoidal and Simson's method of numerical integration (K5)
- **CO6** Understand the basics of C-programming and conditional statements (K6)

UNIT I : SOLUTIONS OFEQUATIONS (18 HOURS)

Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations-Zeros of polynomials – Roots of polynomials, non linear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods–Convergence of solutions in Bisection and Newton –Raphson methods – Limitations of Bisection and Newton-Raphson methods.

UNIT II : LINEAR SYSTEM OF EQUATIONS (18 HOURS)

Simultaneous linear equations and their matrix representation – Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method -Eigen values and eigenvectors of matrices – Direct method – Power method and Jacobi Method to find the Eigen values and Eigen vectors.

UNIT III : INTERPOLATION ANDCURVEFITTING (18 HOURS)

Interpolation with equally spaced points-Newton forward and backward interpolation - Interpolation with unevenly spaced points –Lagrange interpolation–Curve fitting–Method of least squares–Fitting a polynomial

UNIT IV : DIFFERENTIATION, INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS (18 HOURS)

Numerical differentiation–Numerical integration–Trapezoidal rule–Simpson's rule – Error estimates – Gauss-Legendre, Gauss-Laguerre, Gauss – Hermite –solution of ordinary differential equations–Euler and Runga Kutta methods.

UNIT V: PROGRAMMING WITH C (18 HOURS)

Flowcharts–Integer and floating point arithmetic expressions–Built – in functions–Executable and non-executable statements–Subroutines and functions–Programs for the following computational methods: (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/ non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange interpolation, (d) Trapezoidal and

Simpson's Rules, (e) Solution of first order differential equations by Euler's method.

BOOKS FOR STUDY:

1. V.Rajaraman, 1993,Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi
2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rdEdition, NewAgeIntl., NewDelhi
3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, NewDelhi
4. F.Scheid,1998,Numerical Analysis, 2nd Edition, Schaum's series, Mc GrawHill, New York
5. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P.Flannery, 1992, Numerical Recipes in FORTRAN,2nd Edition, Cambridge Univ. Press

BOOKS FOR REFERENCE

1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-analgorithmic approach,3rdEdition,McGrawHill,)
2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley, MA.
3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, NewYork.
4. S.S.Kuo,1996, Numerical Methods and Computers,Addison-Wesley.
5. V. Rajaraman, Programming in FORTRAN / ProgramminginC, PHI, NewDelhi

WEB SOURCES

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874
3. https://nptel.ac.in/course/122106033/
4. https://nptel.ac.in/course/103106074/
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

PROJECT

Sub. Code: 23PPHC43

Semester IV	Hours 6	Credits 4

Structure of the Project Report

1. Cover Page
2. Certificate
3. Declaration
4. Acknowledgement
5. Chapter-I Introduction
6. Chapter-II
7. Chapter-III
8. Chapter-IV
9. Chapter-V Conclusion and Scope for further research

Assessment

Internal : 100 Marks

External : 100 Marks

PHYSICS OF NANO SCIENCE AND TECHNOLOGY
(Course Code: 23PPHE41)

Semester IV	EC 6	Hours 4	Credits 5

Course Outcomes: At the end of the course the students must be able to

CO1 Recall historical development, classification, and synthesis methods of nanomaterials(K1)
CO2 Grasp properties of special nanomaterials: carbon fullerenes, nanotubes, etc (K2)
CO3 Apply knowledge of physical, mechanical, optical, and electrical properties to nano-scale analysis (K3)
CO4 Analyze synthesis techniques: vapor deposition, sol-gel, ball milling, lithography, etc. (K4)
CO5 Evaluate structural and chemical characterization techniques: XRD, STM, TEM, spectroscopy(K5)
CO6 Create applications in electronics, colorants, DNA chips, drug delivery, etc. (K6)

UNIT I : INTRODUCTION (12 HOURS)

Introduction History of nanotechnology - Classification of nanomaterials: Definition of - Zero, one and two dimension nano structures Examples Classification of synthesis methods. Surface energy Chemical potential as a function of surface curvature Electrostatic stabilization - Steric stabilization-DLVO theory.

