Sadakathullah Appa College

(Autonomous)

.Reaccredited by NAAC at an A^{++} Grade with a CGPA of 3.56/4.0 in the IV Cycle

.An ISO 9001:2015 Certified Institution

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

DEPARTMENT OF PHYSICS

CBCS SYLLABUS

For

M. Sc. PHYSICS

(Applicable for students admitted in June 2024 and onwards)

(As per the Resolution of the Academic Council Meetings held on 01.06.2024)

CONTENTS

Programme Structure & Credits – PG (Sciences)
2024 - 2027

Sem	Course Type	Title of the Course	Course Code	H/W	C	Marks		
						I	E	T
I	Core-I	Mathematical Physics	24PCPH11	6	5	40	60	100
	Core-II	Classical Mechanics and Relativity	24PCPH12	5	5	40	60	100
	Core-III	Linear and Digital IC and Applications	24PCPH13	5	4	40	60	100
	Core-P-I	General Physics Practical - I	24PCPH1P1	4	2	20	30	50
	Core-P-II	Electronics Practical	24PCPH1P2	4	2	20	30	50
	EC-I	Physics of Nanoscience and Technology	24PEPH11A	4	3	40	60	100
		Plasma Physics	24PEPH11B					
		Materials Science	24PEPH11C					
	EC-II (IDC-I)	Basics of Digital Electronics	24PIPH11	2	2	15	35	50
		SOP		-	-			
				30	**23**			**550**
II	Core-IV	Quantum Mechanics -I	24PCPH21	5	5	40	60	100
	Core-V	Statistical Mechanics	24PCPH22	5	4	40	60	100
	Core-P-III	General Physics Practical –II	24PCPH2P1	4	2	20	30	50
	Core-P-IV	Advanced Electronics Practical	24PCPH2P2	4	2	20	30	50
	EC-III	Advanced Mathematical Physics	24PEPH21A	4	3	40	60	100
		Medical Physics	24PEPH21B					
		Characterization of Materials	24PEPH21C					
	EC-IV (IDC-II)	Solar Energy Utilization	24PIPH21	2	2	15	35	50
	SEC-I	Spectroscopy	24PSPH21	4	3	40	60	100
	SEC-II	Skill Enhancement Course-III NPTEL-SWAYAM Online Certification Course (or) Naan Muthalvan : (Choose any one course from the list of courses suggested by TANSCHE)	24PSPH22	2	2	-	-	50
		SOP		-	1			100
	Summer – Internship Industry Training during the 1st year vacation - credits be given in the third semester mark statement							
				30	**23+1**			**700**

Department of PG & Research Department of Physics
Programme: M.Sc.,
Programme Outcomes

PO NO.	Upon Completion of M.Sc. Physics Degree Programme, the Graduates will be able to:
PO 1	**Disciplinary Knowledge** • Acquire in-depth scientific knowledge in the core areas of study
PO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** • Enrich skills of observation to draw logical inferences from scientific experiments/ programming and skills of creative thinking to develop novel ideas. • Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations..
PO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** • Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. • Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects • Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PO 4	**Ethical Awareness/Team Work / Environmental Conservation and Sustainability** • Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviors such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. • Realise that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PO 5	**Digital Literacy / Self-Directed / Learning /Usage of ICT / Lifelong Learning** • Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. • Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes (PSO)

PSO NO.	Upon Completion of M.Sc Physics Degree Programme, the Graduates will be able to:	POs mapped
PSO-1	Acquire knowledge in analytic and critical thinking skills in major branches of Physics.	PO1, PO2
PSO-2	Familiarize themselves with contemporary research in various fields of Physics by enhancing pedagogical and scientific writing skills for Projects through modern methods.	PO3, PO4
PSO-3	Develop leadership skill and find ways to apply their knowledge of Physics with advancement in higher education and career besides the desire to remain lifelong learners.	PO1, PO4, PO5
PSO-4	Solve issues concerned in the society with the help of Physics and its principles.	PO3, PO4, PO5
PSO-5	Demonstrate the various concepts of Physics through the practical courses which are framed in relevance to that of the theory courses.	PO1, PO2, PO3

Semester - I	MATHEMATICAL PHYSICS		24PCPH11			
Core – I			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	6			5

General Objective:

Mathematical Physics provides firm foundation in various mathematical methods developed and used in understanding different physical phenomena.

Learning Objectives

LO	The learners will be able to:
LO-1	Equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
LO-2	Extend their manipulative skills to apply mathematical techniques in their fields
LO-3	Help students apply Mathematics in solving problems of Physics
LO-4	Develop problem solving skill in Fourier and Laplace transforms.
LO-5	Comprehend knowledge in Mathematical Physics and its applications.

UNIT – I LINEAR VECTOR SPACE (18 Hours)

Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure –linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – orthogonal transformations and rotation.

UNIT – II COMPLEX ANALYSIS PROBABILITY&STATISTICS (18 Hours)

Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem.

Probability – Introduction – Addition rule of probability – Multiplication law of probability–Introduction to statistics–Mean, median, mode and standard deviations.

UNIT- III MATRICES (18 Hours)

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

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

Definitions -Fourier transform 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. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions.

UNIT- V DIFFERENTIAL EQUATIONS (18 Hours)

Second order differential equation- Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and Reciprocity theorem

TEXT BOOKS

1. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
2. P.K. Chattopadhyay, 2013, Mathematical Physics (2nd edition), New Age, New Delhi
3. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt.Ltd., India
4. B. D. Gupta, 2009, Mathematical Physics (4th edition), Vikas Publishing House, New Delhi.
5. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., 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 3. 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.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	PSO1, PSO3	K1, K2
CO-2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	PSO1, PSO3	K2, K3
CO-3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	PSO1, PSO2, PSO3	K4
CO-4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology.	PSO2, PSO3	K4, K5
CO-5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	PSO1, PSO2, PSO4	K2, K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code			Title of the Course				Hours		Credit
I	24PCPH11			MATHEMATICAL PHYSICS				90		5
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	3	3	3	3	3	2	3	2
CO-2	2	3	3	3	3	3	3	2	2	2
CO-3	3	3	3	2	2	3	3	2	3	2
CO-4	3	3	3	3	2	3	3	2	2	2
CO-5	3	2	3	3	2	3	3	2	2	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Signature: Head of the Department

Semester - I	CLASSICAL MECHANICS AND RELATIVITY		24PCPH12			
Core – I			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5			5

General Objective:

To understand the motion of particles through Lagrangian and Hamiltonian formulations.

