BON SECOURS COLLEGE FOR WOMEN (AUTONOMOUS)

Accredited with A++ Grade by NAAC in Cycle II

Affiliated to Bharathidasan University, Tiruchirappalli

UGC Recognized 2(f) and 12(B) Institution

VILAR BYPASS, THANJAVUR - 613 006, TAMIL NADU

DEPARTMENT OF PHYSICS

Programme: M.Sc Physics

SYLLABUS

SEMESTER - I

CORE COURSE-I

CLASSICAL MECHANICS & RELATIVITY

COURSE CODE: 24PPH101

CONTACT HOURS / WEEK: 05 **CREDITS: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

Units	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-1	**CO-1**	Understand problems involving Lagrangian and Hamiltonian mechanics.	K1-K5
Unit-2	**CO-2**	Acquire knowledge of central force problem and rigid body dynamics	K1-K5
Unit-3	**CO-3**	Solve problems through canonical transformations and Hamilton's Jacobi technique	K1-K5
Unit-4	**CO-4**	Understand the concept of small oscillation.	K1-K5
Unit-5	**CO-5**	Gain an intuitive understanding of the fundamental principles of both special and general relativity.	K1-K5

K1-Remember; K2-Understand; K3-Apply; K4- Analyze; K5-Evaluate;

Syllabus

Unit I: Lagrangian Formulation

Mechanics of a system of particles-Constraints- Generalized Coordinates-D'Alembert's principle-Lagrange equations-velocity dependent potentials-applications- Simple pendulum-Compound Pendulum-At wood Machine- Hamilton's(Variational) principle- holonomic & Non-holonomic systems.

Unit II Central Force Motion and Rigid Body Dynamics

Central Force Motion: General Features – The Kepler Problem: inverse square law force – Scattering in a central force field. **Rigid Body Dynamics**: Moment of inertia tensor – Euler angles – Euler's equations of motion – Symmetrical top – Problems.

Unit III: Hamiltonian Formulation

Legendre transformation and Hamiltonian equations - Cyclic coordinates and conservation theorems - Hamiltonian equations from Variational principle - canonical transformations - Poisson brackets – equations of motion - conservation theorems in Poisson bracket formulation –Principle of Least action

Unit IV: Hamilton-Jacobi Theory and Small Oscillations

Hamilton-Jacobi equation for Hamilton's principle function -Example: Harmonic oscillator problem-Hamilton's characteristic function-Action-angle variable-application to Kepler problem in action angle variables. Eigen value equation -Normal coordinates-Normal frequencies of vibration-vibrations of linear triatomic molecule.

Unit V: Theory of Relativity

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, acceleration and force in for vector notation and their transformations

TEXT BOOKS:

1. H. Goldstein, 2002, *Classical Mechanics*, 3rd Edition, Pearson Edu.
2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publshing. Co.New Delhi.
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,
6. Sharma H.V, Gupta .S.L. &Kumar .V. (2019)*Classical Mechanics* Pragati Prakashan , New Delhi.

REFERENCE BOOKS:

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.S. Dutta, Mechanics (Pearson, New Delhi, 2012).

Web Resources

1. https://ocw.mit.edu/courses/8-09-classical-mechanics-iii-fall2014/pages/lecture-notes/
2. https://nptel.ac.in/courses/115105098
3. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
4. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
5. https://nptel.ac.in/courses/122/106/122106027/
6. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
7. https://www.britannica.com/science/relativistic-mechanics

CORE COURSE II - MATHEMATICAL PHYSICS

COURSE CODE: 24PPH102

CONTACT HOURS: 5 **CREDIT: 4**

INTERNAL MARKS: 25 **EXTERNAL MARKS: 75**

Course Outcomes: At the end of the course the student will be able to:

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit –I	**CO-1**	Understand basic concepts of vector fields, gradient, divergence and curl.	K1-K5
Unit –II	**CO-2**	Understand the fundamental theorems of complex analysis such as cauchy's and residue theorem	K1-K5
Unit – III	**CO-3**	Proficiency in analyzing the properties of matrices and tensors.	K1-K5
Unit – IV	**CO-4**	Analyzing the efficiency method and solve the problems.	K1-K5
Unit -V	**CO-5**	Apply special functions to solve differential equations.	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate;

SYLLABUS

Unit I: Vectors

Vector integration – Line integral – Path independence – Surface integral – Flux –Volume integral – Green's theorem – Stoke's theorem – Divergence theorem – Orthogonal curvilinear coordinates – Unit vectors in curvilinear coordinate system – Gradient, divergence, curl and Laplacian in cylindrical and spherical polar coordinates

Unit-II: Complex Analysis

Complex variables and functions – Analytic function – Cauchy-Riemann conditions with proof-Complex integration – Cauchy's integral theorem and integral formula – Taylor's and Laurent's series – Residues and Singularities – Poles – Cauchy's residue theorem – Computations of Residue – Evaluation of the definite integrals – Principal value integrals

UNIT III: Matrices

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

Tensor Analysis

Tensors –Rank of the Tensors – Covariant and Contra variant Tensors – Mixed Tensor – Symmetric and Anti-symmetric Tensors – Invariant Tensors – Kronecker Delta – Levi Civita Symbol –Contraction – Tensor product – Exterior Product – Metric Tensor

Unit-IV: Fourier Transforms and Laplace Transforms

Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions - Application - Laplace equation: Potential problem in a semi - infinite strip.

Unit V: Special functions

Linear ordinary differential equations of first & second order Initial value and boundary value problem - Sturm-Liouville's problem – Basic properties– (i) Legendre, (ii) Hermite and (iii) Laguerre differential equations – Power series solutions – Polynomials – Generating function – Rodrigue's formula – Recursion relations-Orthogonality relations

TEXT BOOKS:

1. Unit I- Spiegel M. R. (1974)*Vectors analysis* Schaum's outline series, MHI.
2. Unit I-V Gupta -B.D. (2012) *Mathematical Physics* Vikas Pub. Ltd, IInd Edn..,
3. Unit I-V- Satya Prakash (2007)*Mathematical Physics with Classical Mechanics*, Vth Edn., Sultan Chand & Sons.
4. Unit III- Joshi A.W. (2008) *Elements of Group Theory*, New Age Int.
5. Unit III- Joshi A.W., (2005) *Matrices and Tensors in Physics*, 3rd Edition,
6. Unit I&V-Venkataraman (1999) M. K., *Engineering mathematics* Vth Edn., National Pub.

REFERENCES BOOKS:

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.
3. Narosa, New Delhi.
4. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York.
5. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated EastWest,
6. New Delhi.
7. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition,
8. International Edition, McGraw-Hill, New York.

WEB SOURCES

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

CORE COURSE-III

ADVANCED ELECTRONICS

COURSE CODE: 24PPH103

CONTACT HOURS / WEEK: 05 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

UNIT	Co. No.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO1**	Understand the fundamentals of Integrated Circuits and Op- Amp.	K1-K5
Unit 2	**CO2**	Gain a comprehensive understanding of the linear and Non linear Applications of OP-Amp	K1- K5
Unit 3	**CO3**	Acquire knowledge in designing active filters, timers and PLL using operational amplifiers (op-amps).	K1-K5
Unit 4	**CO4**	Gain proficiency in designing voltage regulator circuits for various applications	K1-K5
Unit 5	**CO5**	Explore the knowledge in design and operation of comparator, Encoder, De-coder, Flip-Flop, Registers and Counters	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate;

SYLLABUS

UNIT I: Integrated Circuits and Operational Amplifier

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

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- Monostable and Astable operations and applications, Triangular and Square waveform generators

UNIT III: Active Filters &Timer and Phase Locked Loops Active Filters:

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: IC 555timer, description of functional diagram, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL.

UNIT IV: Voltage regulator & D to A and A to D converters

Voltage Regulator: Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator

D to A and A to D converters: 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: Digital Circuits

Digital comparator – Parity generator/checker – Data selector - BCD to decimal decoder – Seven segment decoder – Encoders – RS, JK, D, T and JK master-slave flip-flops. Serial-in serial-out, Serial-in parallel-out and Parallel-in serial-out shift registers – Synchronous, asynchronous, ring and up/down (using mod 10) counters - Multiplexers – De-multiplexers.

Books for Study:

1. Ramakant A. Gayakwad, (2012), *OP-AMP and Linear Integrated Circuits*, 3rd edition, Prentice Hall / Pearson Education, NewDelhi.
2. Roy Choudhury. D, Shali B.Jain (2012), *Linear Integrated Circuit* , 4th edition, New Age International Pvt. Ltd.,New Delhi, India
3. Vijayendran. V,2008, *Introduction to Integrated electronics (Digital & Analog),*S. Viswanathan Printers & Publishers Private Ltd, Reprint.V

Reference Book

1. V.K. Mehta and Rohit Mehta, Digital Electronics: Principles and Applications, 7th Edition, S. Chand Publishing.
2. Robert F. Coughlin and Frederick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th Edition, Pearson.
3. Jacob Millman and Christos C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, 2nd Edition, McGraw-Hill.
4. M. Morris Mano, Digital Design, 5th Edition, Pearson.

E material

1. https://www.electronics-tutorials.ws/opamp/op-amp.html
2. https://www.tescaglobal.com/integrated-circuits/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/op-amp-applications/
4. https://www.electronics-tutorials.ws/filter/filter_1.html
5. https://www.tescaglobal.com/phase-locked-loops-pll/

CORE LABORATORY- I

ADVANCED GENERAL PHYSICS LAB

COURSE CODE: 24PPH301

CONTACT HOURS/WEEK: 4 **CREDIT: 2**

INTERNAL MARKS: 40 **EXTERNAL MARKS: 60**

Course Outcomes: At the end of the course the student will be able to:

UNIT	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
CO1	Understand the basic principles of Optics & Spectroscopy.	**K2-K3**
CO2	Acquire the skill of handling instruments.	**K2-K3**
CO3	Develop the skill of experimenting collaboratively and ethically.	**K2-K3**
CO4	Develop critical thinking skills by evaluating experimental methods, questioning assumptions and considering the broader implications of their findings.	**K2-K3**
CO5	Analyze and interpret experimental data to draw conclusions	**K2-K3**

K2-Understand; **K3**-Apply;

EXPERIMENTS:

1. Charge of an electron by spectrometer.
2. Determination of thermal conductivity of a good conductor – Forbe's method.
3. Determination of bulk modulus of a liquid using ultrasonic interferometer.
4. Planck's constant - Photoelectric cell.
5. Band gap energy of a semiconductor - Four-probe method.
6. Determination of L of a coil by Anderson's method.
7. Determination of e/m of an electron by Thomson's method.
8. Determinations of wavelength of a laser source using plane diffraction grating and thickness of a wire.
9. Polarizability of liquids by finding the refractive indices at different wavelengths.
10. Magnetic susceptibility of a paramagnetic solution using Quincke's tube method.
11. Study of Hall effect in a semiconductor.
12. Determination of magnetic susceptibility of liquid by Guoy method.
13. Measurement of Conductivity - Four probe method.
14. Measurement of Band gap energy- Thermistor.

15. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
16. Determination of Viscosity of the given liquid – Meyer's disc
17. Measurement of Coefficient of linear expansion- Air wedge Method
18. Determination of Specific charge of an electron – Thomson's method.
19. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
20. GM counter – Characteristics and inverse square law.
21. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method.
22. Determination of Thickness of thin film- Michelson Interferometer.

REFERENCES:

1. S. Srinivasan, A Text Book of Practical Physics, S. Sultan Chand Publications,2005.
2. Department of Physics, Practical Physics, (B.Sc Physics Main), St. Joseph's College, Tiruchirapalli 2009.

ELECTIVE COURSE-I

8085 MICROPROCESSOR AND 8051 MICROCONTROLER

COURSE CODE: 24PPH201

CONTACT HOURS / WEEK: 05 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course student will be able to:

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-1	**CO1**	Gain a thorough understanding of the internal architecture of a 8085 microprocessor, including its various components	K1-K5
Unit-2	**CO2**	Gain the knowledge on 8085 peripheral devices and develop proficiency in writing assembly language programs for the 8085 microprocessor.	K1-K5
Unit-3	**CO3**	Grasp the architecture of the 8051 microprocessor, including various devices	K1-K5
Unit-4	**CO4**	Comprehend the architecture of the 8051 microcontroller and Assembly Language Programming.	K1-K5
Unit-5	**CO5**	Understand the Interrupt Programming and Interface to External World	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate;

Syllabus

Unit I: 8085 Microprocessor Architecture

8085 microprocessor architectures – Various registers – Central processing unit of microcomputers –Instruction set - Addressing modes - Data transfer group – Logical group – Branch group – Stack and I/O control instructions- Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085

Unit II: Peripheral Devices and Their Interfacing and **Software Programs (8085 only)**

Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer - Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface -

Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature and strain)

Unit III: 8051 Microcontroller Hardware

Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory

Unit IV: 8051 Instruction Set and Assembly Language Programming

Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming

UNIT V: Interrupt Programming and Interfacing to External World

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051: Nested interrupts, Software triggering of interrupt. LED Interface

TEXT BOOKS:

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 6th Edition, Penram International Publication (India) Pvt. Ltd.,2013
2. B. Ram, Fundamentals of Microprocessor and Microcomputers (Dhanpat Rai Publication, New Delhi, 2006).
3. M. A. Mazidi, J. G. Mazidi and R. Mckinlay, The 8051 Microcontroller and Embbeded Systems using Assembly and C (Pearson, New Delhi, 2007).
4. A. P. Godse and D. A. Godse, Microprocessors and Microcontrollers (Technical Publications, Pune, 2021).
5. K. Kant, Microprocessors and Microcontroller (Prentice Hall of India, New Delhi, 2013).

