HAJEE KARUTHA ROWTHER HOWDIA COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University, Madurai.)

Re Accredited with A++ Grade by NAAC (3rd Cycle)

Uthamapalayam, Theni District. Pin Code: 625 533.

DEPARTMENT OF PHYSICS

MASTER OF SCIENCE – PHYSICS

SYLLABUS

Choice Based Credit System – CBCS

(As per TANSCHE/MKU Guidelines)

with

Outcome Based Education (OBE)

(with effect from Academic Year 2023 -2024 onwards)

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College Vision and Mission

Vision

Our vision is to provide the best type of higher education to all, especially to students hailing from minority Muslim community, rural agricultural families and other deprived, under privileged sections of the society, inculcating the sense of social responsibility in them. Our college is committed to produce talented, duty-bound citizens to take up the challenges of the changing times.

Mission

Our mission is to impart and inculcate social values, spirit of service and religious tolerance as envisioned by our beloved Founder President Hajee Karutha Rowther.

The Vision beckons ..... the Mission continues forever.

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Department Vision and Mission

Vision

To thrive for the truth of nature in terms of agreements of theory with practice and stand firm even if ideas fail till new notions are formed. Physics portraits the landscape of life and this department look forward to explore the physics lying beneath our observations.

Mission

The mission of this department is to teach and learn physics in a collaborative, performance – based pathway; we look to encourage the students towards observation and analysis of the natural world and to provide the tools and skills to the students to be torch bearers of physics by contributing effectively to the existing laws of nature.

PROGRAM OUTCOMES

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., Physics**
Programme Code	
Duration	**PG – 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Programme Scheme Eligibility

A candidate who has passed B.Sc., as the Major subject with Mathematics & Chemistry Ancillary is eligible for the Master of Science – Physics Degree.

Duration of the Course:

M.Sc., Physics – 2 years (4 Semesters).

Medium of instruction:

English.

For Programme Completion

A Candidate shall complete:

- Part III - Core papers in semesters I, II, III and IV respectively
- Part III - Elective papers in semesters I, II, III and IV respectively
- Part IV - Non- Major Elective papers in semester II and III respectively
- Part IV - Skill Enhancement Course papers in semester II, III and IV respectively
- Part V – Extension activity in semester IV respectively

Scheme of Examinations under Choice Based Credit System

Term End Examinations (TEE)	- 75 Marks
Continuous Internal Assessment Examinations (CIAE)	- 25 Marks
Total	- 100 Marks

Pattern of Continuous Internal Assessment Examinations (CIAE)

Average of Two Internal Tests (each 20 marks)	- 20 Marks
Seminar / Quiz / Assignment	- 05 Marks
Total	- 25 Marks

Practical Examination

Internal	– 40 marks
External	– 60 marks
Total	- 100 Marks

Pattern of Term End Examinations

(Max. Marks: 75 / Time: 3 Hours)

External Examinations Question Paper Pattern

Section – A (10 X 1 = 10 Marks)

Answer ALL the questions.

- Questions 1 - 10
- Two questions from each unit
- Multiple choice questions and each question carries Four choices

Section – B (5 X 7 = 35 Marks)

Answer ALL the questions, choosing either a or b.

- Questions 11 - 15
- Two questions from each unit (either…. or…. type)
- Descriptive Type

Section – C (3 X 10 = 30 Marks)

- Answer ALL the questions, choosing either a or b.
- Questions 16 – 18
- Descriptive Type

Passing Marks

A Candidate passes the M.Sc., Physics degree by scoring a minimum of 50% of Marks (internal + external) in each course of the Programme. No minimum marks for internal assessment.

- Minimum 34 Marks (45%) for External Examination in Theory Courses.
- Minimum 27 Marks (45%) for External Examination in Practical.