UNIT II : SPECIAL NANOMATERIALS (12 HOURS)

Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene derived crystals, Carbon nanotubes. Micro and Mesoporous Materials: Ordered mesoporous structures, Random mesoporous structures, crystallinemicroporous materials. Core-shell structures: Metal-oxide structures, Metal-polymer structures–Nanocomposites.

UNIT III : PROPERTIES (12 HOURS)

Physical properties of nanomaterials: Melting points, Specific heat capacity and lattice constants Mechanical properties Optical properties - Surface Plasmon Resonance - Quantum size effects Electrical property: Surface scattering, charge of electronic structure, Variation of magnetism with size-Super para magnetism.

UNIT IV : SYNTHESIS (12 HOURS)

Synthesis of nano materials: Physical vapour deposition Chemical vapour deposition plasma arching Sol gel Ball milling technique Reverse micellar technique - Electro deposition. Synthesis of Semiconductors: Nanostructures fabrication by physical techniques lithography-Nanomanipulator.

UNIT V : CHARACTERIZATION AND APPLICATIONS (12 HOURS)

Structural Characterization: X-Ray diffraction Scanning tunneling Microscopy - Transmission Electron Microscopy-Chemical Characterization: Optical spectroscopy.
Applications: Molecular electronics and Nano electronics, Nano electromechanical systems-Colorants and pigments -DNA chips-DNA array devices - Drug delivery system

BOOKS FOR STUDY:

1. Nanotechnology, Wilson M, K Kannangara, G. Smilt, M. Simmons and B. Boguse-Overseas Press, 2005
2. Nanoscale Materials in Chemistry, Kenneth F. Klablunde, John wiley and sons, Inc., 2001.
3. The Essentials, Pradeep T, Nano: Tata MC Graw-Hill publishing company limited, 2007.

BOOKS FOR REFERENCE:

1. Nano biotechnology: Concepts, Applications and Perspectives, Christ of M. Niemeyer, Chad A.4.Mirkin, 2004,
2. Nano medicine, Freitas RA, Landes., TX publication, 1996.
3. Nano Materials, Viswanathan B, Narosa publishing house, 2010.

ATMOSPHERIC PHYSICS
(Course Code: 23PPHE41)

Semester IV	EC 6	Hours 4	Credits 5

Course Outcomes: At the end of the course the students must be able to

CO1 To impart knowledge on the physical universe and its evolution(K1)
CO2 To make the student to understand fundamental principles and techniques of astronomy and astrophysics(K2)
CO3 To make the student to study electromagnetic radiation from stars, atomic spectra and classification of stars(K3)
CO4 To provide information about the properties and the evolution of stars(K4)
CO5 To render information about astronomical instrumentation(K5)
CO6 To have a deep knowledge about cosmic radiations and neutrinos (K6)

UNIT I : PHYSICAL & DYNAMIC METEOROLOGY (12 HOURS)

Physical Meteorology: Structure of Earth‟s Atmosphere and Composition- Law of Thermodynamics of the Atmosphere- Adiabatic Process-Potential Temperature-Clausius-Clapyeron Equation-Laws of Black Body Radiation-Solar and Terrestrial Radiation-Albedo-Green House Effect-Heat Balance of Earth Atmosphere System.

UNIT II : DYNAMIC METEOROLOGY (12 HOURS)

Fundamental Forces-Structure of Static Atmosphere-Momentum, Continuity and Energy Equations-Thermodynamics of the Dry Atmosphere-Elementary Applications of the Basic Equations-Circulation Theorem-Vorticity-Potential Vorticity and Potential Vorticity Equations.