Learning Objectives

LO	The learners will be able to
LO-1	Understand fundamentals of classical mechanics.
LO-2	Understand Lagrangian formulation of mechanics and apply it to solve equation of motion.
LO-3	Understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.
LO-4	Discuss the theory of small oscillations of a system.
LO-5	Learn the relativistic formulation of mechanics of a system.

UNIT- I LAGRANGIAN FORMULATION (15 Hours)

Mechanics of a particle and system of particles – Conservation laws: conservation of linear and angular momentum– Constraints and degrees of freedom – Generalised co-ordinates - D' Alembert's principle of virtual work – Lagrange's equations of motion – non-holonomic system- application of Lagrange's equations of motion: simple pendulum, Atwood's machine, free particle in space - velocity dependent potential.

UNIT – II TWO BODY CENTRAL FORCE PROBLEM (15 Hours)

Reduction to the equivalent one body central force problem – Equations of motion and first integrals – Virial theorem – The equivalent one dimensional problem and classification of orbits – Differential equation for the orbit - Kepler's problem: Inverse square law of force – Scattering in a central force field – Transformation of scattering problems to laboratory coordinates.

UNIT – III KINEMATICS OF RIGID BODY MOTION (15 Hours)

Independent coordinates of a rigid body – Orthogonal transformation-Euler angles – Coriolis force-Angular momentum and Kinetic energy of motion about a point – Inertia tensor and Moment of inertia- Euler's equations of motion (Newtonian & Lagranjian Method) – Torque free motion of a rigid body – heavy symmetrical top.

UNIT- IV HAMILTONIAN FORMULATION AND CANONICAL TRANSFORMATION (15 Hours)

Calculus of variation - Principle of least action – Other forms of action Principles – Hamilton's principle-Lagrange's equation from Hamilton's principle- Canonical transformation – Generating Functions – Poisson's brackets and its properties – Hamilton's-Jacobi equation for Hamilton's

principal function – Example: Harmonic Oscillator problem – Hamilton's characteristic Function – Action angle variables.

UNIT - V SMALL OSCILLATIONS AND THEORY OF RELATIVITY (15 Hours)

Stable and unstable Equilibrium - Lagrange's equation of motion for small oscillations - Normal Co-ordinates and normal frequencies of vibration - Free vibrations of linear tri atomic molecule- Basic Postulates of Special theory of Relativity - Lorentz transformation- Force and energy equations in relativistic Mechanics- Lagrangian and Hamiltonian formulation of relativistic mechanics.

TEXT BOOKS

1. H. Goldstein, 2002, Classical Mechanics, 3rd Edition, Pearson Edu.
2. J. C. Upadhyaya, Classical Mechanics, HimalayaPublshing. 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, 2001

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.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the fundamentals of classical mechanics.	PSO1, PSO2, PSO3	K2
CO-2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	PSO2, PSO3	K3
CO-3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	PSO1, PSO2, PSO3	K3, K5
CO-4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	PSO2, PSO3, PSO4	K4, K5
CO-5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	PSO1, PSO3	K2, K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PCPH12	CLASSICAL MECHANICS AND RELATIVITY	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	2	3	3	3	2	2	2	3	3	2
CO-2	2	3	3	3	2	2	2	3	3	3
CO-3	2	3	3	3	2	2	2	3	3	3
CO-4	2	3	3	3	2	2	2	3	2	3
CO-5	2	3	3	3	2	2	2	3	2	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	LINEAR AND DIGITAL ICs AND APPLICATIONS		24PCPH13			
Core – III			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5			4

General Objective:

To introduce the theoretical concept of linear and digital ICs and their various applications.

Learning Objectives

LO	The learners will be able to
LO-1	Introduce the basic building blocks of linear integrated circuits.
LO-2	Teach the linear and non-linear applications of operational amplifiers.
LO-3	Introduce the theory and applications of PLL.
LO-4	Introduce the concepts of waveform generation and introduce one special function ICs.
LO-5	Exposure to digital IC's

UNIT – I INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER (15 Hours)

Introduction- Classification of IC's- basic information of Op-Amp 741 and its features- the ideal Operational amplifier- Op-Amp internal circuit and Op-Amp- DC Characteristics.

UNIT – APPLICATIONS OF OP-AMP (15 Hours)

Linear applications of OP-AMP: Solution to simultaneous equations and differential equations- Instrumentation amplifiers- V to I and I to V converters.

Non-linear applications of OP-AMP: Sample and Hold circuit- Log and Antilog amplifier- multiplier and divider- Comparators- Schmitt trigger- Multivibrators- Triangular and Square waveform generators.

UNIT – III ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS (15 Hours)

Active Filters: Introduction- Butterworth filters – 1st order, 2nd order low pass and high pass filters- band pass- band reject and all pass filters.

Timer and Phase Locked Loops: Introduction to IC 555 timer- description of functional diagram- monostable and astable operations and applications- Schmitt trigger- PLL – Introduction- basic principle- phase detector/comparator- voltage-controlled oscillator (IC 566).

UNIT – IV VOLTAGE REGULATOR & D to A AND A to D CONVERTERS (15 Hours)

Voltage Regulator: Introduction- Series Op-Amp regulator- IC Voltage Regulators- IC 723 general purpose regulators- Switching Regulator. D to A and A to D Converters: Introduction, basic DAC techniques -weighted resistor DAC- R-2R ladder DAC- inverted R-2R DAC, A to D converters - parallel comparator type ADC- counter type ADC- DAC and ADC Specifications.

UNIT – V CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs (15 Hours)

CMOS Logic: CMOS logic levels- MOS transistors- Basic CMOS Inverter- NAND and NOR gates- CMOS AND-OR-INVERT and OR-AND-INVERT gates.