REFERENCE BOOKS:

1. Kenneth L. Short, “Microprocessors and programmed Logic”, 2nd Ed, Pearson Education Inc.,2003
2. Barry B. Brey, “The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium IV, Architecture, Programming & Interfacing”, Eighth Edition, Pearson Prentice Hall, 2009.

WEB-RESOURCES

1. https://kanchiuniv.ac.in/coursematerials/VIJAYARAGHAVAN_mp%20_mc% 20notes.pdf
2. https://nptel.ac.in/courses/108105102

BIO PHYSICS

COURSE CODE: 24PPH204

CONTACT HOURS / WEEK: 5 **CREDITS: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

COURSE OUTCOMES:

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-I	**CO-1**	Understand the structural organization and function of living cells and should able to apply the cell signalling mechanism and its electrical activities.	**K1-K5**
Unit-II	**CO-2**	Comprehension of the role of biomolecular conformation to function	**K1-K5**
Unit-III	**CO-3**	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	**K1-K5**
Unit-IV	**CO-4**	To know the effects of various radiations on living systems and how to prevent ill effects of radiations.	**K1-K5**
Unit-V	**CO-5**	Analyse and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	**K1-K5**

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate;

SYLLABUS

UNIT I: CELLULAR BIOPHYSICS

Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.

UNIT II: MOLECULAR BIOPHYSICS

Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins.

Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation.

Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.

UNIT III: MEMBRANE AND NEURO BIOPHYISCS

Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and c – Ion channels. Nervous system: Organization of the nervous system – Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation

UNIT IV: RADIATION BIO PHYSICS

X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.

UNIT V: PHYSICAL METHODS IN BIOLOGY

Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

TEXT BOOKS

1. Biophysics, VasanthaPattabhi, N. Gautham, Narosa Publishing, 2009
2. Biophysics, P. S. Mishra VK Enterprises, 2010.
3. Biophysics, M. A Subramanian, MJP Publishers, 2005.
4. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.

REFERENCE BOOKS

1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008).
2. Essential cell biology by Bruce Albert et al (Garland Science)
3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983).

4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media).
5. Biological spectroscopy by Iain D. Campbell, Raymond A. Dwek

WEB RESOURCES

1. General Bio:http://www.biology.arizona.edu/DEFAULT.html
2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm
3. Electrophoresis:http://learn.genetics.utah.edu/content/labs/gel/
4. Online biophysics programs: http://mw.concord.org/modeler/

   https://blanco.biomol.uci.edu/WWWResources.html

ELECTIVE COURSE III

MATERIALS SCIENCE

COURSE CODE:24PPH207

CONTACT HOURS /WEEK: 04 **CREDITS: 4**

INTERNAL MARKS: 25 **EXTERNAL MARKS:75**

COURSE OUTCOMES:

Unit	CO's	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit I	CO1	Understand the fundamental principles governing the behavior of optoelectronic materials, including their electronic band structures and optical properties.	K1-K5
Unit II	CO2	Acquire knowledge on Processing of ceramics and structure of ceramics	K1-K5
Unit III	CO3	Understand the synthesis of polymer, processing techniques and application of polymers	K1-K5
Unit IV	CO4	Acquire knowledge on the fabrication of composite materials.	K1-K5
Unit V	CO5	Understand about shape memory alloys, metallic glasses and nanomaterials.	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate;

SYLLABUS

UNIT I: OPTOELECTRONIC MATERIALS

Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.

UNIT II: CERAMIC MATERIALS

Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass

ceramics

UNIT III: POLYMERIC MATERIALS

Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.

UNIT IV: COMPOSITE MATERIALS

Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.

UNIT V: NEW MATERIALS

Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes

TEXT BOOKS

1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007
2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.
3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi(For units 2,3,4 and 5)
4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill
5. M. Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha Agencies

REFERENCE BOOKS

1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012.
2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011.
3. Lawrence H. VanVlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley.
4. H. Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of

Materials Science, 2nd Edition, Springer.

5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.

WEB RESOURCES

1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
2. https://nptel.ac.in/courses/112104229
3. https://archive.nptel.ac.in/courses/113/105/113105081
4. https://nptel.ac.in/courses/113/105/113105025/
5. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

ELECTIVE COURSE-IV

ADVANCED OPTICS

COURSE CODE: 24PPH210

CONTACT HOURS / WEEK: 05 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

UNIT	CO. NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO-1**	Discuss the transverse character of light waves and different polarization phenomenon	K1-K5
Unit 2	**CO-2**	Discriminate all the fundamental processes involved in laser devices and to analyse the design and operation of the devices	K1-K5
Unit 3	**CO-3**	Demonstrate the basic configuration of a Fiber optic – communication system and advantages	K1-K5
Unit 4	**CO-4**	Identify the properties of nonlinear interactions of light and matter	K1-K5
Unit 5	**CO-5**	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate

SYLLABUS

UNIT 1: POLARIZATION AND DOUBLE REFRACTION

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity

UNIT II: LASERS

Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Chemical lasers – HCl laser – Semiconductor laser

UNIT III: FIBER OPTICS

Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor

UNIT IV: NON-LINEAR OPTICS

Wave propagation in an anisotropic crystal - Polarization response of materials to light Basic principles – Harmonic generation – Second harmonic generation – Sum and difference frequency Generation- Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Terahertz - Bi-stability -Self-focusing of light

UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS

Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect

Books for Study

1. K.R. Nambiar, Lasers: Principles, Types and Applications (New Age Inter-national Publishers Ltd, New Delhi, 2014).
2. B.B. Laud, Lasers and Nonlinear Optics, 3rd Edn. (New Age, New Delhi, 2011).
3. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
4. R.W. Boyd, Nonlinear Optics, 2nd Edn. (Academic Press, New York, 2003).
5. G.P. Agarwal, Fiber-Optics Communication Systems, 3rd Edn. (John Wiley, Singapore, 2003).

Books for Reference

1. W.T. Silvast, Laser Fundamentals (Cambridge University Press, Cambridge, 2003).
2. D.L. Mills, Nonlinear Optics – Basic Concepts (Springer, Berlin, 1998)
3. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition.

WEB RESOURCES

1. https://www.youtube.com/watch?v=WgzynezPiyc
2. https://www.youtube.com/watch?v=ShQWwobpW60
3. https://www.ukessays.com/essays/physics/fiber–optics–and–it-applications.php
4. https://www.youtube.com/watch?v=0kEvr4DKGRI
5. http://optics.byu.edu/textbook.aspx

ELECTIVE COURSE V

PHYSICS OF NANO SCIENCE AND TECHNOLOGY

COURSE CODE:24PPH213

CONTACT HOURS / WEEK: 4 **CREDITS: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

COURSE OUTCOMES:

UNIT	COs	AT THE END OF THE COURSE, THE STUDENT WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	CO1	Understand the fundamental concepts of nanomaterials and nanotechnology.	K1-K5
UNIT II	CO2	Identify and classify various types of nanomaterials	K1-K5
UNIT III	CO3	Explain the quantum effects in nanomaterials like quantum dots, wires, and wells.	K1-K5
UNIT IV	CO4	Compare the surface effects and properties of nanoparticles, nanoclusters, and nanocomposites.	K1-K5
UNIT V	CO5	Discuss the significance of nanohybrids and their applications.	K1-K5

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

SYLLABUS

UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials- Nanoparticles- Nano clusters – Nanocomposite- Nanohybrids.

UNIT II: PROPERTIES OF NANOMATERIALS

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

UNIT III: SYNTHESIS AND FABRICATION

Top – down method - Bottom - up method- Physical vapour deposition - Chemical vapour

deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.

UNIT IV: CHARACTERIZATION TECHNIQUES

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – X-ray photoelectron spectroscopy (XPS) - Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT V: APPLICATIONS OF NANOMATERIALS

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification - Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.

TEXT BOOKS

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. K. Ravichandran, K. Swaminathan, P. K. Praseetha and P. Kavitha, Introdution to Nanotechnology (Jazym Publications, Tiruchirappalli, 2019)
3. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
4. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
5. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
6. Nanotechnology and Nanoelectronics, D.P. Kothari,V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt.Ltd, New Delhi. (2018)

REFERENCE BOOKS

1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press (2004).
2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA
3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J.H.Fendler John Wiley and Sons. (2007)

4. Textbook of Nanoscience and Nanotechnology, B.S.Murty, et al., Universities Press. (2012)
5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

WEB RESOURCES

1. www.its.caltec.edu/feyman/plenty.html
2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
3. http://www.understandingnano.com
4. http://www.nano.gov
5. http://www.nanotechnology.com

ELECTIVE COURSE-VI

SPECTROSCOPY

COURSE CODE: 24PPH216

CONTACT HOURS/WEEK: 04 **CREDIT: 04**

INTERNAL MARK: **25** **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course, student will be able to

UNIT	Co. No.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT-I	CO1	Understand the fundamental principles of atomic and molecular spectroscopy and how molecules interact with electromagnetic radiation.	K1-K5
UNIT-II	CO2	Apply various spectroscopic techniques (microwave, infrared, Raman, and UV) to analyze molecular structures and transitions.	K1-K5
UNIT-III	CO3	Interpret spectral data to deduce information about molecular energy levels, functional groups, and bonding.	K1-K5
UNIT-IV	CO4	Demonstrate the use of spectroscopic instruments (e.g., spectrometers) and analyze experimental data effectively.	K1-K5
UNIT-V	CO5	Investigate the applications of spectroscopy in chemical analysis, materials science, and other fields.	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

SYLLABUS

Unit I: ATOMIC AND MOLECULAR SPECTROSCOPY

Molecular spectroscopy-Experimental methods -Central field approximation—Spin orbit interaction-Doublet separation-Intensities-Complex atoms-Coupling schemes-Energy levels-Selection rules and intensities in dipole transtition-Heiter London theory-Atomic and molecular hybrid orbitals-Hartree-Fock equations-Method of self -consistent field

Unit II: MICROWAVE SPECTROSCOPY

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 - Hyperfine structure and quadrupole moment of linear molecules - Microwave spectrometer-Instrumentation

Unit-III: INFRARED SPECTROSCOPY

The vibrating diatomic molecule-the energy of a diatomic molecule-Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- 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 - Interpretation of vibrational spectra

Unit -IV: RAMAN SPECTROSCOPY

Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy.

Unit-V: UVSPECTROSCOPY

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Colour in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications.

TEXT BOOKS

1. Collin N Banwell and Mc Cash: Fundamentals of molecular spectroscopy 4th Edn-TMH
2. G. Aruldas: Molecular structure and spectroscopy -prentice hall
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
4. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers.
5. B P Straughn & S Walker: Spectroscopy volume1-Chapman and Hall

REFERENCE BOOKS

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.

WEB-RESOURCES-

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee
4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

ELECTIVE COURSE-VII

GLOBAL WARMING & CLIMATE CHANGE

COURSE CODE: 24PPH219

CONTACT HOURS / WEEK: 04 **CREDITS: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course student will be able to:

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO1**	Understand the causes, effects and solutions for different environmental problem	K1-K5
Unit 2	**CO2**	Analyze the climatological pattern, changes, and their effect on the earth.	K1-K5
Unit3	**CO3**	Acquire knowledge about global warming and its effects.	K1-K5
Unit4	**CO4**	Understand the main aspects of climate and how it is affected due to various anthropogenic activities.	K1-K5
Unit5	**CO5**	Demonstrate the potential social, economic, and environmental consequences of climate change and the action plans involved in its mitigation.	K1-K5

K1-Remember; K2-Understand;K3-Apply; K4-Analyze; K5-Evaluate;

Syllabus

UNIT I: Climatology

Definition- Types – Physical, Regional & Applied, Climate Classification – Empirical, Genetic & Applied. Geographical Classification – Tropical Zone, Temperature& Polar Zone. Koppen's Climate Classification. World Classification Based on Climate Profile

UNIT II: Causes for Climate Change & Green House Gases

Definition of Climate Change – Causes and Impacts of Climate Change- Green House Gases (Sources, Effects)- Role of Oceans and Forests as Carbon Sinks, Stratospheric Ozone Shield and Ozone depletion. Effect of Climate Change on Weather and Climatic Patterns, Ice Caps, Glaciers, Agriculture, Biodiversity, Sea Level, Tourism

UNIT III: Global warming

Global Temperature, Influence of Green House Gases on Global Warming, Intergovernmental Panel on Climate Change (IPCC), Projections for Future Climate Change. Extreme Climate Events and Vulnerability

UNIT IV: Mitigation Strategies

Importance of Climate Mitigation– Renewable Energy- Green Building, Energy Efficiency, Reducing Consumption, Low Carbon Development Sectors with High Mitigation Potential. Emission Trading & Carbon Credits

UNIT V: Action Plans on Climate Change

National and International Action Plan, Policies, Protocols and Agreements. United Nation Framework Convention on Climate Change (UNFCCC) - The Kyoto Protocol. MontrealProtocol. Overview of Conference of Parties (CoP). Highlights of Key Issues for Future Climate Change Regime.