UNIT III : CLIMATE & MONSOON DYNAMICS (12 HOURS)

Climate Classification-Polar, Artic, Antarctic, Temperate & Tropical Climates Wind, Temperature & Pressure Distribution over India in the Lower, Middle and Upper Atmosphere during Pre- Post- and Mid-Monsoon Season-Dynamics of Monsoon Depression and Easterly Waves-Intra Seasonal and Interannual Variability of Monsoon-Quasi-Bi Weekly and 30-60 Day Oscillations-Walker Circulation, Southern Oscillations & El Nino

UNIT IV : ATMOSPHERIC POLLUTION (12 HOURS)

Role of Meteorology in Atmospheric Pollution-Atmospheric Boundary Layer-Air Stability-Local Wind Structure-Ekman Spiral-Turbulence & Boundary Layer Scaling-Residence Time and Reaction Rates of Pollutants-Sulphur Compounds-Carbon Compounds-Organic compounds-Aerosols- Toxic Gases and Radio Active Particles-Trace Gases

UNIT V: RADAR METEOROLOGY (12 HOURS)

Basic Meteorology-Radar Principles and Technology-Radar Signal Processing & Display-Weather Radar- Observation of Precipitating Systems-Estimation of Precipitation-Radar observation of Tropical Storms & Cyclones-Use of Weather Radar in Aviation-Clear Air Radars-Observation of a Clear Air Phenomena

BOOKS FOR STUDY:

1. Atmospheric Science: An Introductory Survey, John M. Wallace and Peter V. Hobbs, Academic Press, 2nd Edition, 2006.
2. Atmospheric Physics, John Houghton, Oxford University Press, 1st Edition, 2002.
3. Introduction to Atmospheric Physics, David G. Andrews, Cambridge University Press, 1st Edition, 2010.

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BOOKS FOR REFERENCE:

1. Dynamic Meteorology-J.R. Holton-Academic Press- NY
2. The Physics of Monsoons-R.N. Keshvamurthy& M. Shankar Rao-Allied Publishers
3. Principles of Air Pollution Meteorology-Tom Lyons &Prillscott-CBS Publishers &Distributors

NUMERICAL METHODS USING C
(Course Code: 23PPHS41)
PRACTICALS – VI (Any Eight experiments)

Semester IV	SEC 3	Hours 4	Credits 2

List of Experiments:

1. Lagrange interpolation with Algorithm, Flow chart and output.
2. Newton forward interpolation with Algorithm, Flowchart and output.
3. Newton backward interpolation with Algorithm, Flowchart and output.
4. Curve-fitting: Least squares fitting with Algorithm, Flowchart and output.
5. Numerical integration by the trape zooidal rule with Algorithm, Flow chart and output.
6. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
7. Finding Roots of a Polynomial- Bisection Method–
8. Finding Roots of a Polynomial-Newton Raphs on method
9. Solution of Simultaneous Linear Equation by Gausse limination method.
10. Solution of Simultaneous Linear Equation by Gauss Jordon method.
11. Solution of Ordinary Differential Equation by Euler method
12. Runge Kutta Fourth Order Method for solving first order Ordinary Differential Equations

ENERGY PHYSICS
(Course Code: 23PPHEC1)

Course Outcomes: At the end of the course the students must be able to

CO1 To learn about various renewable energy sources (K1).
CO2 To know the ways of effectively utilizing the oceanic energy(K2)
CO3 To study the method of harnessing wind energy and its advantages(K3)
CO4 To learn the techniques useful for the conversion of biomass into energy (K4)
CO5 To know about utilization of solar energy (K5)
CO6 To understand the various sources of solar energy(K6)

UNIT I : INTRODUCTION TO ENERGY SOURCES

Conventional and non–conventional energy sources and their availability – prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy

UNIT II : ENERGY FROM THE OCEANS

Energy from tides–Basic principle of tidal power–utilization of tidal energy

UNIT III : WIND ENERGY SOURCES

Basic principles of wind energy conversion–power in the wind–Wind energy conversion–Advantages and disadvantages of wind energy conversion

UNIT IV : ENERGY FROM BIOMASS

Biomass conversion Technologies– wet and dry process–Biogas Generation: Introduction–Aerobic and anaerobic digestion – Advantages of anaerobic digestion.

UNIT V : SOLAR ENERGY SOURCES

Solar cells: Solar cells for direct conversion of solar energy to electric powers–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.

BOOKS FOR STUDY

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. Principles of Energy Conversion, Archie W. Culp and Charles C. Williams, McGraw-Hill Education, 1st Edition, 1982.