Combinational Circuits Using TTL 74XX ICs: Study of logic gates using 74XX ICs- Comparator (IC 7485)- BCD to 7-segment decoder (IC7447)- Encoder (IC74147) Multiplexer (IC74151)- Demultiplexer (IC 74154). Sequential Circuits Using TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194).

TEXT BOOKS

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

REFERENCE BOOKS

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

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	PSO1, PSO2, PSO4	**K1, K5**
CO-2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	PSO1, PSO3	**K3**
CO-3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	PSO1, PSO2, PSO4	**K1, K3**
CO4	Learn about various techniques to develop A/D and D/A converters.	PSO2, PSO4, PSO5	**K2**
CO-5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	PSO1, PSO5	**K1, K4**

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	**24PCPH13**	**LINEAR AND DIGITAL ICs AND APPLICATIONS**	**75**	**4**

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO-1	3	3	3	3	2	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	3	3	3	2	3	3	3	3	2
CO-5	3	3	3	2	2	3	3	3	2	2
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	GENERAL PHYSICS PRACTICALS - I		24PCPH1P1			
Core P – I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50			4	2

General Objective:

To train the students with advanced experimental techniques in Physics and to handle sophisticated equipment and analyze the data.

Learning Objectives

LO	The learners will be able to
LO-1	Understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
LO-2	Calculate the thermodynamic quantities and physical properties of materials.
LO-3	Analyze the optical and magnetic properties of materials.
LO-4	Expose to a hands-on training to use the He-Ne laser source
LO-5	Identify the various parameters in ESR spectrometer and Ultrasonic interferometer experiments

(Any Eight)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of viscosity of the given liquid – Meyer's disc
3. Determination of Thickness of the enamel coating/diameter of a wire by diffraction
4. Determination of Specific charge of an electron – Thomson's method
5. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
6. GM counter – Characteristics and inverse square law.
7. Molecular spectra – AlO band.
8. Determination of Planck constant – LED method
9. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
10. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
11. Ultrasonic Interferometer – Velocity and compressibility of any two liquidmutuals
12. Cauchy's constants by least square fit (Experimental method)

13. ESR Spectrometer – Determination of Lande's factor
14. Biprism – Determination of wave length (optic bench)
15. Dielectric constants and loss of liquids

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, Pragati Prakasan.
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences.

REFERENCE BOOKS

1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
2. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO1	Understand the strength of material using Young's modulus.	PSO1, PSO2, PSO3	**K2**
CO-2	Acquire knowledge of thermal behavior of the materials.	PSO1, PSO5	**K1**
CO-3	Understand theoretical principles of magnetism through the experiments.	PSO1, PSO3, PSO4	**K2**
CO-4	Acquire knowledge about arc spectrum and applications of laser, Improve the analytical and observation ability in Physics Experiments	PSO1, PSO4, PSO5	**K3, K4**
CO-5	Promote ethical conduct in scientific research, including the proper handling and reporting of experimental data.	PSO2, PSO5	**K5**
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	**24PCPH1P1**	**GENERAL PHYSICS PRACTICAL-I**	**60**	**2**

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO-1	2	2	2	3	2	2	2	2	3	2
CO-2	2	2	3	3	3	2	2	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	ELECTRONICS PRACTICAL		24PCPH1P2			
Core P – II			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50			4	2

General Objective:

To educate the students in electronics so that they can verify and develop confidence to handle sophisticated equipment.

Learning Objectives

LO	The learners will be able to
LO-1	Observe the applications of FET and UJT.
LO-2	Study the different applications of operational amplifier circuits.
LO-3	Learn about Combinational Logic Circuits and Sequential Logic Circuits
LO-4	Study the Wien's bridge, Phase shift oscillators
LO-5	Study the D/A Convertors circuits

(Any Eight)

1. Construction of relaxation oscillator using UJT / Study of important electrical characteristics of IC741.
2. FET Characteristics / V- I Characteristics of different colours of LED.
3. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
4. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
5. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer/ Construction of square wave Triangular wave generator using IC 741
6. Construction of a quadrature wave using IC 324 / Construction of pulse generator using the IC 741 – application as frequency divider
7. Construction of Op-Amp – 4 bit Digital to Analog Converter (Binary Weighted and R/2R Ladder type)
8. Study of Binary to Gray and Gray to Binary code conversion.
9. Study of R-S, clocked R-S and D-Flip flop using NAND gates / Study of Masters slave J-K flip flop.
10. Study of J-K, D and T flip flops using IC 7476/7473 / Inverting and Non-Inverting Amplifier using OP-AMP Characteristics.
11. Arithmetic operations using IC 7483- 4-bit binary addition.
12. Study of Arithmetic logic unit using IC 74181/ BCD Adder

13. Construction of Encoder and decoder circuits using ICs / SCR Characteristics
14. Study of Half Adder and Full Adder
15. Transistor Characteristics/ Characteristics of Opto electronics devices – LDR-Photodiode-LED-Photovoltaic cell.

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, Pragati Prakasan.
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences.
3. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing.
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

REFERENCE BOOKS

1. Advanced Practical Physics, S.P Singh, Pragati Prakasan.
2. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.
5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Conduct experiments on applications of UJT, FET. Acquire knowledge about V- I Characteristics of different colours of LED. Understand the characteristics of Wien's bridge oscillator and Phase shift using Op-Amp	PSO1, PSO3, PSO5	K4, K1
CO-2	Acquire knowledge about Schmidt trigger circuits, square wave, and Triangular wave generator. To analyze and study the Construction and working of a quadrature wave and pulse generator	PSO1, PSO3	K2, K4
CO-3	Understand the Construction of Op-Amp – 4 bit Digital to Analog Converter and Acquire knowledge about the Study of Binary to Grey code conversion	PSO1, PSO5	K1, K2
CO-4	Acquire knowledge about the Study of flip flops. Understand the Inverting and Non-Inverting Amplifier using OP-AMP Characteristics, working of Arithmetic operations using IC 7483 and BCD adder.	PSO1, PSO4, PSO5	K1, K2
CO-5	Acquire knowledge about Construction of Encoder and decoder circuits, SCR characteristics, Transistor characteristics, half adder and full adder and study of Opto electronics devices	PSO1, PSO4, PSO5	K1, K2
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code		Title of the Course					Hours		Credit
I	24PCPH1P2		ELECTRONICS PRACTICALS					60		2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	2	2	2	3	3	2	2	2	3	3
CO-2	2	2	3	3	3	2	2	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	PHYSICS OF NANOSCIENCE AND TECHNOLOGY		24PEPH11A			
Elective – IA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

To introduce the students to the basic ideas of nanomaterials and its application in research field.

