

(For the candidates admitted 2026 – 2027 onwards)

Course	CC1	Semester – I	Course Code: B1PPHC1
Course Title	MATHEMATICAL PHYSICS		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Matrices, vectors, differentiation, integration, differential equations		
Learning Objectives	To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program. To extend their manipulative skills to apply mathematical techniques in their fields. To help students apply Mathematics in solving problems of Physics		

UNITS	Course Details
Unit– 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.
Unit – 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.
Unit – III	MATRICES: Types of Matrices and their properties – Conjugate of a matrix – Hermitian and Unitary Matrices – Matrix algebra: Basic operations on matrices – Rank of a Matrix - Adjoint of a matrix – Inverse of a matrix – Characteristic equation – Trace of a matrix– Cayley–Hamilton theorem – Eigen values and Eigen vectors of symmetric and non symmetric matrices.
Unit – IV	FOURIER TRANSFORMS & LAPLACE TRANSFORMS: Definitions –Fourier transform and its inverse – Transform of Gaussian function and Dirac delta function–Fourier transform of derivatives – Cosine and sine transforms – Convolution theorem. Laplace transform and its inverse – Transforms of derivatives and integrals – Differentiation and integration of transforms – Dirac delta functions.
Unit–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.

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, <i>Mathematical Physics</i> (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, <i>Mathematical Physics</i> (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.
Ref. 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, 6th Edition, International Edition, McGraw–Hill, New York
Web Resources	1. www.khanacademy.org 2. https://youtu.be/LZnRIOA1_2I 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath 4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SIED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSE OUTCOMES:

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

CO1	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
CO2	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.	K2, K3
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	K4
CO4	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	K4, K5
CO5	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	K2, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC2	Semester – I	Course Code: B1PPHC2
Course Title	CLASSICAL MECHANICS AND RELATIVITY		
Credits - 6	Instruction Hours–6		Medium : English
Pre-Requisites	Fundamentals of mechanics, Foundation in mathematical methods.		
Learning Objectives	To understand fundamentals of classical mechanics. To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. To discuss the theory of small oscillations of a system. To learn the relativistic formulation of mechanics of a system.		

UNITS	Course Details
Unit– 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 – transformation equations – principle of virtual work.
Unit – II	LAGRANGIAN FORMULATION: Mechanics of a particle and a system of particles – Conservation laws – Constraints – Generalized coordinates – D’Alembert’s principle and Lagrange’s equation – Hamilton’s variational principle – Lagrange’s equations of motion from Hamilton’s principle – Conservation theorems and symmetry properties – Applications of Lagrange’s equations to linear harmonic oscillator, simple pendulum and Atwood’s machine.
Unit – III	HAMILTONIAN FORMULATION: 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.
Unit – IV	SMALL OSCILLATIONS: Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule – principle of least action – canonical transformation – Liouville’s theorem - Rigid body dynamics – Euler’s angle – moment of inertia tensor – Euler’s equation of motion – symmetric top.
Unit–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 vector notation and their transformations
Text Books	1) H. Goldstein, 2002, <i>Classical Mechanics</i> , 3rd Edition, Pearson Edu. 2) J. C. Upadhyaya, <i>Classical Mechanics</i> , Himalaya Publishing. Co. New Delhi. 3) R. Resnick, 1968, <i>Introduction to Special Theory of Relativity</i> , Wiley Eastern, New Delhi. 4) R. G. Takwala and P.S. Puranik, <i>Introduction to Classical Mechanics</i> –Tata – McGraw Hill, New Delhi, 1980.

	5) N. C. Rana and P.S. Joag, Classical Mechanics – Tata McGraw Hill, 2001
Ref. books	1) K. R. Symon, 1971, <i>Mechanics</i> , Addison Wesley, London. 2) S. N. Biswas, 1999, <i>Classical Mechanics</i> , Books & Allied, Kolkata. 3) Gupta and Kumar, <i>Classical Mechanics</i> , KedarNath. 4) T.W.B. Kibble, <i>Classical Mechanics</i> , ELBS. 5) Greenwood, <i>Classical Dynamics</i> , 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) https://nptel.ac.in/courses/122/106/122106027/ 4) https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/ https://www.britannica.com/science/relativistic-mechanics

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of classical mechanics.	K2
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3, K5
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K4, K5
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K2, K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

Question Paper Pattern

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC3	Semester – I	Course Code: B1PPHC3
Course Title	COMMUNICATION ELECTRONICS		
Credits - 6	Instruction Hours – 6		Medium : English
Pre–Requisites	Knowledge of Regions of electromagnetic spectrum and its characteristics		
Learning Objectives	To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth’s atmosphere and along the surface of the earth. To gain knowledge in the generation and propagation of microwaves. To acquire knowledge about radar systems and its applications and also the working principle of colour television. To learn the working principle of fiber optics and its use in telecommunication. To understand the general theory and operation of satellite communication systems.		