M.Sc., Physics

Semester - I

Part	Course Category	Course code	Course Title	Credits	Hours
III	Core – I	23PPHCC11	Mathematical Physics	**5**	**6**
	Core – II	23PPHCC12	Classical Mechanics and Relativity	**5**	**6**
	Core Practical – III	23PPHCC1P	Practical - I	**5**	**6**
	Elective- I	23PPHDE11	Linear and Digital ICs and Applications	**4**	**6**
	Elective- II	23PPHGE11	Materials Science	**3**	**6**
			Total	**22**	**30**

Semester - II

Part	Course Category	Course code	Course Title	Credits	Hours.
III	Core – IV	23PPHCC21	Statistical Mechanics	**5**	**6**
	Core – V	23PPHCC22	Quantum Mechanics –I	**5**	**6**
	Core Practical – VI	23PPHCC2P	Practical - II	**3**	**6**
	Elective- III	23PPHDE21	Advanced Optics	**3**	**5**
	Elective – IV	23PPHGE21	Solid Waste Management (SWM)	**3**	**5**
IV	SEC – I (NME - I)	23PPHSE21	Medical Physics	**2**	**2**
			Total	**21**	**30**

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC11	**MATHEMATICAL PHYSICS**	**Core**	**5**	**6**	**25**	**75**	**100**

Pre-Requisites		
Matrices, vectors, differentiation, integration, differential equations		
Learning Objectives		
L1	To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program	
L2	To extend their manipulative skills to apply mathematical techniques in their fields	
L3	To help students apply Mathematics in solving problems of Physics	
UNIT	**Contents**	**No. of Hours**
I	**LINEAR VECTOR SPACE** 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 – Direct sum and invariant subspace – orthogonal transformations and rotation	18
II	**COMPLEX ANALYSIS** Review of Complex Numbers -de Moivre's theorem-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 and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders	18
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 – Diagonalization	18
IV	**FOURIER TRANSFORMS & LAPLACE TRANSFORMS**	18

	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	
V	**DIFFERENTIAL EQUATIONS** Second order differential equation- Sturm-Liouville's theory - 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 -Sturm-Liouville's type equation in one dimension & their Green's function.	18
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
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	K1,K2,K3,K4,K5
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.	K1,K2,K3,K4,K5
3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	K1,K2,K3,K4,K5,K6
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	K1,K2,K3,K4,K5,K6
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	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		
Textbooks		
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 East West, New Delhi.
5.	C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York
Web Resources	
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
5.	https://archive.nptel.ac.in/courses/115/106/115106086/

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC12	CLASSICAL MECHANICS AND RELATIVITY	Core	5	6	25	75	100

Pre-Requisites		
Fundamentals of mechanics, Foundation in mathematical methods.		
Learning Objectives		
L1	To understand fundamentals of classical mechanics.	
L2	To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.	
L3	To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.	
L4	To discuss the theory of small oscillations of a system.	
L5	To learn the relativistic formulation of mechanics of a system.	
UNIT	**Contents**	**No. of Hours**
I	**PRINCIPLES OF CLASSICAL MECHANICS** Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.	18
II	**LAGRANGIAN FORMULATION** D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.	18
III	**HAMILTONIAN FORMULATION** Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.	18
IV	**SMALL OSCILLATIONS** Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	18
V	**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.	18

VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Understand the fundamentals of classical mechanics.	K1,K2,K3,K4,K5
2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K1,K2,K3,K4,K5
3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K1,K2,K3,K4,K5,K6
4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K1,K2,K3,K4,K5,K6
5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Textbooks	
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, 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*, Kedar Nath.
4.	T.W.B. Kibble, *Classical Mechanics*, ELBS.
5.	Greenwood, *Classical Dynamics*, PHI, New Delhi.
Web Resources	
1.	http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2.	https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
3.	1. https://nptel.ac.in/courses/122/106/122106027/
4.	https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5.	https://www.britannica.com/science/relativistic-mechanics

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC1P	PRACTICAL - I	Core	5	6	40	60	100