Learning Objectives

LO	The learners will be able to
LO-1	Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.
LO-2	Provide the basic knowledge about nanoscience and technology.
LO-3	Learn the structures and properties of nanomaterials.
LO-4	Acquire the knowledge about synthesis methods and characterization techniques and its applications.
LO-5	Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.

UNIT – I FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY (12 Hours)

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.

UNIT – II PROPERTIES OF NANOMATERIALS (12 Hours)

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 (12 Hours)

Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition.

UNIT – IV CHARACTERIZATION TECHNIQUES (12 Hours)

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

UNIT – V APPLICATIONS OF NANOMATERIALS (12 Hours)

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – 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. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
5. 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 – Huozhong Gao – 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.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	PSO1, PSO3, PSO4	**K1, K2**
CO-2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	PSO2, PSO4	**K1**
CO-3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	PSO1, PSO2, PSO3	**K2, K3**
CO-4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	PSO2, PSO4	**K4**
CO-5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	PSO2, PSO3, PSO4	**K3**
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	**24PEPH11A**	**PHYSICS OF NANOSCIENCE AND TECHNOLOGY**	**60**	**3**

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO-1	3	3	3	2	2	3	3	3	2	2
CO-2	3	3	3	2	2	3	3	3	2	3
CO-3	3	3	2	2	3	3	3	2	2	3
CO-4	3	3	3	2	3	3	3	3	2	3
CO-5	3	3	2	2	2	3	3	2	2	3
STRONG (3), MEDIUM (2) and LOW (1).										

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Semester - I	PLASMA PHYSICS		24PEPH11B			
Elective – IB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

An introduction to plasma physics, plasma diagnostics techniques and its application to various generators.

Learning Objectives

LO	The learners will be able to
LO-1	Explore the plasma universe by means of in-site and ground-based observations.
LO-2	Understand the model plasma phenomena in the universe.
LO-3	Explore the physical processes which occur in the space environment
LO-4	Develop their understanding of various probe technique for measurement of Plasma parameters.
LO-5	Relate the possible applications of plasma physics.

UNIT – I FUNDAMENTAL CONCEPTS OF PLASMA (12 Hours)

Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Optical properties of plasma.

UNIT – II MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD (12 Hours)

Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field- Magneto- hydrodynamics - Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour.

UNIT – III PLASMA OSCILLATIONS AND WAVES (12 Hours)

Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.

UNIT – IV PLASMA DIAGNOSTICS TECHNIQUES (12 Hours)

Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method - conclusion.

UNIT - V APPLICATIONS OF PLASMA PHYSICS (12 Hours)

Magneto hydrodynamic Generator - Basic theory - Principle of Working-Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode.

TEXT BOOKS

1. Plasma Physics- Plasma State of Matter- S. N.Sen, PragatiPrakashan, Meerut.
2. Introduction to Plasma Physics-M. Uman
3. Krall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley, CA: San Francisco Press, 1986. ISBN: 9780911302585.Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw-Hill, 1967. ISBN: 9780070628120.
4. Goldston, R. J., and P. H. Rutherford. Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995. ISBN: 9780750301831.
5. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK: Cambridge University Press, 2005. ISBN: 9780521675741.

REFERENCE BOOKS

1. Chen, F. F. Introduction to Plasma Physics. 2nd ed. New York, NY: Springer, 1984. ISBN: 9780306413322.
2. Introduction to Plasma Theory-D.R. Nicholson
3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507.
4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139.
5. Huddlestone, R. H., and S. L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	PSO1, PSO3	K1, K2
CO-2	Understand the plasma and learn the magneto-hydrodynamics concepts applied to plasma.	PSO2, PSO3	K2
CO-3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	PSO1, PSO3	K1, K3
CO-4	Analyze the different principle and techniques to diagnostics of plasma.	PSO2, PSO4	K2, K5
CO-5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	PSO3, PSO4	K4
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credit			
I	24PEPH11B	PLASMA PHYSICS				60	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	1	1	3	3	2	1	1
CO-2	3	3	2	1	1	3	3	2	1	1
CO-3	3	3	2	2	1	3	3	2	2	1
CO-4	3	3	3	2	1	3	3	3	2	1
CO-5	3	3	3	2	1	3	3	3	2	1
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	MATERIALS SCIENCE		24PEPH11C			
Elective – IC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

This course involves investigating the relationships that exist between processing, structure, property and performance of materials.

Learning Objectives

LO	The learners will be able to
LO-1	Gain knowledge on optoelectronic materials
LO-2	Learn about ceramic processing and advanced ceramics
LO-3	Understand the processing and applications of polymeric materials
LO-4	Gain knowledge on the fabrication of composite materials
LO-5	Learn about shape memory alloys, metallic glasses and nanomaterials

UNIT-I OPTOELECTRONIC MATERIALS (12 Hours)

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 PLASMA PROCESSING (12 Hours)

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 (12 Hours)

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 (12 Hours)

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 (12 Hours)

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
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.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Acquire knowledge on optoelectronic materials	PSO1	**K1**
CO-2	Be able to prepare ceramic materials	PSO2, PSO3	**K3**
CO-3	Be able to understand the processing and applications of polymeric materials	PSO1, PSO2, PSO4	**K2, K3**
CO-4	Be aware of the fabrication of composite materials	PSO1, PSO5	**K5**
CO-5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	PSO1, PSO2, PSO3	**K1**
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	**24PEPH11C**	**MATERIALS SCIENCE**	**60**	**3**

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO-1	2	3	3	2	2	2	3	3	2	2
CO-2	2	3	3	2	2	2	3	3	2	2
CO-3	2	3	2	2	2	2	3	2	2	2
CO-4	1	3	2	3	2	1	3	2	3	2
CO-5	2	3	2	2	2	2	3	2	2	2
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester - I	BASICS OF DIGITAL ELECTRONICS		24PIPH11			
Elective –II-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2			2

General Objective:

Digital techniques are helpful because it is a lot easier to get an electronic device to switch into one of a number of known states than to accurately reproduce a continuous range of values.