REFERENCE BOOKS:

1. Climate Change and Biodiversity: Perspectives and Mitigation Strategie Prabha Shastri Ranade, (2008), ICFAI University press,
2. Environmental Science: Earth as a Living Planet. Botkin, Daniel B. and Keller, Edward A. (2007), 6th ed. John Wiley &Sons,USA.
3. Climate Change: A Multidisciplinary Approach. Burroughs, W.J. (2007), 2nd ed. Cambridge University Press. 2007.
4. The Global Environment in the Twenty-First Century -Prospects for International Co operation. Chasek, P. S. (2004), Indian Reprint by Manas Publications, New Delhi.
5. Climate Change: Scenario, Strategies and Solutions. Claussen, E. ed. (2001), Arlington VA.
6. Climate Change-An Indian Perspective. Dash, S. K. (2007), Centre for Environment Education and Cambridge University Press Pvt. Ltd., New Delhi.

7. Earth Summit. Dodds, F. (ed.). (2002), A New Deal. Earthscan Publications Ltd., UK.
8. Environmental Science: A Study of Interrelationships. Enger, E.D. and Smith, B. F.(2006),11th ed. McGraw Hill Inc., USA. 2006.
9. Climate Change: Causes, Effects, Solutions. Hardy, John T. (2003),Wiley& Sons, USA.
10. Global Environmental Issues. Harris, F. (2004),Wiley& Sons, Inc., USA.
11. Global Warming: The Hard Science. Harvey L. D. D. (2000),NY: PrenticeHall.IPCC, Emission Scenarios, Inter Governmental Panel on Climate Change, Cambridge University Press, 2000.

WEB RESOURCES

- climate.nasa.gov/
- www.ucsusa.org
- www.eesi.org
- www.climate.gov
- www.renewableenergyworld.co
- http://nca2014.globalchange.gov.
- http://rhg.com/wpcontent/uploads/2014/06/RHG_AmericanClimateProspectus_June2014_LowRes1.pdf.
- http://www.unc.edu/~jjwest/ClimateCourse-Syllabus_2015.pdf

CORE COURSE IV - QUANTUM MECHANICS

COURSE CODE: 24PPH104

CONTACT HOURS: 05 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

UNIT	CO.No.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit:1	**CO1**	Understand quantum mechanics' formalism and foundational principles.	K1-K5
Unit:II	**CO2**	Analyze quantum systems through energy eigenvalue problems.	K1-K5
Unit:III	**CO3**	Apply advanced quantum formalisms and representation techniques.	K1-K5
Unit:IV	**CO4**	Analyze quantum systems using advanced approximation techniques and theoretical frameworks.	K1-K5
Unit:V	**CO5**	Analyze and apply theoretical concepts of angular momentum, spin, and wave function symmetry.	K1-K5

Syllabus

Unit I: BASIC FORMALISM

Interpretation of the wave function - Normalized and orthogonal wave functions-Time-dependent Schrödinger equation-Time-independent Schrödinger equation-Stationary states-Ehrenfest's theorem- Linear vector space- Eigen functions and Eigenvalues- Hermitian Operator- Postulates of Quantum Mechanics- General Uncertainty relation- Expectation value of dynamical quantities.

Unit II: ONE AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator.

Unit III: GENERAL FORMALISM

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

Unit IV: APPROXIMATION METHODS

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy

levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator

Unit V: ANGULAR MOMENTUM

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

TEXT BOOKS:

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, J. Pandhyopathyay, Quantum Mechanics, McGraw Hill, New Delhi, 2017.
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. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.

REFERENCE BOOKS:

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.

E material

1. http://www.feynmanlectures.caltech.edu/III_20.html
2. www.nptel.ac.in/courses/112105051
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

CORE COURSE V - ELECTROMAGNETIC THEORY

COURSE CODE: 24PPH105
CONTACT HOURS: 04 **CREDIT: 4**
INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course student will be able to:

UNITS	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-I	**CO1**	Understand Coulomb's Law, Gauss's Law, electrostatic potential, and energy density in electrostatic fields.	K1-K5
Unit-II	**CO2**	Explain the magnetic vector potential and the magnetic field of a localized current distribution.	K1-K5
Unit-III	**CO3**	Apply Maxwell's equations to analyze wave equations and solve for plane wave solutions in different gauges, including Coulomb and Lorentz gauges.	K1-K5
Unit-IV	**CO4**	Analyze the wave equation, retarded potentials, and how waves move in different media, including conducting and non-conducting environments.	K1-K5
Unit-V	**CO5**	Evaluate wave propagation, reflection, refraction, and transmission in different media, using Fresnel's equations and total internal reflection.	K1-K5

Syllabus

UNIT I: ELECTROSTATICS AND POLARISATION:

Coulomb's law - Gauss's law in differential form - Poisson's equation - Laplace's equation – Work and energy in electrostatics – Energy of a point charge distribution – Dielectrics – Induced dipoles – Gauss's Law in the presence of dielectrics.

Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT II: MAGNETOSTATICS

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.

UNIT III: MAXWELL EQUATIONS

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 PROPAGATION

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: ELEMENTARY PLASMA PHYSICS

The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magneto sonic waves.

TEXT BOOKS:

1. D.J. Griffith Introduction to Electrodynamics (Pearson, Newyork,2013)
2. Electromagnetic theory and Electrodynamics, Sathya Prakash. Kadernath
3. Electromagnetic Theory, K.K. Chopra, G.C. Agarwal, K. Nath &Co., Meerut,
4. A.K. Saxena, Electromagnetic Theory and Applications (Narosa Publications)
5. http://nptel.ac.in/courses/108104087

REFERENCE BOOKS

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.

WEB RESOURCES

1. https://www.Sciencedirect.com>ele...
2. https://elearn.nptel.ac.in>nptel>e...
3. https://sist.sathyabama.ac.in>...
4. https://archive.nptel.acin>courses

CORE COURSE VI - ADVANCED MATHEMATICAL PHYSICS

COURSE CODE: 24PPH106
CONTACT HOURS: 5 **CREDIT: 4**
INTERNAL MARKS: 25 **EXTERNAL MARKS: 75**

COURSE OUTCOMES:

Unit	CO. No.	Upon completion of this course, the students will be able to	Cognitive Level
UNIT 1	**CO1**	Understand basic concepts of vector space, orthogonalityof vector, vector space, linear operators	K1 -K5
UNIT 2	**CO2**	Understand and apply the concept of ordinary differential equations, boundary value problems.	K1 - K5
UNIT 3	**CO3**	Apply the concept of Hyper geometric functions & series	K1 - K5
UNIT 4	**CO4**	Analyze the concepts of group theory.	K1 - K5
UNIT 5	**CO5**	Evaluate the concepts of probability.	K1 - K5

SYLLABUS

UNIT-I LINEAR VECTOR SPACE:

Definiton of linear vector space – Examples – Linear independence – Basis and dimensions of a vector space – Scalar product – Schwartz Inequality – Orthogonality of vectors – Linear transformations – Linear operator – Matrix representation of a linear operator.

UNIT-II ORDINARY DIFFERENTIAL EQUATIONS

Methods of finding solutions of first and second order ordinary differential equations (ODEs) with constant coefficients – initial value and boundary value problem – Methods of finding solutions –Superposition principle – Wronskian –Defintion of ordinary and singular points of second order ODEs – Power series solution – Examples – Solutions about ordinary point and singular point in power series

UNIT-III HYPER GEOMETRIC FUNCTION:

Hypergeometric series – Elementary properties of Hypergeometric function – Integral representation of Hypergeometeric function – Solution of Hypergeometric differential equation – Confluent Hypergeometric function.

UNIT 1V: GROUP THEORY:

Definition of group theory –Group table – Sub Group – Classes – SU(2)-SU(3) Group-Isomorphism and Homorphism – Schur's Lemma – Orthogonality therorm – The character of

representation – Reducible and Irreducible - Formation of character table – Point Groups – Elementary ideas of rotation Groups.

UNIT – V PROBABILITY:

Definition – Addition rule of probability – Multiplication law of probability – Probability distribution – Binomial distribution – The first four moments of Binomial distribution – Poisson distribution – Normal distribution – The first four moments of Poisson and Normal distribution – Applications of Binomial, Poisson and Normal distributions – Central limit theorem.

TEXT BOOKS:

1. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
2. Sathya Prakash, *Mathematical Physics*, Sultan chand & sons, New Delhi.
3. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
4. P.K. Chattopadhyay, 2014, Mathematical Physics (3rd Revised edition), New Age, New Delhi.
5. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt.Ltd., India
6. B. D. Gupta, 2010, Mathematical Physics (4th edition),Vikas Publishing House, New Delhi.

REFERENCE BOOKS

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 E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated EastWest, New Delhi.
5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6th Edition, International Edition, McGraw-Hill, New York

WEB SOURCES

1. https://youtu.be/LZnRlOA1_2I
2. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
3. .https://nptel.ac.in/course/115105097
4. .https://nptel.ac.in/course/115103036

CORE LAB II

ANALOG & DIGITAL ELECTRONICS LAB

COURSE CODE-24PPH302
CONTACT HOURS: 4 **CREDIT: 2**
INTERNAL MARKS: 40 **XTERNAL MARKS: 60**

Course Outcomes: At the end of the course the student will be able to:

CO. No.	Upon completion of this course, the students will be able to	Cognitive Level
CO2	Design and verify amplifier, oscillator, waveform generator, and multivibrator circuits using op-amps and IC 555.	**K6**
CO3	Implement and analyze digital circuits including flip-flops, shift registers, and counters using logic ICs.	**K4**
CO4	Design and verify code converters, display circuits, arithmetic circuits, and ALU operations using digital ICs.	**K6**
CO5	Analyze the operation of data conversion circuits such as A/D and D/A converters and evaluate their performance.	**K5**

LIST OF EXPERIMENTS:

1. Design and verify the operation of FET Amplifier
2. BCD to 7 segment display.
3. A stable and monostable multivibrators using IC 555.
4. Characteristics of UJT.
5. Characteristics of SCR.
6. Characteristics of LDR.
7. Design and study of Wein bridge oscillator using op-amp.
8. Design and study of square and triangular waves generators using op-amp.
9. V-I characteristics of a solar cell.
10. Operation of shift register using serial-in serial-out, serial-in parallel-out and parallel-in serial-out.
11. Digital to analog converter - R-2R Ladder and Binary weighted method.
12. Study of A/D converter - Counter ramp type method.

12. Flipflops using NOR Gates.
13. Study of R-S, Clocked R-S and D-Flip-flop using NAND gates.
14. Study J-K, Dand T Flip-Flop using IC7476/7473.
15. Arithmetic operations using IC 7483-4-bit binary addition and subtraction.
16. Study of Arithmetic logic unit using IC 74181.
17. IC 7490 as scalar and seven segment display using IC 7447.
18. BCD to Excess-3 and Excess-3 to BCD code conversion.
19. Shift register and ring counter and Johnson counter-IC 7476/IC 7474
20. Study of binary up/down counters- IC 7476/IC 7473

REFERENCES:

1. J. Millman and C. C. Halkias, Electronic Devices and Circuits (McGraw Hill, New Delhi, 1985).
2. G. Kennedy, Electronic Communication Systems (McGraw Hill, New Delhi, 1994).
3. D. R. Choudhury and S. Jain, Linear Integrated circuits (New Age International, New Delhi, 2001)
4. V. Vijayendran, Digital Fundamentals, Viswanathan Printers & Publishers,2009.
5. Dr. S.S. Sharma, Advanced Practical Physics-Vol-II, (Ratan Prakashan Mandir,Agra).
6. K. A. Navas, Electronics Lab Manual, Volume I&II (Rajat Publications, New Delhi, 2015).
7. M. N. Avadhanulu, A. A. Dani and P. M. Pokley, Experiments in Engineering Physics (S. Chand, New Delhi, 1999).

CORE LAB III - COMPUTATIONAL PROGRAMMING LAB

COURSE CODE: 24PPH303
CONTACT HOURS: 4 **CREDIT: 2**
INTERNAL MARKS: 40 **EXTERNAL MARKS: 60**

Course Outcomes: At the end of the course the student will be able to:

CO No.	Course Outcome	K Level
CO1	Understand the fundamental concepts of numerical methods and computational techniques.	**K2**
CO2	Apply numerical methods to solve algebraic equations, interpolation, and integration problems.	**K3**
CO3	Implement algorithms and flowcharts to solve differential equations and linear systems using computational tools.	**K3**
CO4	Analyze numerical data using statistical methods, random number generation, and curve fitting techniques.	**K4**
CO5	Evaluate and interpret computational results for scientific and physical problems.	**K5**

EXPERIMENTS: (Minimum of Twelve Experiments from the list)

1. Least-square curve fitting- Straight-line fit.
2. Least-square curve fitting-Exponential fit.
3. Real roots of one-dimensional nonlinear equations –Newton Raphson method.
4. Complex roots of one-dimensional nonlinear equations-Newton Raphson method
5. Interpolation-Lagrange method.
6. Numerical integration – Composite trapezoidal rule.
7. Numerical integration – Composite Simpson's 1/3 rule.
8. Solution of a second order ODE –Euler method.
9. Solution of a first order ODE-Fourth-order-Runge Kutta method.
10. Finding Roots of a Polynomial - Bisection Method.
11. Calculation of mean and standard deviation of a set of uniform random numbers.
12. Computation of eigenvalues of linear harmonic oscillator by numerically solving Schrodinger equation.