BOOKS FOR REFERENCE

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
2. Introduction to Non–Conventional Energy Resources –Raja et. al., Sci. Tech Publications.

CHARACTERISATION OF MATERIALS
(Course Code: 23PPHEC2)

Course Outcomes: At the end of the course the students must be able to

- **CO1** To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques. (K1)
- **CO2** To make the students understand some important electrical and optical characterization techniques for semiconducting materials. (K2)
- **CO3** To understand the methods of various spectroscopic techniques (K3)
- **CO4** To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. (K4)
- **CO5** To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes. (K5)
- **CO6** To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.(K6)

UNIT I : X-RAY AND SPECTROSCOPIC METHODS

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, XPS, Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis – Particle size

UNIT II : ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

Two probe and four probe methods- van der Pauw method – Hall probe and measurement –C-V characteristics –Photoluminescence – light – matter interaction – instrumentation

UNIT III : ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

SEM, EDAX, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Atomic force microscopy (AFM)

UNIT IV : MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - fluorescence microscopy

UNIT V : THERMAL ANALYSIS

Introduction – thermo gravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)

BOOKS FOR STUDY:

1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991
4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

BOOKS FOR REFERENCE:

1. Cullity, B.D., and Stock, R.S., Elements of X-Ray Diffraction", Prentice-Hall, (2001).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009).
4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).

INTRODUCTION TO PARTICLE PHYSICS
(Course Code: 23PPHEC3)

Course Outcomes: At the end of the course the students must be able to

CO1 To have a thorough understanding of particle physics(K1)
CO2 To understand the standard model of physics(K2)
CO3 To be able to work in high energy physics phenomenology(K3)
CO4 To analyze the various rules of electrodynamics(K4)
CO5 To acquire the classification of elementary particles(K5)
CO6 To understand the importance of cosmology(K6)

UNIT I:

Historical introduction – Origin of is ospin and strangeness.

UNIT II:

Relativistick in ematics – Decay and two body scattering, Relativistic wave equation– Klein-Gordon and Dirac equations

UNIT III:

Symmetry: Discrete and Continuous groups – classification of particles-mesons, baryons and quarks-SU(n)symmetry-origin of colors.

UNIT IV:

Electromagnetic interactions – Feynman rules for electro dynamics-electron-electron and electron-nucle on scattering - Rosen-Bluth formula - Deep inelastic scattering – introduction to Proton model, Weak interactions - Fermi theory - CP violation – introduction to neutrin oscillations.

UNIT V:

Brief discussion of electro-weak theory - symmetry breaking - Higgs mechanism and the origin of mass –QCD and the standard model –Interface between particle physics and astrophysics–cosmology– big bang theory-dark matter-origin of dark energy

BOOKS FOR STUDY:

1. Introduction to Elementary Particles, David Griffiths, Wiley-VCH, 2nd Edition, 2008
2. Particle Physics, Martin Shaw, Wiley, 1st Edition, 1996.
3. Quarks and Leptons: An Introductory Course in Modern Particle Physics, Francis Halzen and Alan D. Martin, Wiley, 1st Edition, 1984.

BOOKS FOR REFERENCE:

1. Particle Physics and Introduction to Field Theory, Mark Thomson, Cambridge University Press, 1st Edition, 2013.
2. Modern Particle Physics, Mark Thomson, Cambridge UnivPress, 1st Edition2013.

LASER PHYSICS
(Course Code: 23PPHEC4)

Course Outcomes: At the end of the course the students must be able to

CO1 To develop knowledge in the basics of lasers (K1)

CO2 To enhance comprehension in the principles of lasers (K2)

CO3 To explore the control of laser properties (K3)

CO4 To familiarize with the diverse applications of lasers (K4)

CO5 To analyse the lasing mechanisms of lasers(K5)

CO6 To know the importance of electro optic and acousto optic effects(K6)

UNIT 1 : WAVE PROPAGATION IN ANISOTROPIC MEDIA

Double refraction – plane waves in an isotropic media – wave refractive index –ray refractive index – the ray velocity surface – The index ellipsoid.