UNITS	Course Details
Unit– I	ANTENNAS AND WAVE PROPAGATION: Radiation field and radiation resistance of short dipole antenna–grounded antenna–ungrounded antenna–antenna arrays–broadside and end side arrays–antenna gain–directional high frequency antennas–sky wave–ionosphere–Ecles and Larmor theory–Magnento ionic theory–ground wave propagation
Unit – II	MICROWAVES: Microwave generation—multi cavity Klystron–reflex klystron–magnetron travelling wave tubes (TWT) and other microwave tubes–MASER–Gunn diode–wave guides–rectangular wave guides–standing wave indicator and standing wave ratio(SWR)
Unit – III	RADAR AND TELEVISION: Elements of a radar system–radar equation–radar performance Factors radar transmitting systems–radar antennas–duplexers–radar receivers and indicators–pulsed systems–other radar systems–colour TV transmission and reception–colour mixing principle–colour picture tubes– Delta gun picture tube–PIL colour picture tube–cable TV, CCTV and theatre TV
Unit – IV	OPTICAL FIBER: Propagation of light in an optical fibre–acceptance angle–numerical aperture–step and graded index fibres–optical fibres as a cylindrical wave guide–wave guide equations–wave guide equations in step index fibres–fibre losses and dispersion–applications
Unit–V	SATELLITE COMMUNICATION: Orbital satellites–geostationary satellites–orbital patterns–satellite system link models–satellite system parameters–satellite system link equation link budget–INSAT communication satellites
Text Books	1. Handbook of Electronics by Gupta and Kumar, 2008 edition. 2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988. 3. Taub and Schilling, principles of communication systems, second edition, Tata McGraw Hill (1991). 4. M. Kulkarani, Microwave and radar engineering, Umesh Publications, 1998.

	5. Mono Chrome and colour television, R. R. Ghulathi
Ref. books	1. Electronic communications – Dennis Roddy and Coolen, Prentice Hall of India, IV edition, 1995. 2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998 3. Dennis Roddy and Coolen, 1995, <i>Electronics communications</i>, Prentice Hall of India IV Edition. 4. Wayne Tomasi, 1998 “<i>Advanced Electronics communication System</i>” 4th edition, Prentice Hall of India, 1998 5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, <i>Electronic Devices and Circuits</i>, Tata McGraw–Hill Publishing Company Limited, New Delhi, Second Edition.
Web Resources	1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/ 2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/ 3. http://nptel.iitm.ac.in/ 4. http://web.ewu.edu/ 5. http://nptel.iitm.ac.in/

COURSE OUTCOMES:

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

CO1	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface Evaluate the energy and power radiated by the different types of antenna	K1, K5
CO2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides– discuss and compare the different methods of generation of microwaves	K4
CO3	Classify and compare the working of different radar systems– apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military– elaborate and compare the working of different picture tube	K3
CO4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it–discover the use of optical fiber as wave guide	K1, K3
CO5	Explain the importance of satellite communication in our daily life–distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

Question Paper Pattern

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC4	Semester – I	Course Code: B1PPHC4P
Course Title	PRACTICAL – I		
Credits - 6	Instruction Hours–6		Medium : English
Pre–Requisites	Knowledge and hands on experience of basic general and electronics experiments of Physics		
Learning Objectives	To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.To calculate the thermodynamic quantities and physical properties of materials.To analyze the optical and electrical properties of materials.		