13. Numerical integration by Newton's cotes formula with Algorithm, Flow chart and output.
14. Gaussian random number generation –Box and Muller method.
15. Solution of Simultaneous Linear Equation by Gauss elimination method.

TEXT BOOKS

1. Numerical methods in Science and Engineering - M.K. Venkataraman, National Publishing Co. Madras, 1996
2. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice-Hall, New Delhi.
3. V. Raja Raman, Programming in C++, PHI, New Delhi.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Ed. New Age International, New Delhi.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, New Delhi.

REFERENCE BOOKS

1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw-Hill).
2. B.F. Gerald and P.O. Wheately, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.
3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York.
4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison - Wesley, London.
5. Stroustrup, Programming: Principles and Practice Using C++ (Addison Wesley, Massachusetts, 2014).

ELECTIVE-NUMERICAL METHODS AND C++ PROGRAMMING

Course Code: 24PPH202

Contact Hours: 4 **Credit: 4**

Internal Marks: 25 **External Marks: 60**

Course Outcomes:

UNIT	CO. NO.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Understand and solve nonlinear equations using numerical methods	K1 – K5
UNIT II	**CO2**	Analyze and solve linear systems using matrix methods	K1 - K5
UNIT III	**CO3**	Apply interpolation, curve fitting, and numerical integration methods.	K1 - K5
UNIT IV	**CO4**	Understand C++ fundamentals, object-oriented concepts, and control structures.	K1 - K5
UNIT V	**CO5**	Apply C++ features: encapsulation, polymorphism, inheritance, and file handling.	K1 - K5

Syllabus

UNIT I: SOLUTIONS OF EQUATIONS

Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods – Convergence of solutions in Bisection and Newton-Raphson methods

UNIT II: LINEAR SYSTEM OF EQUATIONS

Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations –Jacobi Method to find the Eigen values and Eigen vectors

UNIT III: INTERPOLATION AND NUMERICAL INTEGRATION

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. Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule(1/3), Euler and Solution of first order differential equation using Runga Kutta methods.

UNIT IV: FUNDAMENTAL OF C++ LANGUAGE

Object Oriented Programming paradigm – Benefits of OOP – Applications of C++ - Structure of C++ program –Tokens: keywords identifiers and constants –Basic data type – User defined data types – Scope resolution operator. Control structures: Decision making with simple if – if-else – nesting of if –else –switch – goto statement – looping with while – do- while- for statements –

break and continue statements – arrays-Library functions – User –defined functions.

UNIT V: SPECIAL FEATURES OF C++:

Encapsulation – Polymorphism – Classes and objects – Specifying a class – Creating objects – Accessing class members – Defining member functions–Friendly functions – Constructors-Destructors –Function overloading-Operator overloading — Overloading binary operators - Rules for overloading operators- Derived classes-Inheritance –Files.

TEXT BOOKS

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, 3rd Edition, New Age Intl., New Delhi
3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, New Delhi
4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York

REFERENCE BOOKS

1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,)
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, New York.
4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley.

ELECTIVE- II
MEDICAL PHYSICS

COURSE CODE: 24PPH205
CONTACT HOURS/WEEK: 04 **CREDIT: 04**
INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit I	**CO1**	Learn the fundamentals, production and applications of X-rays.	K1-K5
Unit II	**CO2**	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	K1-K5
Unit III	**CO3**	Apply knowledge on Radiation Physics	K1-K5
Unit IV	**CO4**	Analyze Radiological imaging and filters	K1-K5
Unit V	**CO5**	Assess the principles of radiation protection	K1-K5

SYLLABUS

UNIT I: X-RAYS AND TRANSDUCERS

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

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

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

UNIT IV: MEDICAL IMAGING PHYSICS

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

UNITV: RADIATION PROTECTION

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

TEXT BOOKS

1. K. Thayalan, Basic Radiological Physics (2nd Ed), Jaypee Brothers Medical Publishers, New Delhi, (2017)
2. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology: - LippincotWilliams and Wilkins, 1990.
3. Faiz M. Khan & John P. Gibbons, The Physics of Radiation Therapy (4th Ed), Lippincott Williams & Wikins, Philadelphia, (2010)
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.

REFERENCE BOOKS

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, 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

1. https:nptel.ac.in/courses/108/103/108103157/
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/

ELECTIVE – II

CHARACTERIZATION OF MATERIALS

COURSE CODE: 24PPH208

CONTACT HOURS / WEEK: 04 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

UNIT	CO. No.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit:1	**CO1**	Understand X-ray and spectroscopic techniques for comprehensive material characterization.	K1-K5
Unit:II	**CO2**	Utilize optical microscopy methods and image analysis tools to study material microstructures.	K1-K5
Unit:III	**CO3**	Analyze nanoscale material properties using advanced microscopy techniques like SEM, TEM, STEM, and AFM.	K1-K5
Unit:IV	**CO4**	Understand and apply thermal analysis techniques (TGA, DTA, DSC) for determining weight loss, decomposition, specific heat capacity, and thermo mechanical parameters.	K1-K5
Unit:V	**CO5**	Apply electrical and optical characterization methods (two-probe, four-probe, Hall effect, C-V profiling, photoluminescence) to assess material and device properties.	K1-K5

SYLLABUS

UNIT I: X-RAY AND SPECTROSCOPIC METHODS

Introduction-Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses. Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy

UNIT II: MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy

UNIT III: ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

Introduction-SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Scanning tunnelingmicroscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.

UNIT IV: THERMAL ANALYSIS

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves –

differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.

UNITV: ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

TEXT BOOKS

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).

REFERENCE BOOKS

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).
5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)

WEB SOURCES

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization

TECHNOLOGICAL ADVANCES IN MODERN PHYSICS DISCOVERIES

COURSE CODE: 24PAB401

CONTACT HOURS / WEEK: 2 **CREDIT: 1**

INTERNAL MARKS: 25 **EXTERNAL MARKS: 75**

Course Outcomes: At the end of the course the student will be able to:

UNIT	CO. No.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Understand the different categories in which the Nobel Prizes are awarded.	K1 – K5
UNIT II	**CO2**	Grasp the theoretical underpinnings of gravitational waves and the key technological advancements that have enabled their detection.	K1 - K5
UNIT III	**CO3**	Gain a comprehensive understanding of the development and impact of advanced telescopes and observational technologies in modern astronomy.	K1 - K5
UNIT IV	**CO4**	Analyze the progress and implementation of superconducting materials and magneto resistive technologies in contemporary scientific and technological fields.	K1 - K5
UNIT V	**CO5**	Evaluate the development and applications of ultrafast lasers, high- intensity laser physics, and Nobel-winning contributions to photonics	K1 - K5

SYLLABUS

UNIT 1: HISTORY OF THE NOBEL PRIZE:

Founding of the Nobel Prize- Categories of the Nobel Prize- Impact of the Nobel Prize-Nobel Prize Ceremonies- Nobel Prize in the 21st Century- Nobel Prize and Public Engagement.

UNIT 2: GRAVITATIONAL WAVES AND COSMOLOGY

Detection of gravitational waves: Theoretical foundation and technological milestones-Role of laser interferometry in astrophysics- Nobel-winning advancements in LIGO and Virgo collaborations.

UNIT 3: INNOVATIONS IN OBSERVATIONAL ASTRONOMY

Development of advanced telescopes and observational technologies- Cosmic microwave background radiation detection and its significance-Imaging black holes and advancing high-resolution astronomy.

UNIT 4: ADVANCEMENTS IN SOLID-STATE AND CONDENSED MATTER PHYSICS

Contributions to superconductivity and magnetoresistance- Development of advanced imaging and nanoscale technologies- Applications in quantum materials and spintronics.

UNIT 5: FRONTIERS IN LASER AND PHOTONIC TECHNOLOGIES

Development and applications of ultrafast lasers-High-intensity laser physics and its role in material sciences- Nobel-winning contributions to photonics.

REFERENCE BOOKS

1. The Nobel Prize: The Story of Alfred Nobel and the Most Famous Prize in the World by Michael Worek.
2. Quantum Physics: What Everyone Needs to Know by Michael Raymer.
3. Gravitational Waves: How Einstein's Spacetime Ripples Reveal the Secrets of the Universe by Brian Clegg.
4. Lasers: Principles and Applications by K.R. Nambiar.
5. Modern Cosmology by Scott Dodelson.
6. Condensed Matter Physics by Michael P. Marder.

CORE COURSE

CONDENSED MATTER PHYSICS

COURSE CODE: 24PPH107
CONTACT HOURS/WEEK: 5 **CREDIT: 4**
INTERNAL MARKS: 25 **EXTERNAL MARKS: 75**

Course Outcomes: At the end of the course the student will be able to:

Units	CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-1	**CO1**	Understand and describe crystal structures and reciprocal space.	K1-K5
Unit- 2	**CO2**	Explain electronic band structures using tight-binding and nearly free electron models.	K1-K5
Unit- 3	**CO3**	Analyze lattice vibrations and phonons.	K1-K5
Unit- 4	**CO4**	Understand Fermi surfaces and electron dynamics in metals.	K1-K5
Unit- 5	**CO5**	Understand superconductivity and BCS theory.	K1-K5

SYLLABUS

UNIT I: CRYSTAL PHYSICS

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law — Bravais Lattices- Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - - Atomic form factor - Structure factor- Scattered Wave Amplitude - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT II: LATTICE DYNAMICS

Lattice with one and two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons – Einstein’s and Debye’s theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.

UNIT III: THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

UNIT IV: MAGNETISM

Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.

UNIT V: SUPERCONDUCTIVITY

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Type I and II Superconductors.

Theoretical Explanation: Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory –Single particle tunneling - Josephson tunneling - DC and AC Josephson effects – SQUIDS- High temperature Superconductors

TEXT BOOKS:

1. S.O. Pillai, *Solid State Physics*. Narosa Publications.
2. A.J. Dekker, *Solid State Physics*. Macmillan India, New Delhi.

REFERENCE BOOKS

1. C. Kittel., (2019). *Introduction to Solid State Physics*. Wiley, New Delhi.
2. N.W. Ashcroft., & N.D. Mermin, *Solid State Physics*. Holt-Saunders (Indian Edition).
3. S.L. Gupta., & V. Kumar, (2000). *Solid State Physics*. Kedar Nath Ram Nath, Meerut.

ADVANCED QUANTUM MECHANICS

COURSE CODE: 24PPH108

CONTACT HOURS / WEEK: 05 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

Units	CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-1	**CO1**	Understand and apply the crucial concepts of scattering theory such as partial wave analysis and Barn approximation.	K1-K5
Unit- 2	**CO2**	Analyze time-dependent perturbation theory and its applications in radiation and transition probabilities.	K1-K5
Unit- 3	**CO3**	Apply relativistic quantum equations and interpret electron spin and antiparticle concepts.	K1-K5
Unit- 4	**CO4**	Examine Dirac formalism, gamma matrices, and relativistic invariance of quantum systems.	K1-K5
Unit- 5	**CO5**	Understand and apply classical field theory and quantize scalar fields using second quantization.	K1-K5

K1-Remember; K2-Understand; K3-Apply; K4-Analyze; K5-Evaluate;

Syllabus

UNIT 1: SCATTERING THEORY

Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for s wave – Optical theorem – Transformation from centre of mass to laboratory frame.

UNIT II: TIME DEPENDENT PERTURBATION THEORY:

Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation

UNIT III: RELATIVISTIC QUANTUM MECHANICS:

Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron – Magnetic Moment of an Electron Due to Spin

UNIT IV: DIRAC EQUATION:

Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman's theory of positron (Elementary ideas only without propagation formalism)

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION:

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

TEXT BOOKS:

1. P. M. Mathews, & K. Venkatesan. (2010). *A Textbook of Quantum Mechanics* (2nd ed., 37th reprint). Tata McGraw-Hill, New Delhi.
2. G. Aruldhas. (2009). *Quantum Mechanics* (2nd ed.). Prentice Hall of India, New Delhi.
3. N. Zettili. (2017). *Quantum Mechanics: Concepts and Applications* (2nd ed.). Wiley.
4. L. I. Schiff. (1968). *Quantum Mechanics* (3rd ed., International Student Edition). McGraw-Hill Kogakusha, Tokyo.
5. S. Prakash. *Advanced Quantum Mechanics* (5th ed.). A Pragati Edition, Kedarnath Ramnath Publisher.

REFERENCE BOOKS:

1. D. J. Griffiths. (2011). *Introduction to Quantum Mechanics* (4th ed.). Pearson.
2. A. Ghatak, & S. Lokanathan. (1984). *Quantum Mechanics: Theory and Applications* (4th ed.). Macmillan, India.
3. E. Merzbacher. (1998). *Quantum Mechanics* (2nd ed.). John Wiley and Sons, New York.
4. L. D. Landau, & E. M. Lifshitz. (1981). *Quantum Mechanics: Non-Relativistic Theory* (3rd ed.). Pergamon Press, Oxford.
5. J. D. Bjorken, & S. D. Drell. (1964). *Relativistic Quantum Mechanics*. McGraw-Hill International Edition.