Learning Objectives

LO	The learners will be able to
LO-1	Gain a solid understanding of the binary number system and its significance in digital electronics.
LO-2	Learn how to convert between decimal and binary representations and vice versa.
LO-3	Learn about the fundamental logic gates such as AND, OR, NOT, NAND, NOR, and XOR.
LO-4	Understand the truth tables and logic expressions associated with each gate.
LO-5	Understand the concept of Karnaugh maps and use them for simplifying logic expressions.
LO-6	Understand the concept of synchronous and asynchronous sequential circuits and their applications.
LO-7	Learn techniques for analyzing digital systems, including state diagrams, state tables, and state equations.

UNIT - I Number system (6 Hours)

Binary numbers – Decimal to Binary conversion – Octal numbers – Octal to Binary conversion –Hexadecimal numbers – Hexadecimal to Binary conversions – Binary Arithmetic – 1's complement subtraction – 2's complement subtraction – BCD addition.

UNIT - II Boolean algebra (6 Hours)

Laws of Boolean algebra – De Morgan's theorem – Algebraic simplification of logical expressions – Logic gates – Combinational logic design – Karnaugh map representation of logical functions – K-map simplification using minterm (2, 3 and 4 variables) – K-map simplification using max terms (2, 3 and 4 variables).

UNIT- III Combinational circuits (6 Hours)

Half adder – Full adder – Half subtractor – Full subtractor – Multiplexer – Demultiplexer – Encoder – Decimal to BCD encoder – Decoder – BCD to seven segment decoder – Application of combinational circuits .

UNIT - IV Sequential circuits (6 Hours)

Sequential circuits – RS flip flop using NOR gates – clocked RS flip flop – D flipflop – JK flip flop – Master Slave JK flip flop – T flip flop – Register and shift register – Types of registers – Application of sequential circuits.

UNIT - V Counters and Converters and Logic families (6 Hours)

Counters – asynchronous counter – synchronous counter – Decade counter – Application of counters – D/A converter: Ladder type – A/D converter: Counter type – Application of converters – Transistor Transistor Logic (TTL).

TEXT BOOKS

1. V. Vijayendran, Digital fundamentals. S. Viswanathan Printers and Publishers Pvt. Ltd., (2009).
2. Virendra Kumar, Digital electronics, New Age International Publishers (2007).
3. R. Muthusubramanian, Salivahanan, Basic Electrical and Electronics Engineering, Tata MCGraw Hill Education Pvt. Ltd., (2011).

REFERENCE BOOKS :

1. Avinashi Kapoor and L. K. Maheswari, Digital Electronics - Principles and Practice, Macmillan India Limited (2004).
2. D. A. Godse and A.P. Godse, Digital electronics, Technical Publlsher, Pune (2008).
3. Morris Mano, Digital Logic and Computer Design, Pearson Education (2004).
4. Don Leach, Albert Malvino, Digital principles and applications, McGraw-Hill Inc., US (1994).
5. P.S. Manoharan, “Digital Electronics and Microprocessors”, Charulatha Publications.Chennai (2013).

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understanding of binary number systems, including binary arithmetic operations and conversions between binary, decimal, and hexadecimal representations.	PSO1, PSO3	K2
CO-2	Understand the principles and characteristics of basic logic gates (AND, OR, NOT, NAND, NOR, XOR) and their truth tables.	PSO1, PSO3	K2
CO-3	Able to analyze and design combinational logic circuits using logic gates.	PSO1, PSO3,PSO5	K4, K5
CO-4	Gain knowledge about principles of sequential logic and the behavior of latches, flip-flops, counters, and shift registers.	PSO1, PSO4,PSO5	K1, K3
CO-5	Develop problem-solving and critical thinking skills through the analysis and synthesis of digital circuits.	PSO2, PSO4, PSO5	K4, K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PIPH11	BASICS OF DIGITAL ELECTRONICS	30	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	2	2	2	3	3	3	3	3
CO-2	3	3	2	2	2	3	3	3	2	3
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	3	2	2	3	3	2	3	2	2
CO-5	3	3	3	3	2	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester – II	QUANTUM MECHANICS - I		24PCPH21			
Core-IV			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5			5

General Objective:

To develop the knowledge about atoms dual nature of particle and wave functions and its applications.

Learning Objectives

LO	The learners will be able to
LO-1	Develop the physical principles and the mathematical background important to quantum mechanical descriptions.
LO-2	Describe the propagation of a particle in a simple, one-dimensional potential.
LO-3	Formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
LO-4	Explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
LO-5	Discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

UNIT –I BASIC FORMALISM (15 Hours)

Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – Mathematical proof of Uncertainty relation for one dimensional wave packet.

UNIT - II ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS (15 Hours)

Particle in a box - Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – 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 (15 Hours)

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Unitary transformation – Parity and time reversal – matrix theory of linear harmonic oscillator.

UNIT – IV ANGULAR MOMENTUM (15 Hours)

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Eigen values and matrix representation of J^2 , J_z and J_+, J_- - Spin angular momentum – Addition of angular momenta – Clebsch Gordan (CG) Coefficients – Calculation of Clebsch Gordan coefficients for $J_1 = ½$, $J_2 = ½$.

UNIT – V APPROXIMATION METHODS (15 Hours)

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

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. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982.
5. 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.