List of Experiments
(Minimum Twelve Experiments)
1. Determination of Planck Constant – LED Method 2. Measurement of Band gap energy– Thermistor 3. Determination of Specific charge of an electron – Thomson’s method. 4. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating. 5. Determination of Diffraction pattern of light with circular aperture using Diode/He–Ne laser 6. Determination of Wavelength– Michelson Interferometer 7. Arc spectrum – Iron. 8. FET CS amplifier– Frequency response, input impedance, output impedance 9. V– I Characteristics of different colours of LED. 10. Half adder and Full adder using NAND gates. 11. Determination of q, η, σ by elliptical fringes method. 11. Planck’s constant Determination. 12. Determination of wavelength and particle size determination– using LASER light. 13. Four probe method – Determination of resistivity of powdered samples. 14.Determination of magnetic susceptibility of liquid by Guoy’s method. 15.Determination of magnetic susceptibility of liquids by Quincke’s method. 16. Determination of specific rotatory power of a liquid using polarimeter. 17. Construction of Dual power supply for IC experiments (9–0–9V) 18. Characteristics of UJT. 19. Characteristics of LDR. 20. Study of MOD counter (7490) and Seven Segment Decoder (7447).

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. 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. Chattopadhyay, 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:

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

CO1	Understand the strength of material using Young's modulus.	K2
CO2	Acquire knowledge of thermal behaviour of the materials.	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1, K3
CO5	Improve the analytical and observation ability in Physics Experiments	K3, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC5	Semester– II	Course Code: B2PPHC5
Course Title	ELECTROMAGNETIC THEORY		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Different coordinate systems, Laplace’s equation, conducting & non–conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma		
Learning Objectives	To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables. To understand Biot – Savart’s law and Ampere’s circuital law. To comprehend the physical ideas contained in Maxwell’s equations, Coulomb & Lorentz gauges, conservation laws. To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves. To grasp the concept of plasma as the fourth state of matter		

UNITS	Course Details
Unit– I	ELECTROSTATICS: Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Example of solutions for boundary value problems: Potential Distribution Between Two Parallel Conducting Plates - Potential Around a Conducting Sphere. Polarization and displacement vectors – Boundary conditions – Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.
Unit – II	MAGNETOSTATICS: Biot–Savart’s Law – Ampere’s law – Magnetic vector potential and magnetic field of a localized current distribution – Magnetic moment, force and torque on a current distribution in an external field – Magneto static energy – Magnetic induction and magnetic field in macroscopic media – Boundary conditions – Uniformly magnetized sphere.
Unit – III	MAXWELL EQUATIONS: Faraday’s laws of Induction – Maxwell’s displacement current – Maxwell’s equations – Vector and scalar potentials – Gauge invariance – Wave equation and plane wave solution– Coulomb and Lorentz gauges – Energy and momentum of the field –Poynting’s theorem – Lorentz force – Conservation laws for a system of charges and electromagnetic fields.
Unit – IV	WAVE PROPAGATION: Plane waves in non–conducting media – Linear and circular polarization, reflection and refraction at a plane interface – Waves in a conducting medium – Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials – Radiation from a localized source – Oscillating electric dipole
Unit–V	ELEMENTARY PLASMA PHYSICS: The Boltzmann Equation – Simplified magneto–hydrodynamic equations – Electron plasma oscillations – The Debye shielding problem – Plasma confinement in a magnetic field – Magneto–hydrodynamic waves – Alfven waves and magnetosonic waves.

Text Books	1. D. J. Griffiths, 2002, <i>Introduction to Electrodynamics</i>, 3rd Edition, Prentice–Hall of India, New Delhi. 2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, <i>Foundations of Electromagnetic Theory</i>, 3rd edition, Narosa Publishing House, New Delhi. 3. J. D. Jackson, 1975, <i>Classical Electrodynamics</i>, Wiley Eastern Ltd. New Delhi. 4. J. A. Bittencourt, 1988, <i>Fundamentals of Plasma Physics</i>, Pergamon Press, Oxford. 5. Gupta, Kumar and Singh, <i>Electrodynamics</i>, S. Chand & Co., New Delhi
Ref. books	1. W. Panofsky and M. Phillips, 1962, <i>Classical Electricity and Magnetism</i>, Addison Wesley, London. 2. J. D. Kraus and D. A. Fleisch, 1999, <i>Electromagnetics with Applications</i>, 5th Edition, WCB McGraw–Hill, New York. 3. B. Chakraborty, 2002, <i>Principles of Electrodynamics</i>, Books and Allied, Kolkata. 4. P. Feynman, R. B. Leighton and M. Sands, 1998, <i>The Feynman Lectures on Physics</i>, Vols. 2, Narosa Publishing House, New Delhi. 5. Andrew Zangwill, 2013, <i>Modern Electrodynamics</i>, Cambridge University Press, USA.
Web Resources	1. http://www.plasma.uu.se/CED/Book/index.html 2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html 3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html 4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/ 5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSE OUTCOMES:

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

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	K1, K5
CO2	Use Biot–Savart’s law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	K2, K3
CO3	Apply Maxwell’s equations to describe how electromagnetic field behaves in different media	K3
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	K3, K4
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	CC6	Semester – III	Course Code: B2PPHC6
Course Title	QUANTUM MECHANICS		
Credits – 6	Instruction Hours–6		Medium : English
Pre-Requisites	Newton's laws of motion, Schrodinger's equation, integration, differentiation.		
Learning Objectives	To learn the physical principles and the mathematical background important to quantum mechanical descriptions. To understand the propagation of a particle in a simple, one-dimensional potential. To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential. To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature. To explore the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.		

UNITS	Course Details
Unit– I	BASIC FORMALISM: Postulates of Quantum Mechanics -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 – Simultaneous measurability of observables – General Uncertainty relation
Unit – 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 – Bloch waves in a periodic potential – Kronig-penny square well – periodic potential – Linear harmonic oscillator: Operator method – Three dimensional harmonic oscillator - Rigid rotator – Hydrogen Atom.
Unit – III	GENERAL FORMALISM: Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal.
Unit – IV	PERTURBATION THEORY: Time independent perturbation theory for non-degenerate states – Degenerate states – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) — Application to simple harmonic oscillator.
Unit–V	ANGULAR MOMENTUM: Eigenvalue spectrum of general angular momentum – Ladder operators $L_{\pm}$ – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

Text Books	1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition (37th Reprint), Tata McGraw–Hill, New Delhi, 2010. 2. G. Aruldas, 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, 4th Edition, Macmillan, India, 1984.
Ref. 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, Pergamon 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

COURSE OUTCOMES:

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

CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1, K5
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K3, K4
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	K1
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	K4, K5
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K3, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC7	Semester – II	Course Code: B2PPHC7
Course Title	STATISTICAL MECHANICS		
Credits - 6	Instruction Hours–6		Medium : English
Pre–Requisites	Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium, Brownian motion		
Learning Objectives	To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics. To identify the relationship between statistic and thermodynamic quantities. To comprehend the concept of partition function, canonical and grand canonical ensembles. To grasp the fundamental knowledge about the three types of statistics. To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time.		

UNITS	Course Details
Unit– I	STATISTICAL THERMODYNAMICS: Fundamentals of work, energy and heat – First law of thermodynamics – Heat content and heat capacity –Specific heat - Entropy-Formulation of second law in terms of entropy-Thermodynamic potentials and its reciprocity relation – properties of thermodynamic relations - Nernst heat theorem (third law of thermodynamics) – Consequences of third law(Coefficient of expansion of pure solid, specific heat C_p and C_v , the unattainability of absolute zero).
Unit – II	KINETIC THEORY OF GASES: Gibb’s phase rule-phase space-The mean free path-order and variation of mean free path-Mean free path and collision probability – Maxwell-Boltzmann law of distribution of velocities- Mean free path and collision probability- viscous hydrodynamics - Transport phenomena – Diffusion (definition only)-The Brownian motion.
Unit – III	CLASSICAL STATISTICAL MECHANICS: Thermodynamic potentials- Significance of thermodynamic potentials- Relation of thermodynamic potentials with their variables – Statistical ensembles – Types – Micro, Canonical, Grand canonical ensembles – Comparison of Ensembles – Liouville’s theorem– Entropy of a perfect gas – Gibb’s Paradox – Partition function and its relation with thermodynamic quantities (Partition function (Z), Enthalpy (S), Entropy(H), Helmholtz free energy (F)).
Unit – IV	QUANTUM STATISTICS: Quantum statistics of identical particles – Density of matrix –Maxwell – Boltzmann distribution law -Bose-Einstein’s distribution law – Fermi –Dirac distribution law – Black body and Planck’s radiation law – Thermionic emission - Einstein’s theory of specific heat of solids –Helium I and II – peculiar properties of Helium II.
Unit–V	FLUCTUATION AND PHASE TRANSITIONS: Fluctuations in Ensembles – Motion due to fluctuating force(Fokker Plank equation) – Thermodynamic irreversible process – Triple point – Vander Walls equation and phase transition – Ehrenfest equation(up to Clausius –Clapeyron equation) – Ising model (Bragg Williams method) –one dimensional Ising model – Landau Theory of Phase transition .