Web Resources

1. MIT OpenCourseWare. (2013). *Quantum Physics II: Lecture Notes, Chapter 9*. Retrieved May 21, 2025, from https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture-notes/MIT8_05F13_Chap_09.pdf
2. Feynman, R. P. *The Feynman Lectures on Physics, Volume III, Chapter 20*. Retrieved May 21, 2025, from https://www.feynmanlectures.caltech.edu/III_20.html
3. MIT Physics Department. *Handout on Quantum Mechanics*. Retrieved May 21, 2025, from https://web.mit.edu/8.05/handouts/jaffe1.pdf
4. Manchester University. *Quantum Mechanics Lecture Notes, Chapter 3*. Retrieved May 21, 2025, from https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf
5. Haywood, R. *Group Theory Lectures: Lecture 1*. Retrieved May 21, 2025, from https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf

THERMODYNAMICS AND STATISTICAL MECHANICS

COURSE CODE: 24PPH109

CONTACT HOURS/WEEK: 5 **CREDIT: 4**

INTERNAL MARK: **25** **EXTERNAL MARK: 75**

COURSE OUTCOMES: At the end of the course, student will be able to

Units	CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT-I	**CO1**	Understand and apply the laws of thermodynamics, interpret microstates and macrostates, and explain the concept of ensembles and equilibrium in statistical systems.	K1-K5
UNIT-II	**CO2**	Analyze microcanonical ensembles and relate statistical mechanics to thermodynamic properties such as entropy, including resolving paradoxes like Gibbs paradox.	K1-K5
UNIT-III	**CO3**	Utilize canonical and grand canonical ensembles to calculate partition functions and derive thermodynamic quantities, including fluctuations in energy and density.	K1-K5
UNIT-IV	**CO4**	Distinguish between classical and quantum statistics, and apply Fermi-Dirac and Bose-Einstein statistics to systems like ideal gases and blackbody radiation.	K1-K5
UNIT-V	**CO5**	Examine real gas behavior using cluster expansions and virial equations, and explore fluctuations, Ising models, and transport phenomena such as Brownian motion.	K1-K5

SYLLABUS

UNIT 1: EQUILIBRIUM THERMODYNAMICS

Review of Laws of thermodynamics and thermodynamic potentials – Microstates and Macrostates of classical and quantum systems – Phase space – μ-space and Γ-space – Density

of states – Expression for density of states in energy space and momentum space – Introduction to Ensembles – Ensemble average – Principle of a priori probability – Thermodynamic probability – Boltzmann entropy relation- Liouville's theorem – Equilibrium solutions.

UNIT II: STATISTICAL MECHANICS AND THERMODYNAMICS

Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT III: CANONICAL AND GRAND CANONICAL ENSEMBLES

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

UNIT IV: CLASSICAL AND QUANTUM STATISTICS

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

UNIT V: REAL GAS, ISING MODEL AND FLUCTUATIONS

Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one dimension. Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion.

TEXT BOOKS

1. S. K. Sinha. (1990). *Statistical Mechanics*. Tata McGraw Hill, New Delhi.
2. F. Reif. (1965). *Fundamentals of Statistical and Thermal Physics*. McGraw-Hill, New York.
3. R. K. Pathria. (1996). *Statistical Mechanics* (2nd ed.). Butterworth-Heinemann, New Delhi.

REFERENCE BOOKS

1. L. D. Landau, & E. M. Lifshitz. (1969). *Statistical Physics*. Pergamon Press, Oxford.
2. K. Huang. (2002). *Statistical Mechanics*. Taylor and Francis, London.
3. W. Greiner, L. Neise, & H. Stöcker. *Thermodynamics and Statistical Mechanics*. Springer Verlag, New York.

4. A. B. Gupta, & H. Roy. (2002). *Thermal Physics*. Books and Allied, Kolkata.

WEB-RESOURCES

1. https://youtu.be/xT5SWnbdgTo
2. https://youtu.be/Ish6pFp3w2g
3. https://youtu.be/sCL9dovdDPo
4. https://youtu.be/QlzWNDgkJjk
5. https://youtu.be/LTh2hpmrgNk

CORE PRACTICAL

ADVANCED EXPERIMENTAL PHYSICS LAB

Contact hours/week:4 **(Practical)** **Credit: 2**

Internal Marks: 40 **External Marks: 60**

Course Outcomes: At the end of the course the student will be able to:

CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
CO1	Understand and verify the basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR) through hardware implementation.	K3
CO2	Design and implement combinational logic circuits such as multiplexers, demultiplexers, encoders, and decoders.	K6
CO3	Analyze, design, and implement sequential logic circuits like counters.	K6
CO4	Develop skills to use modern digital ICs and troubleshoot basic digital circuits.	K4
CO5	Apply theoretical digital logic concepts in practical experiments and develop an ability to design small-scale digital systems.	K3

LIST OF EXPERIMENTS

1. Determination of wavelength of the spectral lines using Iron Arc spectrum.
2. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
3. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
4. Determination of Planck Constant – LED Method.
5. Study of Binary to Gray and Gray to Binary code conversion.
6. Construction of Encoder and Decoder circuits using ICs 7404, 7432, 7410.
7. Study of synchronous parallel 4-bit binary up/down counter using IC 74193.

8. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493.
9. Study of Modulus Counter IC 7490.
10. Construction of Multiplexer and Demultiplexer using ICs 7404,7408,7432.
11. 8-bit addition and subtraction, multiplication and division using microprocessor 8085.
12. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array.
13. Sorting in ascending and descending order using microprocessor 8085.
14. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary using microprocessor 8085.
15. Addition of multi byte numbers, Factorial using microprocessor 8085.
16. Clock program- 12/24 hours-Real time application – Six Digits Hexa Decimal and Decimal Counters using microprocessor 8085
17. Interfacing of LED – Binary up/down counter, BCD up/down counter and N/2N up/down counter using microprocessor 8085.
18. Interfacing of seven segment display using microprocessor 8085.
19. Interfacing of 8-bit R / 2R ladder DAC (IC 741) – Wave form generation – Square, Rectangular, Triangular, Saw tooth and Sine waves using microprocessor 8085.
20. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action using microcontroller 8051.
21. Interfacing of Temperature Controller and Measurement using microcontroller 8051.
22. Interfacing of Traffic light controller using microcontroller 8051.
23. Study of DAC interfacing (DAC 0900)
24. Study of ADC interfacing (ADC 0809).
25. Control of stepper motor using microprocessor.

TEXT BOOKS

1. M. N. Srinivasan, S. Balasubramanian, & R. Renganathan. (2000). *A Textbook of Practical Physics*. Sultan Chand & Sons, New Delhi.

REFERENCE BOOKS

1. S. L. Gupta, & V. Kumar. *Practical Physics*. Pragati Prakashan.
2. K. A. Navas. *Electronic Lab Manual, Vol. I*. Rajath Publishing.

3. D. V. Hall. (2008). *Microprocessors and Interfacing: Programming and Hardware*. Tata McGraw-Hill Publications.
4. V. Vijayendran. (2005). *Fundamentals of Microprocessor–8085* (3rd ed.). S. Visvanathan Pvt. Ltd.

LASER THEORY AND APPLICATIONS

COURSE CODE: 24PPH211

CONTACT HOURS/WEEK: 04 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course the student will be able to:

Unit	CO. NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Understand the physical principles governing the operation of lasers, including the processes of emission and absorption of radiation.	**K1-K5**
UNIT II	**CO2**	Explain the role of population inversion, laser media, and pumping mechanisms in achieving laser action.	**K1-K5**
UNIT III	**CO3**	Differentiate laser light from ordinary light by identifying key beam properties such as coherence, directionality, and monochromaticity.	**K1-K5**
UNIT IV	**CO4**	Analyze the role of lasers in fiber-optic communication systems, including the function of optical sources and detectors.	**K1-K5**
UNIT V	**CO5**	Evaluate various industrial applications of lasers, including cutting, welding, drilling, and surface treatment.	**K1-K5**

Syllabus

Unit –I Elements of laser physics

Basic steps- Physical Principles- Spontaneous emission-stimulated emission- Absorption-Significance of Einstein Coefficients-Active material- Population inversion-Laser medium-Co-efficient of gain-Pumping and pumping schemes.

Unit –II Properties of lasers

Different beams of light-Characteristics of laser beams-Coherence-Spatial Coherence-Temporal Coherence-Relation between size of the source and Coherence of the field-Relation between Coherence and Monochromaticity-Brightness and intensity-Directionality-Monochromaticity-Focusability.

Unit –III Types of laser

Solid state laser-Ruby laser-Nd-Yag laser-Nd-glass laser-Liquid lasers-Gas lasers-colour centre lasers-Liquid lasers-Chemical lasers-X-ray lasers-Free electron lasers-Semiconductor diode lasers-Homo junction and Hetero junction laser.

Unit –IV Laser Communication

Introduction-Degradation of signal in optical fibres-Optical Sources for Fibre Optical Communication-Powering and coupling-Photo detectors-Operation of Optical receivers-Digital Transmission-Analogue Communication systems-Coherent Communication-Essential characteristics of laser in fibre optic Communication.

Unit –V Industrial Applications of lasers

Industry-high power gas lasers-Material processing with lasers-Metals and lasers-Interactions-Material processing mechanism-Hole drilling with lasers-Cutting process with lasers-laser welding-Micro laser welding-Deep penetration welding-laser hardening.

Books for study:

1. K. R. Nambiar. (2006). *Lasers: Principles, Types and Applications*. New Age International Publishers.
2. B. B. Laud. (2011). *Lasers and Non-Linear Optics* (3rd ed.). New Age International Publishers.

Web resources:

1. http://www.electrical4u.com
2. http://www.vedantu.com
3. http://www.laserax.com
4. http://www.brainkart.com

ELECTIVE COURSE

CRYSTAL GROWTH AND THIN FILM PHYSICS

COURSE CODE: 24PPH214

CONTACT HOURS/WEEK: 04 **CREDIT: 04**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course the student will be able to:

UNIT	CO NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Acquire the basic concepts, Nucleation and Kinetics of crystal growth.	K1-K5
UNIT II	**CO2**	Understand the Crystallization Principles and Growth techniques.	K1-K5
UNIT III	**CO3**	Study various methods of Crystal growth techniques.	K1-K5
UNIT IV	**CO4**	Understand the Thin film formation and thickness Measurement	K1-K5
UNIT V	**CO5**	Apply the techniques of Thin Film Formation and thickness Measurement.	K1-K5

SYLLABUS

UNIT I – CRYSTAL GROWTH KINETICS

Basic concepts, Nucleation and Kinetics of growth Ambient phase equilibrium – super saturation – equilibrium of finite phases equation of Thomson – Gibbs – Types of Nucleation – Formation of critical Nucleus – Classical theory of Nucleation – Homo and heterogeneous formation of 3D nuclei – rate of Nucleation – Growth from vapour phase solutions and melt

UNIT II – CRYSTALLIZATION PRINCIPLES

Crystallization principles and growth techniques classes of crystal system – crystal symmetry – Solvents and solutions – Solubility diagram – Super solubility – expression for super saturation – Metastable zone and introduction period – Miers TC diagram – Solution growth – Low and High temperature solution growth – Slow cooling and solvent evaporation method – Constant temperature bath as a Crystallizer.

UNIT III – GEL, MELT AND VAPOUR GROWTH

Gel, Melt and vapour techniques Principle of Gel techniques – Various types of Gel-Structure and importance of Gel – Methods of Gel growth and advantages – Melt techniques -Czochralski growth – Floating zone – Bridgman method – Horizontal gradient freeze – Flux growth – Hydrothermal growth -Vapour phase growth – Physical, vapour deposition – Chemical vapour deposition -Stoichiometry.

UNIT IV – THIN FILM DEPOSITION METHODS

Thin film deposition methods- Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF magnetron sputtering,MBE, chemical vapour deposition methods, Sol-Gel spin coating, Spray pyrolysis, Chemical bath deposition.

UNIT V – THIN FILM FORMATION AND THICKNESS MEASUREMENT

Nucleation, Film growth and structure – Various stage in thin film formation, Thermodynamics of nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin film, Roll of substrate, Roll of film thickness, Film thickness measurement – Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques**.**

Text Books

1. A. Goswami. (2008). *Thin Film Fundamentals*. New Age, New Delhi.
2. P. Santhana Raghavan & P. Ramasamy. *Crystal Growth Processes*. KRU Publications.
3. J. C. Brice. (1986). *Crystal Growth Processes*. Wiley, New York.

Reference Books

1. M. Ohara and R.C. Reid, “Modeling of Crystal Growth Rates from Solution”

Web Resources:

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

ADVANCED SPECTROSCOPY

CONTACT HOURS/WEEK: 4 **CREDIT: 4**

INTERNAL MARK: **25** **EXTERNAL MARK: 75**

Course Outcomes:

Unit	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Understand crystal structures, symmetry, and diffraction for material analysis.	K1-K5
UNIT II	**CO2**	Explain the principles of laser spectroscopy, including emission characteristics, modes, and applications	K1-K5
UNIT III	**CO3**	Interpret Mossbauer spectroscopy principles, effects, interactions, and applications in structures.	K1-K5
UNIT IV	**CO4**	Analyze XPS spectra for stoichiometry, electronic structure, and applications	K1-K5
UNIT V	**CO5**	Analyze force constants, thermodynamic properties, and molecular modeling from spectroscopy.	K1-K5

Syllabus

UNIT I: ATOMS IN EXTERNAL FIELDS AND RESONANCE SPECTROSCOPY:

Zeeman and Paschen Back Effect of one and two electron systems – selection rules – Stark effect– inner shell vacancy– X-ray– Auger transitions – Compton Effect – NMR – basic principles – classical and quantum mechanical description – spin-spin and spin-lattice relaxation times – magnetic dipole coupling – chemical shift – Knight shift – ESR – basic principles – nuclear interaction and hyperfine structure – g-factor – zero field splitting.