Course Outcome

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	PSO1, PSO3, PSO4	K1, K5
CO-2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	PSO1, PSO3	K3, K4
CO-3	Can discuss the various representations, space time symmetries and formulations of time evolution	PSO1, PSO2, PSO5	K1
CO-4	Can formulate and analyze the approximation methods for various quantum mechanical problems	PSO2, PSO5	K4, K5
CO-5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	PSO2, PSO3, PSO4	K3, K4
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PCPH21	QUANTUM MECHANICS - I	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3
CO-3	2	3	3	2	3	2	3	3	2	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	2	3	3	3	3	2	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Signature: Head of the Department

Semester – II	STATISTICAL MECHANICS		24PCPH22			
Core-V			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5			4

General Objective:

To expose the students to use the probability method in Statistical Mechanics by extending many-body systems.

Learning Objectives

LO	The learners will be able to
LO-1	Acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics
LO-2	Identify the relationship between statistic and thermodynamic quantities
LO-3	Comprehend the concept of partition function, canonical and grand canonical ensembles
LO-4	Grasp the fundamental knowledge about the three types of statistics
LO-5	Get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

UNIT –I PHASE TRANSITIONS (15 Hours)

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT –II STATISTICAL MECHANICS AND THERMODYNAMICS (15 Hours)

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 (15 Hours)

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 (15 Hours)

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 (15 Hours)

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 - Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin's theory.

TEXT BOOKS

1. S. K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
2. B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
3. J. K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
4. F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw -Hill, New York.
5. M. K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill New York.

REFERENCE BOOKS

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

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	PSO1, PSO3	K5
CO2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc.	PSO1, PSO3, PSO4	K4
CO-3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	PSO1, PSO2, PSO5	K1
CO-4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	PSO1, PSO2, PSO4	K4, K5
CO-5	To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model	PSO2, PSO3, PSO4	K3
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PCPH22	STATISTICAL MECHANICS				75		4		
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	3	2	3	3	3	3	2	2
CO-2	3	3	3	3	3	3	3	3	2	3
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	3	3	3	3	3	3	3	2	2
CO-5	3	3	3	2	3	3	3	3	3	2
STRONG (3), MEDIUM (2) and LOW (1).										

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Semester – II	GENERAL PHYSICS PRACTICALS - II		24PCPH2P1			
Core-P-III			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50			4	2

General Objective:

The course aims at exposing the students to the intricacies of handling sophisticated equipments and analysis of results.

Learning Objectives

LO	The learners will be able to
LO-1	Understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
LO-2	Understand the concept of Young's modulus and Poisson's ratio.
LO-3	Analyze the optical and electrical properties of materials.
LO-4	Understand the principle of Quincke's method for measuring susceptibility.
LO-5	Calculate the charge-to-mass ratio of electrons using experimental data.

(Any Eight)

1. Measurement of Susceptibility of liquid - Quincke's method
2. B-H curve using CRO
3. Arc spectrum: Copper
4. Determination of Thickness of thin film. - Michelson Interferometer
5. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
6. Interpretation of vibrational spectra of a given material
7. Mutual inductance – coupling co efficient as a function of distance and angle.
8. Determination of I-V Characteristics and efficiency of solar cell
9. GM counter – Absorption coefficient – Maximum range of β rays
10. Thermal conductivity of the material – Forbe's method
11. Particle size determination using He-Ne Laser.
12. Determine the mechanical properties of solids and find various hardness parameters
13. Calculate the charge of an electron by the method of dispersion
14. Measurement of magnetic susceptibility – Guoy's method
15. Determination of refractive index of liquids using diode laser/He – Ne laser.

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, PragatiPrakasan
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences

REFERENCE BOOKS

1. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
2. Advanced Practical Physics, S.P Singh, PragatiPrakasan
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the strength of material using Young's modulus	PSO1, PSO3, PSO5	K2
CO-2	Acquire knowledge of thermal behavior of the materials	PSO1, PSO4, PSO5	K1
CO-3	Understand theoretical principles of dielectrics through the experiments. Acquire knowledge about the applications of laser	PSO2, PSO4, PSO5	K2, K3
CO-4	Improve the analytical and observation ability in Physics Experiments, Apply skills in designing and planning experiments to investigate specific physical phenomena.	PSO3, PSO4, PSO5	K1, K5
CO-5	Foster curiosity and a spirit of scientific inquiry through hands-on experimentation.	PSO3, PSO5	K4, K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	**24PCPH2P1**	**GENERAL PHYSICS PRACTICALS - II**	**60**	**2**

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO-1	2	2	2	3	2	2	2	2	3	2
CO-2	2	2	3	3	3	2	2	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester – II	ADVANCED ELECTRONICS PRACTICAL		24PCPH2P2			
Core-P-IV			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50			4	2

General Objective:

The course aims at exposing the students to the intricacies of handling sophisticated equipments, designing electronic circuits, trouble shooting and analysis of results

Learning Objectives

LO	The learners will be able to
LO-1	Study the different applications of operational amplifier circuits.
LO-2	Learn about Combinational Logic Circuits and Sequential Logic Circuits
LO-3	Study the BCD to seven segment display circuits
LO-4	Study the various types of oscillators
LO-5	Learn about the different types of counters

(Any Eight)

1. Determination of I-V Characteristics and efficiency of solar cell/ IC 7490 as scalar and seven segment display using IC7447
2. Solving simultaneous equations – IC 741 / IC LM324 / Construction of series voltage regulator
3. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter / Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
4. Construction of second order butterworth multiple feedback narrow band pass filter/Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193/ IC 741
5. Construction of square wave generator using IC 555 – Study of VCO/ Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer
6. Construction of pulse generator using the IC 555 – Application as frequency divider/BCD to Excess- 3 and Excess 3 to BCD code conversion
7. Study of binary up / down counters - IC 7476 / IC7473

8. Shift register / Ring counter and Johnson counter- IC 7476/IC 7474
9. Study of synchronous parallel 4-bit binary up/down counter using IC 74193
10. Study of asynchronous parallel 4-bit binary up/down counter using IC 74193
11. Study of Modulus counter
12. Construction of Multiplexer and Demultiplexer using ICs.
13. Construction of series voltage regulator
14. Arithmetic operations using IC 7483- 4-bit binary subtraction (1's complement).
15. Oscillators (Hartley and Colpitts)

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, PragatiPrakasan
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

REFERENCE BOOKS

1. An advanced course in Practical Physics, D.Chattopadhayay, C.RRakshit, New Central Book Agency Pvt. Ltd
2. Advanced Practical Physics, S.P Singh, PragatiPrakasan
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt.ltd
4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
5. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi.