Pre-Requisites		
Knowledge and hands on experience of basic general and electronics experiments of Physics		
Learning Objectives		
L1	To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.	
L2	To calculate the thermodynamic quantities and physical properties of materials.	
L3	To analyze the optical and electrical properties of materials.	
UNIT	**Contents**	**No. of Hours**
	(Any Twelve Experiments) 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. Measurement of Coefficient of linear expansion- Air wedge Method 4. B-H loop using Anchor ring. 5. Determination of Thickness of the enamel coating on a wire by diffraction 6. Determination of Rydberg's Constant - Hydrogen Spectrum 7. FP Etalon 8. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes. 9. Measurement of Band gap energy- Thermistor 10. Determination of Planck Constant – LED Method 11. Determination of Specific charge of an electron – Thomson's method. 12. Determination of Compressibility of a liquid using Ultrasonics 13. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer 14. GM counter – Characteristics, inverse square law and absorption coefficient. 15. Measurement of Conductivity - Four probe method. 16. Arc spectrum – Iron. 17. Molecular spectra – AlO band. 18. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating. 19. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser. 20. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.	

	21. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench 22. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient 23. Construction of relaxation oscillator using UJT 24. FET CS amplifier- Frequency response, input impedance, output impedance 25. Study of important electrical characteristics of IC741.	
	1. V- I Characteristics of different colours of LED. 2. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp. 3. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp. 4. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer. 5. Construction of square wave Triangular wave generator using IC 741 6. Construction of a quadrature wave using IC 324 7. Construction of pulse generator using the IC 741 – application as frequency divider 8. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type) 9. Study of Binary to Gray and Gray to Binary code conversion. 10. Study of R-S, clocked R-S and D-Flip flop using NAND gates 11. Study of J-K, D and T flip flops using IC 7476/7473 12. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction. 13. Study of Arithmetic logic unit using IC 74181. 14. Construction of Encoder and Decoder circuits using ICs.	
	Total	

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Understand the strength of material using Young's modulus and Conduct experiments on applications of FET and UJT	K1,K2,K3,K4,K5
2	Acquire knowledge of thermal behaviour of the matetials and Analyze various parameters related to operational amplifiers.	K1,K2,K3,K4,K5
3	Understand theoretical principles of magnetism through the experiments and Understand the concepts involved in arithmatic and logical circuits using IC's	K1,K2,K3,K4,K5,K6
4	Acquire knowledge about arc spectrum and applications of laser and Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K1,K2,K3,K4,K5,K6
5	Improve the analytical and observation ability in Physics Experiments and Analyze the applications of counters and registers	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Textbooks	
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, PragatiPrakasan.
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.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHDE11	**LINEAR AND DIGITAL ICs AND APPLICATIONS**	**Elective**	**4**	**6**	**25**	**75**	**100**

Pre-Requisites		
Knowledge of semiconductor devices, basic concepts of digital and analog electronics		
Learning Objectives		
L1	To introduce the basic building blocks of linear integrated circuits.	
L2	To teach the linear and non-linear applications of operational amplifiers.	
L3	To introduce the theory and applications of PLL.	
L4	To introduce the concepts of waveform generation and introduce one special function ICs.	
L5	Exposure to digital IC's	
UNIT	**Contents**	**No. of Hours**
I	**INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER** Introduction, Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp. Characteristics.	18
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, Triangular and Square waveform generators.	18
III	**ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS** 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), low pass filter, monolithic PLL and applications of PLL	18
IV	**VOLTAGE REGULATOR & D to A AND A to D CONVERTERS** 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:	18

	Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.	
V	**CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs** CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).	18
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	K1,K2,K3,K4,K5
2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	K1,K2,K3,K4,K5
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.	K1,K2,K3,K4,K5,K6
4	Learn about various techniques to develop A/D and D/A converters.	K1,K2,K3,K4,K5,K6
5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		
Textbooks		
1	D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India	
2	Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi.	