UNIT II: LASER SPECTROSCOPY

Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tenability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research

UNIT III MOSSBAUER SPECTROSCOPY

Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – hyperfine interactions- instrumentation-Applications: understanding molecular and electronic structures

UNIT IV: X RAY PHOTOELECTRON SPECTROSCOPY

Principle – XPS spectra and its interpretation- ECSA-EDAX- other forms of XPS – chemical

shift - Applications: - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research

UNIT V MOLECULAR MODELLING

Determination of force constants- force field from spectroscopic data-normal coordinate analysis of a simple molecule (H_2O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular modelling using data from various spectroscopic studies.

TEXT BOOKS

1. C. N. Banwell, & E. M. McCash. (1994). *Fundamentals of Molecular Spectroscopy* (4th ed.). Tata McGraw-Hill, New Delhi.
2. D. N. Satyanarayana. (2001). *Vibrational Spectroscopy and Applications*. New Age International Publication.

REFERENCE BOOKS

1. B. K. Sharma. (2015). *Spectroscopy*. Goel Publishing House, Meerut.
2. P. S. Kalsi. (2016). *Spectroscopy of Organic Compounds* (7th ed.). New Age International Publishers.

WEB SOURCES

1. Fundamentals of Spectroscopy - Course (nptel.ac.in)
2. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
3. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

SOLAR ENERGY UTILIZATION

COURSE CODE: 24PPH220

CONTACT HOURS / WEEK: 04 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

Units	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENT WILL BE ABLE TO	COGNITIVE LEVEL
Unit- 1	**CO-1**	Gain knowledge in fundamental aspects of solar energy utilization	K1-K5
Unit- 2	**CO-2**	Equipe to take up related job by gaining industry exposure	K1-K6
Unit- 3	**CO-3**	Develop entrepreneurial skills	K1-K6
Unit- 4	**CO-4**	Be skilled to approach the needy society with different types of solar cells	K1-K5
Unit- 5	**CO-5**	Gain industrialist mindset by utilizing renewable source of energy	K1-K6

K1-Remember; K2-Understand; K3-Apply; K4-Analyze; K5-Evaluate;

Syllabus

Unit I: HEAT TRANSFER

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

Unit II: SOLAR COLLECTOR

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Flat plate - Evacuated tube – Concentrated - Pool and Air collectors Construction – Function - Suitability – Comparison - Storage Tank – Solar fluids - Focusing collector systems – Thermal performance evaluation of optical loss.

Unit III: SOLAR HEATERS

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems - Integral Collector Storage System - Thermosyphon System - Open Loop, Drain Down, Drain Back, Antifreeze Systems - Refrigerant Solar Water Heaters - Solar Heated Pools - Solar Heated Hot Tubs.

Unit IV: SOLAR ENERGY CONVERSION

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

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. Industrial visit – data collection and analysis – presentation.

TEXT BOOKS:

1. G. D. Rai. (1987). *Solar Energy Utilization*. Khanna Publishers, Delhi.
2. M. Sharon, & M. Sharon. (2010). *Carbon Nanoforms and Applications*. McGraw-Hill.
3. S. A. Kalogirou. (2009). *Solar Energy Engineering: Processes and Systems*. Academic Press, London.
4. G. N. Tiwari. (2002). *Solar Energy – Fundamentals, Design, Modelling and Applications*. Narosa Publishing House, New Delhi.
5. S. P. Sukhatme. (1997). *Solar Energy*. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
6. S. P. Sukhatme, & J. K. Nayak. *Solar Energy: Principles of Thermal Collection and Storage*. Tata McGraw-Hill.

REFERENCE BOOKS:

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. 5. Duffie, J.A., Beckman, W.A., "Solar Energy Thermal Process", John Wiley and Sons,2007.

Web Resources

1. R. H. Romer, & W. H. Freeman. (1976). *Energy: An Introduction to Physics*.
2. J. A. Drife, & William. (1974). *Solar Energy Thermal Processes*.
3. J. W. Twidell, & A. D. Weir. (2005). *Renewable Energy Resources*
4. J. A. Duffie, & W. A. Beckman. (2013). *Solar Energy: Thermal Processes* (4th ed.). John Wiley and Sons.
5. J. A. Duffie, & W. A. Beckman. (2007). *Solar Energy Thermal Processes*. John Wiley and Sons.

ELECTIVE COURSE

PCB DESIGN IN SIMULATION

COURSE CODE: 24PPH603

CONTACT HOURS/WEEK:04 **CREDIT:**02

INTERNAL MARK: 40 **EXTERNAL MARK: 60**

COURSE OUTCOME

UNIT No.	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO-1**	Understand circuit creation and perform simulations using Easy EDA software.	K1–K5
Unit 2	**CO-2**	Create PCB layouts and design boards using Proteus.	K1–K5
Unit 3	**CO-3**	Design and analyze RLC circuits and various rectifier configurations.	K1–K5
Unit 4	**CO-4**	Implement clipper and clamper circuits and convert power supplies to PCB format.	K1–K5
Unit 5	**CO-5**	Design, fabricate, and test a regulated power supply and understand Phase-Locked Loop (PLL) characteristics.	K1–K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

SYLLABUS:

1. Introduction to circuit creation and simulation using Easy EDA.
2. Introduction to Layout Tool, and creating Layout board using Proteus
3. Design a RLC circuit & verify it for different values of R, L &C.
4. Design a half wave rectifier using Proteus.
5. Design a full wave centre tapped rectifier using Proteus.
6. Design a clipper circuit using Proteus.
7. Design a clamper circuit using Proteus.
8. Convert the power supply circuit into PCB.
9. Design and fabricate a PCB for Regulated power supply with filter and regulation sections.
10. Phase-Locked Loop characteristics.

TEXT BOOKS

1. P. Scherz, & S. Monk. (2016). *Practical Electronics for Inventors* (4th ed.). McGraw-Hill Education.
2. C. Schroeder. (2013). *PCB Design for Real-World Applications*. Newnes.

REFERENCE BOOKS

Labcenter Electronics. (n.d.). *Proteus in Practice: Simulation and PCB Design* [Lab Manual]. Retrieved May 21, 2025, from https://www.labcenter.com/tutorials/

WEB RESOURCES

1. EasyEDA. (n.d.). *EasyEDA Online Circuit Simulator & PCB Design Tool*. Retrieved from https://easyeda.com
2. EasyEDA. (n.d.). *EasyEDA Documentation and Tutorials*. Retrieved from https://docs.easyeda.com
3. Labcenter Electronics. (n.d.). *Proteus Design Suite – Circuit Simulation and PCB Design Software*. Retrieved from https://www.labcenter.com
4. Labcenter Electronics. (n.d.). *Proteus Tutorials*. Retrieved from https://www.labcenter.com/tutorials/
5. All About Circuits. (n.d.). *Electronics Forum, News, and Projects*. Retrieved from https://www.allaboutcircuits.com
6. Electronics-Tutorials. (n.d.). *Basic Electronics Tutorials and Circuits*. Retrieved from https://www.electronics-tutorials.ws
7. Circuit Digest. (n.d.). *Electronics Projects, Tutorials, and Circuits*. Retrieved from https://circuitdigest.com

ELECTIVE COURSE

QUANTITATIVE SKILLS FOR EMPLOYABILITY

COURSE CODE: 24PPH451

CONTACT HOURS/WEEK:02 **CREDIT:01**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

COURSE OUTCOMES

UNIT No.	CO.NO.	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO-1**	Understand and apply concepts of simplification, algebraic equations, number series, ratios, percentages, and financial mathematics.	K1-K3
Unit 2	**CO-2**	Solve problems related to time, work, speed, probability, mensuration, and data sufficiency using logical and mathematical reasoning.	K1-K4
Unit 3	**CO-3**	Analyze and solve logical reasoning problems involving series, coding-decoding, puzzles, directions, and seating arrangements.	K1-K4
Unit 4	**CO-4**	Evaluate arguments, assumptions, conclusions, and make decisions based on syllogisms, cause-effect, and critical reasoning.	K1-K4
Unit 5	**CO-5**	Interpret data accurately using various charts and graphs and apply ratio, proportion, and percentage analysis in real-life scenarios.	K1-K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

SYLLABUS:

UNIT 1 QUANTITATIVE APTITUDE – 1

Simplification and approximation – Quadratic equation -Equations of Algebra -Number series – Ratio & Proportion – Averages – Percentages - Profit, loss & discount – Simple & compound interest – Partnership – Mixture and Allegation.

UNIT 2 QUANTITATIVE APTITUDE – 2

Time & work – speed, Distance & time – Pipes & Cistern – Probability – Permutation & combination – mensuration – data sufficiency.

UNIT 3 LOGICAL REASONING – 1

Alpha numeric series, Alphabet test – Coding & decoding – Input output – Clocks – Ranking – Direction – Inequality – Blood relation – Puzzle -Seating arrangement – Tabulation.

UNIT 4 LOGICAL REASONING -2

Syllogism – Decision making – Statement and assumption – Statement and argument – statement and conclusion – course of action – cause and effect.

UNIT 5 DATA INTERPRETATION

Various type of charts for Data interpretations (DI) – table, bar chart, pie chart and line graph, Mixed DI, Missing DI, Case study, interpretation using average, ratio and proportion, percentage, boats and streams.

Books for Study

1. R. S. Aggarwal. (2018). *Quantitative Aptitude for Competitive Examinations* (Revised ed.). S. Chand Publishing, New Delhi.
2. R. Verma. (2020). *Fast Track Objective Arithmetic* (2nd ed.). Arihant Publications, New Delhi.
3. R. S. Aggarwal. (2017). *A Modern Approach to Logical Reasoning* (Revised ed.). S. Chand Publishing, New Delhi.
4. A. Sharma. (2021). *How to Prepare for Data Interpretation for CAT* (7th ed.). McGraw Hill Education, New Delhi.
5. M. K. Pandey. (2021). *Analytical Reasoning* (Revised ed.). BSC Publishing Co. Pvt. Ltd., New Delhi.

NUCLEAR AND PARTICLE PHYSICS

COURSE CODE: 24PPH110

CONTACT HOURS/WEEK: 5 **CREDIT: 4**

INTERNAL MARK: **25** **EXTERNAL MARK: 75**

Course Outcomes: At the end of the course, student will be able to

Units	CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT-I	**CO1**	Understand the nature and characteristics of nuclear forces and their role in the stability and interactions of nucleons.	K1-K5
UNIT-II	**CO2**	Analyse the fundamental concepts of nuclear structure and nuclear models including liquid drop, shell, and collective models.	K1-K5
UNIT-III	**CO3**	Apply theoretical principles to evaluate various nuclear reactions, including scattering processes, Q-values, and resonance phenomena.	K1-K5
UNIT-IV	**CO4**	Evaluate different nuclear decay mechanisms such as beta and gamma decay, and interpret related experimental data using decay theories.	K1-K5
UNIT-V	**CO5**	Assess and interpret elementary particle interactions and classification based on quantum numbers and symmetry groups SU(2), SU(3), including applications of the Standard Model.	K1-K5

SYLLABUS

UNIT I: NUCLEAR FORCES

Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.

UNIT II: NUCLEAR MODELS

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers –

angular momenta and parity of ground states – magnetic moment – electric Quadrapole moment - Bohr and Mottelson collective model – rotational and vibrational bands.

UNIT III: NUCLEAR REACTIONS

Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

UNIT IV: NUCLEAR DECAY

Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.

UNIT V: ELEMENTARY PARTICLES

Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gellmann-Nishijima formula-Quark Model. Standard model of particle physics – Higgs boson. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

TEXT BOOKS

1. D. C. Tayal. (2011). *Nuclear Physics*. Himalaya Publishing House.
2. S. Glasstone. (1968). *Source Book of Atomic Energy* (3rd revised ed.). Van Nostrand Reinhold Inc., U.S.

REFERENCE BOOKS

1. L. J. Tassie. (1973). *The Physics of Elementary Particles*. Prentice Hall Press.
2. H. A. Enge. (1974). *Introduction to Nuclear Physics*. Addison Wesley Publishing Company Inc., Reading, New York.
3. K. S. Krane. (2008). *Introductory Nuclear Physics*. John Wiley & Sons.
4. R. Roy, & P. Nigam. (1996). *Nuclear Physics*. New Age Publishers.
5. S. B. Patel. (2011). *Nuclear Physics: An Introduction*. New Age International Pvt Ltd Publishers.