Text Books	1. Heat, thermodynamics, and statistical physics - BrijLal and N. Subrahmanyam and P S HemneS.Chand Publisher 2. Statistical Mechanics – Sathyapraksh -Kedernath and Ramnath –Meerut. 3. S. K. Sinha, 1990, <i>Statistical Mechanics</i> , Tata McGraw Hill, New Delhi. 4. B. K. Agarwal and M. Eisner, 1998, <i>Statistical Mechanics</i> , Second Edition New Age International, New Delhi. 5. J. K. Bhattacharjee, 1996, <i>Statistical Mechanics: An Introductory Text</i> , Allied Publication, New Delhi.
Ref. books	1. F. Reif, Statistical and Thermal physics, McGraw Hill, International Edition. 2. R. Huang, Statistical Mechanics, Wiley Eastern Ltd., New Delhi, (1983). 3. F. Mandl, Statistical physics, John Wiley, London, (1971).
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

COURSE OUTCOMES:

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

CO1	Explain the fundamental principles of thermodynamics, including the laws of thermodynamics, entropy, thermodynamic potentials, and the consequences of the third law.	K4
CO2	Analyze the kinetic theory of gases by applying concepts such as mean free path, molecular velocity distribution, transport phenomena, and Brownian motion.	K5
CO3	Apply the principles of classical statistical mechanics to evaluate thermodynamic properties using statistical ensembles, partition functions, and related thermodynamic potentials.	K1
CO4	Interpret quantum statistical distributions, including Maxwell–Boltzmann, Bose–Einstein, and Fermi–Dirac statistics, and explain their applications to black body radiation, specific heat of solids, and quantum fluids.	K4, K5
CO5	Analyze fluctuations and phase transitions using statistical mechanics concepts, including irreversible processes, phase equilibrium, Ising models, and Landau theory of phase transitions.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	CC8	Semester – II	Course Code: B2PPHC8P
Course Title	PRACTICAL – II		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Knowledge and handling of basic general and electronics experiments of Physics		
Learning Objectives	To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. To calculate the thermodynamic quantities and physical properties of materials. To analyze the optical and electrical properties of materials. To observe the applications of FET and UJT. To study the different applications of operational amplifier circuits. To learn about Combinational Logic Circuits and Sequential Logic Circuits		

List of Experiments
(Minimum Twelve Experiments)
1. Determination of Rydberg's Constant – Hydrogen Spectrum 2. Measurement of Conductivity – Four probe method 3. Determination of Thickness of air film. – Solar spectrum – Hartmann's formula. Edser and Butler fringes. 4. Determination of q, η, σ by hyperbolic fringes method. 5. Determination of e / m of an electron by magnetron method 6. Stefan's Law – verification 7. Optical Fibre – measurements of attenuation coefficient and Numerical aperture 8. Determination of carrier concentration and Hall coefficients in semiconductors. 9. Polarizability of liquids by finding the refractive indices at different wavelengths. 10. Half Subtractor and Full Subtractor using NAND gates 11. Determination of bulk modulus of a liquid by ultrasonic wave propagation. 12. Study of a feedback amplifier – Determination of band width, input and output impedances. 13. Characteristics of SCR. 14. Determination of dielectric constant of a liquid by RF oscillator method. 15. UJT Relaxation oscillator. 16. Determination of Carrier concentrations and Hall coefficient in semiconductor. 17. Determination of magnetic susceptibility of powder sample by Quincke's method. 18. Study of V-I Characteristics of Laser diode and tunnel diode. 19. Design of AC/DC voltage regulator using SCR phase control and timing angle control.

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. Chattopadhyay, 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 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:

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

CO1	Understand the strength of material using Young's modulus	K2
CO2	Acquire knowledge of thermal behaviour of the materials	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1
CO5	Improve the analytical and observation ability in Physics Experiments	K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC9	Semester – III	Course Code: B3PPHC9
Course Title	NUCLEAR AND PARTICLE PHYSICS		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Knowledge of basic structure of atom and nucleus.		
Learning Objectives	Introduces students to the different models of the nucleus in a chronological order. Imparts an in–depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles. Provides students with details of nuclear decay with relevant theories. Exposes students to the Standard Model of Elementary Particles and Higgs boson.		