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

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHGE11	**MATERIALS SCIENCE**	**Elective**	**3**	**6**	**25**	**75**	**100**

Pre-Requisites		
Basic knowledge on different types of materials		
Learning Objectives		
L1	To gain knowledge on optoelectronic materials	
L2	To learn about ceramic processing and advanced ceramics	
L3	To understand the processing and applications of polymeric materials	
L4	To gain knowledge on the fabrication of composite materials	
L5	To learn about shape memory alloys, metallic glasses and nanomaterials	
UNIT	**Contents**	**No. of Hours**
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.	18
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	18
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.	18
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.	18
V	**NEW MATERIALS** Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and	18

	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	
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Acquire knowledge on optoelectronic materials	K1,K2,K3,K4,K5
2	Be able to prepare ceramic materials	K1,K2,K3,K4,K5
3	Be able to understand the processing and applications of polymeric materials	K1,K2,K3,K4,K5,K6
4	Be aware of the fabrication of composite materials	K1,K2,K3,K4,K5,K6
5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	K1,K2,K3,K4,K5,K6

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

Textbooks

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. Van Vlack, 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

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Strong-3 Medium-2 Low-1

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC21	STATISTICAL MECHANICS	Core	5	6	25	75	100

Pre-Requisites		
Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium, Brownian motion		
Learning Objectives		
L1	To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics	
L2	To identify the relationship between statistic and thermodynamic quantities	
L3	To comprehend the concept of partition function, canonical and grand canonical ensembles	
L4	To grasp the fundamental knowledge about the three types of statistics .	
L5	To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time	
UNIT	**Contents**	**No. of Hours**
I	**PHASE TRANSITIONS** 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.	18
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.	18
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.	18
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.	18
V	**REAL GAS, ISING MODEL AND FLUCTUATIONS**	18

	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 - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation	
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K1,K2,K3,K4,K5
2	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. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	K1,K2,K3,K4,K5
3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	K1,K2,K3,K4,K5,K6
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.	K1,K2,K3,K4,K5,K6
5	To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model	K1,K2,K3,K4,K5,K6

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

Textbooks

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 WorthHeinemann, New Delhi.

2.	L. D. Landau and E. M. Lifshitz, 1969, *Statistical Physics,* Pergamon Press, Oxford.
3.	K. Huang, 2002, *Statistical Mechanics,* Taylor and Francis, London
4.	W. Greiner, L. Neise and H. Stoecker, *Thermodynamics and Statistical Mechanics,* Springer Verlang, New York.
5.	A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata.
Web Resources	
1.	https://byjus.com/chemistry/third-law-of-thermodynamics/
2.	https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3.	https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4.	https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5.	https://en.wikipedia.org/wiki/Ising_model

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

Strong-3 Medium-2 Low-1

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC22	QUANTUM MECHANICS – I	Core	5	6	25	75	100

Pre-Requisites		
Newton's laws of motion, Schrodinger's equation, integration, differentiation.		
Learning Objectives		
L1	To develop the physical principles and the mathematical background important to quantum mechanical descriptions.	
L2	To describe the propagation of a particle in a simple, one-dimensional potential.	
L3	To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.	
L4	To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature	
L5	To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.	
UNIT	**Contents**	**No. of Hours**
I	**BASIC FORMALISM** 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 – General Uncertainty relation.	18
II	**ONE DIMENSIONAL 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.	18
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.	18
IV	**APPROXIMATION METHODS** Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom –	18

	Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.	
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.	18
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**90**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1,K2,K3,K4,K5
2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K1,K2,K3,K4,K5
3	Can discuss the various representations, space time symmetries and formulations of time evolution	K1,K2,K3,K4,K5,K6
4	Can formulate and analyze the approximation methods for various quantum mechanical problems	K1,K2,K3,K4,K5,K6
5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K1,K2,K3,K4,K5,K6

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

Textbooks

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.
Web Resources	
1.	http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
2.	http://www.feynmanlectures.caltech.edu/III_20.html
3.	http://web.mit.edu/8.05/handouts/jaffe1.pdf
4.	https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
5.	https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

Strong-3 Medium-2 Low-1

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHCC2P	**PRACTICAL - II**	**Core**	**3**	**6**	**40**	**60**	**100**