WEB-RESOURCES

1. https://youtu.be/H7OipY8RzX0
2. https://youtu.be/BOO-YziUkIE
3. https://youtu.be/nDZxVR_y8BY
4. https://youtu.be/iMhDYarsfII
5. https://youtu.be/JNRKYVnrVf4
6. https://youtu.be/k16dFCdQs9I
7. https://youtu.be/jmSkyHQpTzY

ELECTIVE COURSE

PHYSICS BASED SIMULATION WITH PYTHON

COURSE CODE: 24PPH203

CONTACT HOURS/WEEK: 4 **CREDIT:4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

COURSE OUTCOMES

UNIT No.	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO-1**	Understand and apply the fundamentals of Python programming, including data types, control structures, functions, and modules.	K1-K3
Unit 2	**CO-2**	Apply least squares curve fitting and numerical integration to solve physics problems	K1-K5
Unit 3	**CO-3**	Solve linear and nonlinear equations using Gauss elimination and Newton-Raphson methods with convergence analysis	K1-K5
Unit 4	**CO-4**	Solve ODEs using Euler, Runge-Kutta, and symplectic methods for physical systems.	K1-K5
Unit 5	**CO-5**	Apply Monte Carlo methods to physical problems, evaluate randomness, and simulate systems like radioactive decay and hydrogen atom	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

SYLLABUS:

UNIT 1: PYTHON PROGRAMMING

Introduction to Python – Basic Syntax - Variable and Data Types – list, tuple, dict, and set – Operators – Conditional Statements – if, if- else, Nested if-else – Looping – for, while, Nested loops – Control Statements – break, continue, pass – String Manipulation - Basic Operations and String slices – Python Functions – Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables – Modules

UNIT 2: CURVE FITTING AND NUMERICAL INTEGRATION OF A FUNCTION

Curve fitting: Method of least-squares - Normal equations - Straight-line fit - Exponential and power law fits. Numerical integration: Newton-Cotes quadrature formula - Trapezoidal, Simpson's 1/3 and 3/8 rules - Errors in the formulas - Composite Trapezoidal and Simpson's rules - Errors in the formulas.

UNIT 3: SOLUTIONS OF LINEAR AND NONLINEAR EQUATI+ONS

Simultaneous linear equations: Gauss elimination method - Jordan′s modification - Inverse of a matrix by Gauss-Jordan method. Roots of one-dimensional nonlinear equations: Newton-Raphson method - Termination criteria - Pitfalls - Order of convergence.

UNIT 4: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

First-order equations*:* First-order Euler method - Geometric interpretation - Local and global truncation errors - Fourth-order Runge-Kutta method - Error Versus step size. Second-order equations: Euler method and Fourth-order Runge-Kutta method - Symplectic method for conservative linear harmonic oscillator and pendulum system.

UNIT 5: MONTE CARLO TECHNIQUE

Random variable and random numbers - Uniform random numbers: Mean and variance - Generation by Park-Miller method - Tests for randomness - Basic idea, features and components of Monte Carlo simulation - Description of the methods and C++ programs for the evaluation of definite integrals, estimation of π, radioactive decay and electronic distribution of hydrogen atom.

TEXT BOOKS

1. A. Downey, J. Elkner, & C. Meyers. (2015). *Learning with Python*. Dreamtech Press, New Delhi.
2. S. Taneja, & N. Kumar. (2018). *Python Programming: A Modular Approach*. Pearson India, Noida.

REFERENCE BOOKS

1. J. H. Mathews. (1998). *Numerical Methods for Mathematics, Science and Engineering*. Prentice-Hall of India, New Delhi.
2. S. Rajasekar. (2018). *Symplectic Integrators for Hamiltonian Systems*.
3. S. Rajasekar. (2022). *Monte Carlo Technique*

WEB RESOURCES

1. J. Li, & A. D. Heap. (2014). Environmental Modeling & Software, 53, 173–189. [Lecture notes]. (n.d.). Retrieved May 21, 2025, from https://www.lce.hut.fi/teaching/S-114.1100/lect_9.pdf
2. Wikibooks contributors. (n.d.). *Introduction to Numerical Methods*. Retrieved May 21, 2025, from https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods

ELECTIVE COURSE

BIO MEDICAL INSTRUMENTATION

COURSE CODE: 24PPH206

CONTACT HOURS/WEEK: 04 **CREDIT: 04**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes: At end of the course student will be able to:

Units	CO. No	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit-1	**CO1**	Understand the generation and behavior of various sensing and measurement devices of electrical origin.	K1-K5
Unit- 2	**CO2**	Understand the Bio potential recorders.	K1-K5
Unit- 3	**CO3**	Comprehend the functioning and setup of bio-potential recorders such as ECG, EEG, and ERG.	K1-K5
Unit- 4	**CO4**	Explain the medical assistance/techniques and therapeutic equipments.	K1-K5
Unit- 5	**CO5**	Recognize the significance of biomedical instrumentation field of study	K1-K5

SYLLABUS

UNIT – I HUMAN PHYSIOLOGICAL SYSTEMS AND BIO-POTENTIAL ELECTRODES Transport of ions through the cell membrane – Resting and action potentials – Bio-electric potentials – Design of Medical instruments – Components of the biomedical instrument system – Half cell potential –Types of electrodes –Micro electrodes – Depth and needle electrodes – Surface electrodes – Transducers – Active transducers – magnetic induction type transducers (only).

UNIT – II BIO-SIGNAL ACQUISITION AND PHYSIOLOGICAL ASSIST DEVICES Required conditions for physiological signal amplifiers – Isolation amplifiers – ECG Isolation Amplifier Circuit – Medical preamplifier design – Bio-signal analysis – Physiological Assist Devices: Pacemakers – Typical ranges of pacemaker parameters - External and implanted pacemakers (comparison) – Ventricular asynchronous pacemakers - Defibrillators – DC Defibrillator – Oxygenators – Bubble oxygenators.

UNIT – III BIO-POTENTIAL RECORDERS: Bio signal Recorders: Characteristics of the recording system – Electrocardiography (ECG) – Physiological nature of ECG waveform – ECG Recording setup - Echocardiography – Electroencephalography (EEG) – Origin of EEG – Simple block diagram of EEG recording setup – Electroretinography (ERG).

UNIT – IV OPERATION THEATRE EQUIPMENT: Surgical diathermy- Shortwave diathermy – Ventilators – Pressure limited ventilators – Anesthesia machine – Blood flow meters – Electromagnetic blood flowmeter – Cardiac Output measurements – Fick's method – Spirometer – Gas analyzers – Infrared CO2 analyzer – pH meter – Oxymeters.

UNIT – V SPECIALIZED MEDICAL EQUIPMENTS: Blood Cell counters – Automatic blood cell counter – Digital thermometer – Audiometers – X-rays tube – X-ray machine – Angiography – Bio-telemetry – Elements of Biotelemetry system – Design of Bio-telemetry system – Physiological 59 effects of 50Hz current passage – Micro shock and macro shock – Magnetic Resonance Imaging – principle – MRI Instrumentation.

Text Books:

1. M. Arumugan. (1992). *Biomedical Instrumentation*. Anurada Agencies, Chennai.

Reference Books:

1. R. S. Khandpur. (2014). *Handbook on Biomedical Instrumentation*. McGraw Hill, New Delhi.
2. J. G. Webster, & A. J. Nimunkar. (1999). *Medical Instrumentation: Application and Design*. Wiley, Singapore.
3. L. Cromwell, F. J. Weibell, & E. A. Pfeiffer. (2016). *Biomedical Instrumentation and Measurements*. Pearson, New Delhi.
4. J. J. Carr, & J. M. Brown. (2001). *Introduction to Biomedical Equipment Technology*. Pearson, New Delhi.

Web Sources:

1. https://nptel.ac.in/courses/108105101
2. https://nptel.ac.in/courses/102105090

ANALYSIS OF CRYSTAL STRUCTURE

COURSE CODE: 24PPH209
CONTACT HOURS / WEEK: 04 **CREDIT: 04**
INTERNAL MARKS: 40 **EXTERNAL MARKS: 60**

Course Outcomes: At the end of the course the student will be able to

UNIT	CO,NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Understand the principles of X-ray generation, types of radiation, safety protocols, and components of X-ray instruments such as diffractometers and detectors.	K1-K5
UNIT II	**CO2**	Apply Bragg's law and diffraction concepts to analyze crystal symmetry, Miller indices, and diffraction patterns.	K1-K5
UNIT III	**CO3**	Interpret space groups, identify systematic absences, and calculate structure factors relevant to crystal structure determination.	K1-K5
UNIT IV	**CO4**	Solve and refine crystal structures using methods like direct and Patterson techniques, and critically evaluate refinement quality using statistical measures.	K1-K5
UNIT V	**CO5**	Execute the full crystallographic process from crystal selection to data collection and publication using software tools and proper data handling and ethical practices.	K1-K5

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

SYLLABUS

UNIT 1: X-RAY SOURCES, INSTRUMENTATION, AND CRYSTAL BASICS

Generation of X-rays: X-ray tubes – Characteristic and continuous radiation – Synchrotron radiation. Monochromators: Crystal monochromators – Filters – Selection of wavelength. Safety: Radiation hazards – Protective measures – Instrumentation safety protocols. Instrumentation: Components of single-crystal and powder X-ray diffractometers – Detectors – Goniometers – Cooling systems. Solids: Crystalline and non-crystalline solids – Unit cell and asymmetric unit – Bravais lattices – Seven crystal systems – Lattice types – Introduction to point groups.

UNIT 2: X-RAY DIFFRACTION AND CRYSTAL SYMMETRY

X-ray diffraction: Bragg's law – Diffraction geometry – Diffraction patterns – Ewald sphere construction – Laue conditions. Reciprocal lattice: Construction and interpretation – Real vs. reciprocal lattice. Miller indices and planes: Definition – Interplanar spacing – Indexing diffraction patterns. Symmetry elements: Translational symmetry – Glide planes and screw axes – Non-translational symmetry – Rotation axes, mirror planes, center of inversion. Point groups: Classification – Relationship with crystal systems.

UNIT 3: SPACE GROUPS AND STRUCTURE FACTORS

Space groups: Hermann-Mauguin notation – Types of space groups – Interpretation of symmetry operations in 3D – Relationship between point groups and space groups. Systematic absences: Origin and identification – Reflection conditions. Structure factors: Definition – Atomic scattering factors – Structure factor equations – Effects of symmetry on structure factors – Significance in intensity calculation.

UNIT 4: STRUCTURE SOLUTION AND REFINEMENT METHODS

The phase problem: Nature of the problem – Direct methods – Patterson methods – Use of anomalous scattering. Structure solution techniques: Interpretation of electron density maps – Locating atoms – Solving unknown structures. Refinement of crystal data: Least squares method – Refinement parameters – R-factor, wR-factor, goodness-of-fit – Thermal parameters – Difference Fourier maps. Critical evaluation of refinement: Residual electron density – Data completeness – Restraints and constraints.

UNIT 5: CRYSTALLOGRAPHIC WORKFLOW AND DATA PUBLICATION

Crystallographic experiment: Growing crystals of small molecules – Crystal selection and mounting – Data collection strategies – Data reduction and indexing. Solving crystal

structures: Software packages – SHELXT/SHELXL, Olex2, WinGX, PLATON – Visualization and analysis tools (Mercury). Publishing crystal data: Preparation of CIF files – checkCIF validation – Interpreting alerts – Submission protocols to CSD – Ethical considerations in crystallographic publication.

Textbooks:

1. B. D. Cullity, & S. R. Stock. *Elements of X-ray Diffraction*. Pearson.
2. M. F. C. Ladd, & R. A. Palmer. *Structure Determination by X-ray Crystallography*. Springer.

Reference Books:

1. G. H. Stout, & L. H. Jensen. (Year). *X-ray Structure Determination: A Practical Guide*. Wiley.
2. C. Hammond. (Year). *The Basics of Crystallography and Diffraction*. Oxford University Press.
3. J. P. Glusker, M. Lewis, & M. Rossi. (Year). *Crystal Structure Analysis*. VCH.

DIGITAL COMMUNICATION

COURSE CODE: 24PPH212
CONTACT HOURS / WEEK: 04 **CREDIT: 04**
INTERNAL MARKS: 40 **EXTERNAL MARKS: 60**
Course Outcomes: At the end of the course the student will be able to:

UNIT	CO,NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Analyze signal representation, ISI, PCM, and digital modulation schemes in the presence of noise.	K1-K5
UNIT II	**CO2**	Understand the concept of information theory and analyze the capacity and redundancy in communication systems.	K1-K5
UNIT III	**CO3**	Examine pulse modulation techniques like PAM, PWM, TDM, and PCM along with their transmission requirements and noise handling.	K1-K5
UNIT IV	**CO4**	Apply and analyze error control codes such as Hamming, BCH, RS, and Convolutional Codes.	K1-K5
UNIT V	**CO5**	Understand spread spectrum techniques including PN sequences, DSSS, FHSS, and their applications in anti-jamming and multipath environments	K1-K5

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

Syllabus

UNIT I: SIGNAL ANALYSIS

Pulse code modulation, TDM Differential PCM. Match Filter, Inter symbol interference (ISI). Baseband M-ary PAM transmission, Geometric representation of signals. Correlation Receiver, Digital modulation techniques (ASK, FSK, PSK, DPSK, and M-ray), Effect of noise on digital modulation signals.

UNIT II: INFORMATION THEORY

Communication system – Measurement of information – Coding – Bandot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel- Effects of noise- Capacity of noise in a channel – Shannon Hartley theorem –Redundancy.