UNIT 2 : LASING MECHANISM I

The Einstein Coefficients-Light amplification-The threshold condition-Laser rate Equations Variation of laser power around Threshold – Optimum output coupling –Line broadening mechanisms.

UNIT 3 : LASING MECHANISM II

Modes of a rectangular cavity and the open planar resonator-The quality factor-The ultimate line width of the laser-Mode selection-Q-switching-Mode locking in lasers- -Higher order modes- Ruby lasers-Neodynmium based lasers – The He-Ne laser-The argon ion laser-CO_2 laser–Dye lasers – Excimer lasers-Semiconductor lasers.

UNIT 4 : ELECTRO OPTIC AND ACOUSTO-OPTIC EFFECTS

Index ellipsoid in the presence of an external electric filed-Electrooptic effect in KDP crystal: Longitudinal mode- Raman Nath and Bragg regimes of diffraction –Acousto-optic spectrum analyser

UNIT 5 : NON-LINEAR OPTICAL PHENOMENA

Harmonic Generation–Second Harmonic Generation– Phase Matching Third Harmonic Generation – Optical Mixing – Parametric Generation of Light.

BOOKS FOR STUDY:

1. Optical electronics A.K.Ghatak and K.Thyagarajan, Cambridge University Press1991.

BOOKSFORREFERENCE:

1. Principles of Lasers and Optics, William S.C.Chang, Cambridge University Press, 2005.

APPLICATION OF PHYSICS IN PROBLEM SOLVING
(Course Code: 23PPHVA1)

Course Outcomes:

CO1 To consolidate the concepts and important relations in core physics (K1)
CO2 To explain the information. without derivations and descriptions (K2)
CO3 To know the concepts and relations for solving problems (K3)
CO4 To analyse the physical problems related to physics (K4)
CO5 To correlate the concepts and relations (K5)
CO6 To apply the concepts and relations for solving physics problems relevant to CSIR-NET, JEST and GATE (K6)

UNIT I : APPLICATION OF VECTOR ANALYSIS AND MATRICES

Components of a vector – Vector functions, Derivatives of vector functions, Gradient, divergence and curl – Inverse of a matrix – Orthogonal and unitary matrices –Orthogonal vectors – Systems of linear equations – Eigen value and Eigen vectors.

UNIT II : APPLICATION OF LAGRANGIAN AND HAMILTONIAN

Classification of mechanical systems- Lagranges equations-Lagranges equation for non-holonomic equations-Hamiltonian, Hamiltonian equation for conservative systems- canonical transformations-generating functions.

UNIT III : SOLUTION AND NUMERICAL METHODS IN QUANTUM MECHANICS

Wave- particle duality – Schrodinger equation (time-dependent and time-independent) – Eigenvalue problems (particle in a box, harmonic oscillator, hydrogen atom etc.) – Tunneling through a barrier – Wavefunction in coordinate and momentum representations – Commutators and Dirac notation for state vectors.

UNIT IV : ELECTROMAGNETIC WAVES AND PHOTONS

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields.

UNIT V : ELECTRONIC DEVICES AND CIRCUITS

Circuit Analysis – Circuit laws,Steady state circuits and network theorems – Diode terminal characteristics – Equivalent Circuit Analysis –Rectifier Applications. Characteristics of Bipolar Junction transistors- Operational Amplifiers.

BOOKS FOR STUDY

1. Theory and Problems of Advanced Mathematics, Schaum's outline series - Murray R. Spiegel, (1983) (Unit-I)
2. Theory and Problems of Theoretical Mechanics, Schaum's outline series - Murray R. Spiegel,(1982). (Unit-II)
3. Theory and Problems of Quantum Mechanics, Schaum's outline series – YoavPeleg,ReuvenPnini. (Unit-III)
4. Electromagnetic Theory –David J. Griffiths (Unit-IV)
5. Electronic Devices and Circuit Theory, Robert L. Boylestad , Louis Nashelsky (Unit-V)

BOOKS FOR REFERENCE

1. Principles of Electronics – V.K. Mehta and Rohit Mehta, S. Chand & Co (2017)
2. Fundamentals of Quantum Mechanics, Statistical mechanics & Solid State Physics – S.P. Kuila, S.Chand& Co (2016)
3. Classical Mechanics -J. C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore,Second edition, 2017.