Pre-Requisites		
Knowledge and handling of basic general and electronics experiments of Physics		
Learning Objectives		
L1	To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.	
L2	To calculate the thermodynamic quantities and physical properties of materials.	
L3	To analyze the optical and electrical properties of materials.	
L4	To observe the applications of FET and UJT.	
L5	To study the different applications of operational amplifier circuits.	
L6	To learn about Combinational Logic Circuits and Sequential Logic Circuits	
UNIT	**(Any Twelve Experiments)**	**No. of Hours**
	1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method 2. Determination of Stefan's constant of radiation from a hot body 3. Measurement of Coefficient of linear expansion- Air wedge Method 4. Measurement of Susceptibility of liquid - Quincke's method 5. B-H curve using CRO 6. Measurement of Magnetic Susceptibility - Guoy's method 7. LG Plate 8. Arc spectrum: Copper 9. Determination of Solar constant 10. Determination of e/m - Millikan's method 11. Miscibility measurements using ultrasonic diffraction method 12. Determination of Thickness of thin film. - Michelson Interferometer 13. GM counter – Feather's analysis: Range of Beta rays 14. Iodine absorption spectra 15. Molecular spectra – CN bands 16. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser 17. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source. 18. Measurement of Dielectricity - Microwave test bench	

	19. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility 20. Interpretation of vibrational spectra of a given material	
	1. Determination of I-V Characteristics and efficiency of solar cell. 2. IC 7490 as scalar and seven segment display using IC7447 3. Solving simultaneous equations – IC 741 / IC LM324 4. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter 5. Construction of Current to Voltage and Voltage to Current Conversion using IC 741. 6. Construction of second order butter worth multiple feedback narrow band pass filter 7. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193 8. Construction of square wave generator using IC 555 – Study of VCO 9. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer 10. Construction of pulse generator using the IC 555 – Application as frequency divider 11. BCD to Excess- 3 and Excess 3 to BCD code conversion 12. Study of binary up / down counters - IC 7476 / IC7473 13. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474 14. Study of synchronous parallel 4-bit binary up/down counter using IC 74193 15. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493 16. Study of Modulus Counter 17. Construction of Multiplexer and Demultiplexer using ICs.	
	Total	

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Understand the strength of material using Young's modulus and Conduct experiments on applications of FET and UJT	K1,K2,K3,K4,K5
2	Acquire knowledge of thermal behaviour of the materials and Analyze various parameters related to operational amplifiers	K1,K2,K3,K4,K5
3	Understand theoretical principles of magnetism through the experiments and Understand the concepts involved in arithmetic and logical circuits using IC's	K1,K2,K3,K4,K5,K6
4	Acquire knowledge about arc spectrum and applications of laser and Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K1,K2,K3,K4,K5,K6

5	Improve the analytical and observation ability in Physics Experiments and Analyze the applications of counters and registers	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		
Textbooks		
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	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.R Rakshit, New Central Book Agency Pvt. Ltd	
2.	Advanced Practical Physics, S.P Singh, Pragati Prakasan	
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	

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHDE21	**ADVANCED OPTICS**	**Elective**	**3**	**5**	**25**	**75**	**100**

Pre-Requisites		
Knowledge of ray properties and wave nature of light		
Learning Objectives		
L1	To know the concepts behind polarization and could pursue research work on application aspects of laser	
L2	To impart an extensive understanding of fiber and non-linear optics	
L3	To study the working of different types of LASERS	
L4	To differentiate first and second harmonic generation	
L5	Learn the principles of magneto-optic and electro-optic effects and its applications	
UNIT	**Contents**	**No. of Hours**
I	**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	15
II	**LASERS** Basic principles – 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 – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser	15
III	**FIBER OPTICS** Introduction – 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	15
IV	**NON-LINEAR OPTICS** Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation –	15

	Optical mixing – Parametric generation of light – Self-focusing of light	
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	15
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**75**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Discuss the transverse character of light waves and different polarization phenomenon	K1,K2,K3,K4,K5
2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K1,K2,K3,K4,K5
3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	K1,K2,K3,K4,K5,K6
4	Identify the properties of nonlinear interactions of light and matter	K1,K2,K3,K4,K5,K6
5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	K1,K2,K3,K4,K5,K6