UNIT III: PULSE MODULATION

Pulse amplitude modulation - natural sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM -Effects of noise –Companding – Advantages and application.

UNIT IV: ERROR CONTROL CODING

Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RS Coding, Convolutional Coding, Coding Grain Viterbi Coding.

UNIT V: FIBER OPTICS COMMUNICATIONS

System Design considerations for point-to-point links- Digital systems-Analog systems-System architecture point-to-point links- Distribution networks- Local Area networks-Non-linear effects and system performance.

REFERENCE BOOKS

1. J. Proakis. (1995). *Digital Communication* (3rd ed.). McGraw Hill, Malaysia.
2. M. K. Simen. (1999). *Digital Communication Techniques, Signal Design and Detection*. Prentice Hall of India.
3. D. Roddy, & Coolen. (1995). *Electronics Communications* (4th ed.). Prentice Hall of India.
4. W. Tomasi. (1998). *Advanced Electronics Communication System* (4th ed.). Prentice Hall, Inc.
5. M. Kulkarni. (1988). *Microwave and Radar Engineering*. Umesh Publications.

Text Book

1. B. P. Lathi. *Communication System*. Wiley Eastern.
2. G. Kennedy. *Electronic Communication Systems* (3rd ed.). McGraw Hill.
3. S. Haykin. *Communication System* (3rd ed.). John Wiley & Sons.
4. G. Kennedy, & Davis. (1988). *Electronic Communication System* (4th ed.). Tata McGraw Hill.

5. Taub, & Schilling. (1991). *Principles of Communication System* (2nd ed.). Tata McGraw Hill.
6. R. P. Khare. (2004). *Fibre Optics and Optoelectronics*. Oxford University Press, Oxford.

WEB SOURCES

1. http://nptel.iitm.ac.in/
2. http://web.ewu.edu/
3. http://www.ece.umd.edu/class/enee630.F2012.html
4. http://www.aticourses.com/Advanced%20Topics%20in%20Digital%20Signals

ANALYTICAL CHARACTERIZATION TECHNIQUES

COURSE CODE: 24PPH215

CONTACT HOURS / WEEK: 04 **CREDIT: 04**

INTERNAL MARKS: 40 **EXTERNAL MARKS: 60**

Course Outcomes: At the end of the course the student will be able to

UNIT	CO NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
UNIT I	**CO1**	Explain the principles and applications of structural characterization techniques.	K1-K5
UNIT II	**CO2**	Analyze spectral data from Raman, NMR, and ESR spectroscopy.	K1-K5
UNIT III	**CO3**	Apply optical characterization methods like UV-Vis, PL, and FTIR for material identification	K1-K5
UNIT IV	**CO4**	Evaluate thermal and mechanical properties using TGA, DTA, and mechanical tests	K1-K5
UNIT V	**CO5**	Interpret morphology and nanostructure data using SEM, TEM, and STM	K1-K5

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

Syllabus

UNIT-I STRUCTURAL CHARACTERIZATION

Principle of X-ray spectrometer techniques- small angle X-ray scattering – X-ray photoelectron spectroscopy – Auger relation of core hole – Application, strength and limitations of X-ray photoelectron spectroscopy.

UNIT-II SPEC TRAL CHARAVERIZATION

Laser sources – Laser Raman Spectrometer – Radiation sources – Fourier Transform Interferometer – NMR basic principles – NMR spectrometer – ESR basic principles – Instrumentation of ESR.

UNIT-III OPTICAL CHARACTERIZATION

Instruments for absorption photometry – Photoluminescence principles – Instrumentation and Application – Ultraviolet absorption sepectroscopy – Principle behind IR spectroscopy – Fourier Transform Infrared spectroscopy (FTIR) – Strength of FTIR spectroscopy.

UNIT – IV THERMALAND MECHANICAL CHARACTERIZATION

Thermal methods – Thermogravimetric analysis – Differential Thermal analysis- Mechanical principles: Static and Dynamic measurement – Instrumentation of Extensometer analysis - Bending properties of materials – In – Plane Impact testing.

UNIT-V MORPHOLOGICAL CHARACTERIZATION

Basic principles – Instrumentations: Scanning Electron Microscopy (SEM) – Operation modes – Transmission Electron Microscopy (TEM) – Scanning Tunneling Microscopy (STM).

UNIT –VI CURRENT CONTOURS (For continuous internal assessment only)

Basic principles – Instrumentations: X- ray photoelectron spectroscopy (XPS) –Ultraviolet photoelectron spectroscopy (UPS) – Branauer Emett Teller (BET) theory. Hall effect measurement system – Analytical scanning electron microscope –In-site electrical characterization – Neutron scattering.

TEXT BOOK:

1. N. Banwell. (2008). *Fundamentals of Molecular Spectroscopy*. McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. P. S. Sindu. (2006). *Molecular Spectroscopy*. New Age, New Delhi.
2. H. H. Willard, & L. L. Merritt et al. (2008). *International Methods of Analysis*. CBS Publication, New Delhi.
3. S. Zhang, L. Li, & A. Kumar. (2009). *Materials Characterization Techniques*. CRC Press, Boca Raton.
4. E. N. Kaufmann. (2012). *Characterization of Materials, Volume I*. Wiley, New Jersey.
5. M. Sardela. (2014). *Practical Materials Characterization*. Springer, Heidelberg.
6. P. R. Khangaonkar. (2008). *An Introduction to Material Characterization*. Penram, Mumbai.
7. Y. Leng. (2008). *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*. Wiley, New Jersey.

WEB RESOURCES

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization
6. https://nptel.ac.in/courses/113105101

ELECTIVE COURSE

DATA ANALYSIS AND INTERPRETATION

COURSE CODE: 24PPH218

CONTACT HOURS/WEEK: 04 **CREDIT:04**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

COURSE OUTCOMES

UNIT No.	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit 1	**CO-1**	Understand the types of uncertainties and errors in measurements, and apply basic statistical tools to analyze distributions.	K1-K3
Unit 2	**CO-2**	Analyze different probability distributions and apply error propagation techniques in experimental data.	K1-K4
Unit 3	**CO-3**	Explain the concepts of measurement in research and apply appropriate scaling techniques for data collection tools.	K1-K3
Unit 4	**CO-4**	Understand and compare various primary data collection methods and implement appropriate techniques in research.	K1-K3
Unit 5	**CO-5**	Apply statistical analysis methods to process, interpret, and analyze collected data effectively.	K1-K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

Syllabus

UNIT 1: UNCERTAINTIES IN MEASUREMENTS, PROBABILITY DISTRIBUTIONS, ERROR ANALYSIS

Uncertainties in Measurements: Measuring Errors - accuracy and Precision - systematic errors - Random errors - Significant figures and Round off – Uncertainties - Parent and Sample Distributions - Mean, median and mode - Standard Deviation of Distributions.

UNIT 2: SPECIAL PROBABILITY DISTRIBUTIONS

The Binomial Distribution - The Normal Distribution - Relation Between Binomial and Normal Distributions - The Poisson Distribution - Relation Between the Binomial and Poisson - Distributions Relation Between the Poisson and Normal Distributions - The Central Limit Theorem - The Multinomial Distribution - The Hypergeometric Distribution - The Uniform Distribution - The Cauchy Distribution - The Gamma Distribution The Beta Distribution The Chi-Square Distribution.

Unit 3: DATA COLLECTIONS

Measurement in Research: Measurement Scales - Sources of Error in Measurement - Tests of Sound Measurement - Technique of Developing Measurement Tools - Scaling: Meaning of Scaling - Scale Classification Bases - Important Scaling Techniques - Scale Construction Techniques.

Unit 4: METHOD OF DATA COLLECTION

Collection of Primary Data - Observation Method - Interview Method - Collection of Data through Questionnaires - Collection of Data through Schedules - Difference between Questionnaires and Schedules -Some Other Methods of Data Collection - Collection of Secondary Data.

Unit 5: DATA ANALYSIS

Processing and Analysis of Data: Processing Operations - Some Problems in Processing- Elements/Types of Analysis: Statistics in Research - Measures of Central Tendency- Measures of Dispersion - Measures of Asymmetry (Skewness) - Measures of Relationship - Simple Regression Analysis - Multiple Correlation and Regression - Partial Correlation, Association in Case of Attributes.

Books for Study

1. J. R. Taylor. (1997). *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements* (2nd ed.). University Science Books.
2. P. R. Bevington & D. K. Robinson. (2002). *Data Reduction and Error Analysis for the Physical Sciences* (3rd ed.). McGraw-Hill.
3. S. P. Gupta. (2020). *Statistical Methods*. Sultan Chand & Sons.
4. C. R. Kothari. (2004). *Research Methodology: Methods and Techniques* (2nd rev. ed.). New Age International Publishers.
5. M. R. Spiegel. (2008). *Probability and Statistics* (Schaum's Outline Series). McGraw-Hill Education.
6. A. M. Goon, M. K. Gupta & B. Dasgupta. *Fundamentals of Statistics*, Vols. 1 & 2. The World Press Pvt. Ltd. (Latest ed.).

ENERGY EFFICIENCY AND MANAGEMENT

COURSE CODE: 24PPH221

CONTACT HOURS / WEEK: 04 **CREDIT: 4**

INTERNAL MARK: 25 **EXTERNAL MARK: 75**

Course Outcomes:

Units	CO.NO	UPON COMPLETION OF THIS COURSE THE STUDENTS WILL BE ABLE TO	COGNITIVE LEVEL
Unit- 1	**CO-1**	Understand different energy resources and analyze conventional, non-conventional, and waste-to-energy conversion systems.	K1-K5
Unit- 2	**CO-2**	Acquire knowledge in energy storage and assess national and global energy scenarios and policies.	K1-K5
Unit- 3	**CO-3**	Apply energy management principles, plan energy strategies, and perform energy audits in various facilities.	K1-K5
Unit- 4	**CO-4**	Understand the conservation principles and analyze economic aspects and technologies for efficient energy utilization.	K1-K5
Unit-5	**CO-5**	Identify energy-saving opportunities and propose conservation measures in industrial, residential, and commercial sectors.	K1-K5

K1-Remember; K2-Understand; K3-Apply; K4-Analyze; K5-Evaluate;

Syllabus

UNIT I: ENERGY RESOURCES AND CONVERSION PROCESSES

Energy resources – Renewable and non-renewable - Energy conversion processes and devices -Energy conversion plants -Conventional: Thermal, Hydro, Nuclear fission -Non-conventional: Solar, Wind, Biomass -Energy from waste.

UNIT II: ENERGY STORAGE, DISTRIBUTION AND GLOBAL SCENARIO

Energy storage methods - Electrical energy route – Transmission and distribution -Load curves and characteristics -Plants for base load, intermediate load, peak load -Global and Indian energy scenario -Impact of energy on economy and environment -Energy policies and future strategies.

UNIT III: ENERGY MANAGEMENT AND AUDIT

Energy management – Definition, significance, and objectives -Characterizing energy usage -Energy management program – Implementation and monitoring -Energy strategies and planning -Energy audit – Types and procedures.

UNIT IV: ENERGY CONSERVATION AND ECONOMICS

Principles of energy conservation -Energy economics – Conservation technologies -Co-generation -Waste heat recovery systems -Combined cycle power generation -Heat recuperators and regenerators -Heat pipes and heat pumps

UNIT V: ENERGY CONSERVATION OPPORTUNITIES AND MEASURES

Electrical Energy Conservation Opportunities (ECOs) -Thermodynamic ECOs in chemical process industries -ECOs in residential and commercial buildings -Specific Energy Conservation Measures.

TEXT BOOKS:

1. G. D. Rai. (2011). *Non-Conventional Energy Sources* (5th ed.). Khanna Publishers.
2. S. C. Tripathi. (2016). *Electric Energy: Generation, Utilization and Conservation* (3rd ed.). Tata McGraw Hill.
3. Y. P. Abbi & Shashank Jain. (2006). *Handbook on Energy Audit and Environment Management*. TERI Press.
4. P. Chattopadhyay. (2010). *Engineering Thermodynamics and Energy Conversion* (1st ed.). Oxford University Press.
5. V. V. N. Kishore. (2009). *Renewable Energy Engineering and Technology: Principles and Practice*. TERI Press.

REFERENCE BOOKS:

1. S. P. Sukhatme. (2008). *Solar Energy: Principles of Thermal Collection and Storage* (3rd ed.). Tata McGraw-Hill.
2. D. Yogi Goswami & F. Kreith. (2007). *Energy Conversion* (2nd ed.). CRC Press.
3. P. W. Gannon. (2003). *Energy Management* (2nd ed.). Fairmont Press.
4. C. B. Smith. (2020). *Energy Management Principles* (6th ed.). Elsevier.
5. M. M. El-Wakil. (1984). *Power Plant Technology* (International ed.). McGraw-Hill.
6. S. A. Abbasi & N. Abbasi. (2001). *Renewable Energy Sources and Their Environmental Impact*. PHI Learning Pvt. Ltd.

Web Resources

1. https://nptel.ac.in/courses/112105221
2. https://www.coursera.org/specializations/renewable-energy
3. https://nptel.ac.in/courses/112102733

4. https://beeindia.gov.in/sites/default/files/BEE%20Guide%20Book%202.pdf
5. https://www.exergia-max.com/sites/default/files/documents/EEEM_Handbook_ENG.pdf