QUANTUM COMPUTING
(Course Code: 23PPHVA2)

Course Outcome

CO1 Recall foundational math concepts for quantum computing. (K1)
CO2 Grasp classical computer principles, qubit uniqueness, and Python usage in quantum computing through Qiskit(K2)
CO3 Apply Python for quantum computing, utilizing gates, entanglement, andQiskit for circuit creation. (K3)
CO4 Analyze classical search algorithms versus Grover's, explore Shor's impact on quantum hardware. (K4)
CO5 Evaluate quantum teleportation, superdense coding, Bernstein Vazirani, and Deutsch Algorithms, considering challenges on real hardware. (K5)
CO6 Create quantum circuits, showcasing creativity in using Qiskit for custom functions in Python. (K6)

Unit 1 : Introduction

Classical Computers, Probability, Complex Numbers, Matrix, Matrix Operations, Special Matrices, Linear Transformation, Qubit Introduction, Superposition and Interference, Entanglement, Qubit State, Bra-ket, Multi Qubit

Unit 2 : Python

Introduction to Python, Anaconda Installation, Numbers, Variables, String, Variable Attributes, Lists, Dictionary, Sets, Tuples, Boolean, Comparisons, If Statements, Statements, For Loop, While Loop, Input and Output, Functions, Class, Inheritance, Using Libraries, Modules

Unit 3 : Qiskit

Introduction to Qiskit, Classical Gates, IBM Signup, Quantum Gates, Entanglement, Qiskit, First Circuit, Toffoli

Unit 4 : Teleportation, Bernstein Vazirani and Deutsch

Introduction to Teleportation, Phase and Bloch Sphere, Quantum Teleportation, Introduction to Bernstein Vazirani Algorithm, Introduction to Deutsch Algorithm, Quantum Error Correction

Unit 5 : Grover and Shor

Introduction to Grover's, Classical Search Algorithm, Applying Grover's on Qiskit, Introduction to Shor's Algorithm, Quantum Fourier Transform, Quantum Phase Estimation, Quantum Hardware

BOOKS FOR STUDY:

1. Quantum Computing for Computer Scientists, Mirco A. Mannucci and Noson S. Yanofsky, Cambridge University Press, 2008.
2. Programming Quantum Computers: Essential Algorithms and Code Samples, Eric R. Johnston, NicHarrigan, Mercedes Gimeno-Segovia, O'Reilly Media, 2019
3. Python Crash Course, Eric Matthes, No Starch Press, 2016.

4. Mastering Quantum Computing with IBM QX, Christine Corbett Moran, Packt Publishing, 2019.
5. Quantum Computing: An Applied Approach, Jack D. Hidary, Springer Nature, 2019.
6. Quantum Computing since Democritus, Scott Aaronson, Cambridge University Press, 2013.

BOOKS FOR REFERENCE:

1. Quantum Computation and Quantum Information, M. A. Nielsen, I. Chuang, Cambridge University Press, 2010.
2. Quantum Computing: From Linear Algebra to Physical Realizations, Mikio Nakahara, CRC Press, 2008.
3. Quantum Computer Science: An Introduction, N. David Mermin, Cambridge University Press, 2007.
4. Classical and Quantum Computation, A. Shen, A. Kitaev, and M. Vyalyi, American Mathematical Society, 2002.
5. An introduction to quantum computing, P. Kaye, R. Laflamme, M. Mosca, Oxford University Press, 2006.
6. Quantum Computing as a High School Module, A Perry, arXiv, 2019.

WEB RESOURCES:

1. https://indico.cern.ch/event/970909/
2. https://quantum.ibm.com
3. https://people.eecs.berkeley.edu/~vazirani/f04quantum/quantum.html
4. https://www.cs.tufts.edu/comp/150QCS/
5. https://www.khanacademy.org/math/linear-algebra