Course Outcomes

CO No.	CO Statement	PSOs Mapped	Cognitive Level
CO-1	Understand the I-V Characteristics and efficiency of solar cell. Acquire knowledge about seven segment display using IC7447. Acquire knowledge about the Solving of simultaneous equations using IC 741 and its experiments	PSO1, PSO4, PSO5	K1, K2,K4
CO-2	Understand Study the Construction of square wave generator using IC 555 Acquire knowledge about Construction of Schmidt trigger circuits, pulse generator using the IC 555. Understand the concepts of BCD to Excess- 3 and Excess 3 to BCD code conversion. Analyze the applications of binary up / down counters. Understand the concepts of Shift register, Ring counter and Johnson counter	PSO2, PSO3	K1, K2
CO-3	Acquire knowledge about the pulse generator using the IC 555 – Application as frequency divider. Understand the concepts of BCD to Excess- 3 and Excess 3 to BCD code conversion. Analyze the applications of binary up / down counters. Understand the concepts of Shift register, Ring counter and Johnson counter	PSO1, PSO3, PSO5	K1, K2
CO-4	Analyze the applications of synchronous parallel 4-bit binary up/down counters Understand the concepts involved in the asynchronous parallel 4-bit binary up/down counter. Analyze the applications of Modulus counter. Acquire knowledge about the Construction of Multiplexer and Demultiplexer	PSO2, PSO4	K1, K2, K4
CO-5	Acquire the knowledge about the series voltage regulator. Undestand the concepts of Arithmetic operations. Improve the analytical and observation ability in Physics Experiments. Acquire knowledge about the Hartley and Colpitt Oscillators	PSO1, PSO2, PSO5	K5, K2
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PCPH2P2	ADVANCED ELECTRONICS PRACTICAL	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	2	2	2	3	3	2	2	2	3	3
CO-2	2	2	3	3	3	2	2	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1).										

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Semester – II	ADVANCED MATHEMATICAL PHYSICS		24PEPH21A			
Elective-IIIA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

Improving student comfort with some mathematical techniques and highlighting the applications of mathematical methods to physics systems.

Learning Objectives

LO	The learners will be able to
LO-1	To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.
LO-2	Grasp knowledge to evaluating the discrete and continuous groups.
LO-3	Develop problem-solving skills using a variety of special unitary groups.
LO-4	Discriminate the solution of tensors and tensor calculus problems.
LO-5	Competently use tensor calculus as a tool in the field of applied sciences and related fields.

UNIT – I DISCRETE GROUPS (15 Hours)

Definition of a group, subgroup, class, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.

UNIT – II CONTINUOUS GROUPS (15 Hours)

Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D-matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.

UNIT – III SPECIAL UNITARY GROUPS (15 Hours)

Definition of unitary, unimodular groups SU(2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)-Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the

irreducible representations 3.3*-, 6,6 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G.coefficients for 3 x 3* and 3 x 6 representations.

UNIT – IV TENSORS (15 Hours)

Cartesian vectors and tensors, Four vector in special relativitity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.

UNIT – V TENSOR CALCULUS (15 Hours)

Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0. Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation G=0.

TEXT BOOKS

1. A.W.Joshi, Group Theory for Physicists
2. D.B.Lichtenberg, Unitary Symmetry and Elementary Particles
3. E.Butkov, Mathematical Physics
4. J.V.Narlikar, General Relativity & Cosmology
5. R. Geroch, Mathematical Physics, The University of Chicago press (1985).

REFERENCE BOOKS

1. M.Hamermesh Group Theory
2. M.E.Rose: Elementary Theory of Angular Momentum
3. Georgi : Lie Groups for Physicists
4. E.A.Lord: Tensors, Relativity & Cosmology
5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.

Course outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Gained knowledge of both discrete and continuous groups	PSO1, PSO3	K1
CO-2	Apply various important theorems in group theory	PSO1, PSO2, PSO3	K3
CO-3	Construct group multiplication table, character table relevant to important branches of physics.	PSO3, PSO4	K5
CO-4	Equipped to solve problems in tensors	PSO1, PSO3	K4, K5
CO-5	Developed skills to apply group theory and tensors to peruse research	PSO3, PSO4, PSO5	K2, K3
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PEPH21A	ADVANCED MATHEMATICAL PHYSICS	60	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	2	1	1	3	3	2	1	1
CO-2	3	3	2	1	1	3	3	2	1	2
CO-3	3	3	2	1	2	3	3	2	1	2
CO-4	3	3	2	2	1	3	3	2	2	2
CO-5	3	3	2	2	2	3	3	2	2	2
STRONG (3), MEDIUM (2) and LOW (1)										

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Signature: Head of the Department

Semester – II	MEDICAL PHYSICS		24PEPH21B			
Elective-IIIB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

To educate the students with the fundamental ideas of Physics in medical applications.

Learning Objectives

LO	The learners will be able to
LO-1	Understand the major applications of Physics to Medicine
LO-2	Study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
LO-3	Outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics.
LO-4	Introduce the ideas of Radiography.
LO-5	Form a good base for further studies like research.

UNIT – I X-RAYS AND TRANSDUCERS (12 Hours)

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

UNIT - II BLOOD PRESSURE MEASUREMENTS (12 Hours)

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

UNIT - III RADIATION PHYSICS (12 Hours)

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – 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 (12Hours)

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)

UNIT - V RADIATION PROTECTION (12 Hours)

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

TEXTBOOKS

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

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.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Learn the fundamentals, production and applications of X-rays.	PSO1, PSO4	K1
CO-2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	PSO2, PSO3	K2
CO-3	Apply knowledge on Radiation Physics	PSO1, PSO4	K3
CO-4	Analyze Radiological imaging and filters	PSO4	K4
CO-5	Assess the principles of radiation protection	PSO2, PSO4	K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PEPH21B	MEDICAL PHYSICS				4		3		
Course Outcomes (COs)	Programme Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	3	1	1	3	3	3	1	1
CO-2	3	3	3	2	1	3	3	3	2	1
CO-3	3	3	3	2	1	3	3	3	2	1
CO-4	3	3	3	2	1	3	3	3	2	1
CO-5	3	3	3	1	1	3	3	3	1	1
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester – II	CHARACTERIZATON OF MATERIALS		24PEPH21C			
Elective-IIIC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

To introduce the students to the fundamental ideas of nanomaterials and its various characterization techniques.