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

Textbooks

1	B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.
2	Ajoy Ghatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
3	William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York
4	J. Peatros, Physics of Light and Optics, a good (and free!) electronic book
5	B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,

Reference Books

1.	F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition.
2.	Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH.
3.	Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
4.	Y. B. Band, Light and Matter, Wiley and Sons (2006)
5.	R. Guenther, Modern Optics, Wiley and Sons (1990)

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

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong-3 Medium-2 Low-1

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHGE21	**SOLID WASTE MANAGEMENT**	**Elective**	**3**	**5**	**25**	**75**	**100**

Pre-Requisites		
Basic knowledge of solid waste and its type		
Learning Objectives		
L1	To gain basic knowledge in solid waste management procedures	
L2	To gain industry exposure and be equipped to take up a job.	
L3	To harness entrepreneurial skills.	
L4	To analyze the status of solid waste management in the nearby areas.	
L5	To sensitize the importance of healthy practices in waste managements	
UNIT	**Contents**	**No. of Hours**
I	**SOLID WASTE MANAGEMENT** Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.	15
II	**SOLID WASTE CHARACTERISTICS** Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation	15
III	**TOOLS AND EQUIPMENT** Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique	15
IV	**ECONOMIC DEVELOPMENT** SWM for economic development and environmental protection Linking SWM and climate change and marine litter.	15
V	**INDUSTRIAL VISIT** SWM Industrial visit – data collection and analysis - presentation	15
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**75**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Gained knowledge in solid waste management	K1,K2,K3,K4,K5
2	Equipped to take up related job by gaining industry exposure	K1,K2,K3,K4,K5
3	Develop entrepreneurial skills	K1,K2,K3,K4,K5,K6
4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	K1,K2,K3,K4,K5,K6

5	Adequately sensitized in managing solid wastes in and around his/her locality	K1,K2,K3,K4,K5,K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		
Textbooks		
1	Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).	
2	Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006).	
3	Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS Publications / BSPBooks (.(2020	
4	Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014).	
5	Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016	
Reference Books		
1.	Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012	
2.	Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2	
3.	Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237	
4.	Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 20061SBN-I3: 978-8131709122	
5.	Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693	
Web Resources		
1.	https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648	
2.	https://testbook.com/learn/environmental-engineering-solid-waste-management/	
3.	https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRAR IsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXj J1iACq30KofoaAmFsEALw_wcB	
4.	https://images.app.goo.gl/tYiW2gUPfS2cxdD28	
5.	https://amzn.eu/d/5VUSTDI	

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

Strong-3 Medium-2 Low-1

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PPHSE21	MEDICAL PHYSICS	SEC	2	2	25	75	100

Pre-Requisites		
Fundamentals of physiological concepts, Basics of instruments principle,		
Learning Objectives		
L1	To understand the major applications of Physics to Medicine	
L2	To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.	
L3	To 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.	
L4	To introduce the ideas of Radiography.	
L5	To form a good base for further studies like research.	
UNIT	**Contents**	**No. of Hours**
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	6
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).	6
III	**RADIATION PHYSICS** 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	6
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)	6

V	**RADIATION PROTECTION** Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter	6
VI	**PROFESSIONAL COMPONENTS** Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	
	Total	**30**

Course Outcomes		**Knowledge Level**
CO	**On completion of this course, students will**	
1	Learn the fundamentals, production and applications of X-rays.	K1,K2,K3,K4,K5
2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	K1,K2,K3,K4,K5
3	Apply knowledge on Radiation Physics	K1,K2,K3,K4,K5,K6
4	Analyze Radiological imaging and filters	K1,K2,K3,K4,K5,K6
5	Assess the principles of radiation protection	K1,K2,K3,K4,K5,K6

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

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.

Web Resources

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/

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

Strong-3 Medium-2 Low-1

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

Strong-3 Medium-2 Low-1