Learning Objectives

LO	The learners will be able to
LO-1	Make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
LO-2	Make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques.
LO-3	Make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.
LO-4	Make the students understand some important electrical and optical characterization techniques for semiconducting materials.
LO-5	Introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

UNIT – I THERMAL ANALYSIS (12 Hours)

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.

UNIT – II MICROSCOPIC METHODS (12 Hours)

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy– differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - quantitative metallography - image analyzer.

UNIT – III ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY (12 Hours)

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

UNIT– IV ELECTRICAL METHODS AND OPTICAL CHARACTERIZATION (12 Hours)

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

UNIT– V X-RAY AND SPECTROSCOPIC METHODS (12 Hours)

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) – Application - Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies

TEXTBOOKS

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, Butterworth Heinemann, (1993).

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	PSO1, PSO4	K1, K3
CO-2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	PSO2, PSO5	K2
CO-3	The working principle and operation of SEM, TEM, STM and AFM.	PSO3, PSO5	K2, K3
CO-4	Understood Hall measurement, four – probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	PSO2, PSO4	K3, K4
CO-5	The theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications.	PSO1, PSO4	K4, K5
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credit			
II	24PEPH21C	CHARACTERIZATON OF MATERIALS				60	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	3	2	2	3	3	3	2	2
CO-2	3	3	3	2	2	3	3	3	2	2
CO-3	3	3	2	2	2	3	3	2	2	2
CO-4	2	2	2	3	2	2	2	2	3	2
CO-5	2	2	2	2	2	2	2	2	2	2
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester – II	SOLAR ENERGY UTILIZATION		24PIPH21			
Elective-IV-IDC-II			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2			2

General Objective:

To introduce the students to the fundamentals of solar energy and their various applications.

Learning Objectives

LO	The learners will be able to
LO-1	Impart fundamental aspects of solar energy utilization.
LO-2	Give adequate exposure to solar energy related industries
LO-3	Harness entrepreneurship skills
LO-4	Understand the different types of solar cells and channelizing them to the different sectorsof society
LO-5	Develop an industrialist mindset by utilizing renewable source of energy

UNIT – I HEAT TRANSFER & RADIATION ANALYSIS (6 Hours)

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

UNIT – II SOLAR COLLECTORS (6 Hours)

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

UNIT - III SOLAR HEATERS (6 Hours)

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

UNIT - IV SOLAR ENERGY CONVERSION (6 Hours)

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

UNIT - V NANOMATERIALS IN FUEL CELL APPLICATIONS (6 Hours)

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

TEXT BOOKS

1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.
2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", Mc Graw-Hill, 2010.

3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems‟, Academic Press, London, 2009
4. Tiwari G.N, “Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

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

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Gained knowledge in fundamental aspects of solar energy utilization	PSO1, PSO4	K1
CO-2	Equipped to take up related job by gaining industry exposure	PSO2, PSO3	K3
CO-3	Develop entrepreneurial skills	PSO3, PSO4, PSO5	K5
CO-4	Skilled to approach the needy society with different types of solar cells	PSO4, PSO5	K4
CO-5	Gained industrialist mindset by utilizing renewable source of energy	PSO1, PSO4	K2, K3
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PIPH21	SOLAR ENERGY UTILIZATION	30	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	2	3	3	3	3	2	3	3	3
CO-2	2	3	2	2	3	2	3	2	2	3
CO-3	2	3	2	2	2	2	3	2	2	2
CO-4	2	2	2	3	2	2	2	2	3	2
CO-5	2	2	3	2	3	2	2	3	2	3
STRONG (3), MEDIUM (2) and LOW (1)										

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Semester – II	SPECTROSCOPY		24PSPH21			
SEC-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4			3

General Objective:

To have in depth understanding of various techniques of spectroscopy and to study its applications to modern science.

Learning Objectives

LO	The learners will be able to
LO-1	Comprehend the theory behind different spectroscopic methods
LO-2	Know the working principles along with an overview of construction of different types of spectrometers involved
LO-3	Explore various applications of these techniques in R &D.
LO-4	Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.
LO-5	Understand this important analytical tool

UNIT-I MICROWAVE SPECTROSCOPY (18 Hours)

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Non rigid rotator – Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules.

UNIT-II INFRA-RED SPECTROSCOPY (18 Hours)

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 - IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy.

UNIT-III RAMAN SPECTROSCOPY (18 Hours)

Theory of Raman Scattering - Classical theory – molecular polarizability - 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 -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy.

UNIT-IV RESONANCE SPECTROSCOPY (18 Hours)

Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – Instrumentation techniques of NMR spectroscopy.

Electron Spin Resonance: Basic principle – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR

UNIT-V UV SPECTROSCOPY (18 Hours)

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - transmittance and absorbance - Color in organic compounds - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications.

TEXT BOOKS

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

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.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	PSO1, PSO3	**K2**
CO-2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	PSO2, PSO3, PSO4	**K2, K3**
CO-3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	PSO1, PSO3,	**K5**
CO-4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	PSO1, PSO2, PSO5	**K4**
CO-5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	PSO2, PSO3	**K1, K5**
K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating			

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PSPH21	SPECTROSCOPY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	3	3	2	3	3	3	3	2	3
CO-2	2	2	2	3	3	2	2	2	3	3
CO-3	3	2	3	3	3	3	2	3	3	3
CO-4	3	2	3	3	3	3	2	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
STRONG (3), MEDIUM (2) and LOW (1)										

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