UNITS	Course Details
Unit– I	NUCLEAR MODELS: Liquid drop model – Weizacker mass formula –Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt lines – electric Quadrupole moment – Bohr and Mottelson collective model.
Unit – II	NUCLEAR FORCES: Nucleon – nucleon interaction –properties of nuclear forces – ground state of deuteron – Exchange Forces – Meson theory of nuclear forces – Yukawa potential – neutron-proton scattering – effective range theory – spin dependence of nuclear forces – charge independence.
Unit – III	NUCLEAR REACTIONS: Kinds of nuclear reactions – Reaction kinematics – Q-value – nuclear scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula –Nuclear Chain reaction – four factor formula.
Unit – IV	NUCLEAR DECAY: Beta decay – Continuous Beta spectrum -Pauli neutrino hypothesis - Fermi theory of beta decay - Comparative Half-life, –Fermi Kurie Plot – mass of neutrino – neutrino physics - allowed and forbidden decay —Gamma decay – multipole radiations –internal conversion – nuclear isomerism.
Unit–V	ELEMENTARY PARTICLES: Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups– Gell Mann Okuba Mass formula–Quark Model.
Text Books	1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011) 2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008) 3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996) 4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011) 5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.– 3rd Revised edition (1968)

Ref. books	1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973) 2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974). 3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002) 4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001) 5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.
Web Resources	1. http://bubl.ac.uk/link/n/nuclearphysics.html 2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia.org/article/Nuclear_Forces 3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/ 4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html 5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

COURSE OUTCOMES:

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

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	K1, K5
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	K2, K3
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet–Weigner single level formula	K3
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	K3, K4
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC10	Semester – III	Course Code: B3PPHC10
Course Title	SPECTROSCOPY		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour		
Learning Objectives	To comprehend the theory behind different spectroscopic methods. To know the working principles along with an overview of construction of different types of spectrometers involved. To explore various applications of these techniques in R &D. Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds. Understand this important analytical tool		

UNITS	Course Details
Unit – I	INFRA–RED SPECTROSCOPY: Quantization of energy – Regions of the electromagnetic spectrum – Classification of molecules – Classification of modes of vibrations – Vibrating diatomic molecule as a harmonic and unharmonic oscillator - Parallel and perpendicular bands of symmetric top molecules – Instrumentation techniques – Double beam spectrometer-FT-IR- Interpretation of vibrational spectra
Unit – II	MICROWAVE SPECTROSCOPY: Rotational spectra of diatomic molecules – Rigid Rotor (Diatomic Molecules)– reduced mass – Effect of isotopic substitution – Non rigid rotator – Polyatomic molecules – linear – symmetric top molecules – Microwave oven - Instrumentation techniques – block diagram –Information Derived from Rotational Spectra .
Unit – III	RAMAN SPECTROSCOPY: Theory of Raman scattering – classical theory – Quantum theory – rotational Raman spectra: linear molecules – Symmetric Top molecules – Vibrational Raman Spectra – Raman activity of Molecules H ₂ O and CO ₂ – Mutual Exclusion Principle – Coherent Anti-Stokes Raman Scattering(CARS) – Fourier Transform Raman Spectrometer.
Unit – IV	RESONANCE SPECTROSCOPY: NMR: Nucleus in a magnetic field – Resonance condition – Spin-Spin and Spin-Lattice Relaxation times – Bloch equations – Chemical shift- Instrumentation techniques of NMR spectroscopy- MRI scanner ESR: Principle – Position of ESR absorptions - g factor — ESR spectra of free radicals in solutions –CH ₃ Radical and Benzene Anion - Hyperfine structure of Hydrogen, Deuterium and Tritium – Instrumentation Technique- Working principle.
Unit –V	UV SPECTROSCOPY: Origin of UV spectra – Laws of absorption – Lambert Bouguer law – Lambert Beer law – molar absorptivity – transmittance and absorbance – Color in organic compounds– Absorption by organic Molecule – Choice of Solvent and Solvent effect – Absorption by inorganic systems – Instrumentation – double beam UV– Spectrophotometer.

Text Books	1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi. 2. G Aruldas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi. 3. D.N. Satyanarayana, 2001, <i>Vibrational Spectroscopy and Applications</i>, New Age International Publication. 4. B.K. Sharma, 2015, <i>Spectroscopy</i>, Goel Publishing House Meerut. 5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition), New Age International Publishers.
Ref. 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, Springer Link.
Web Resources	1. https://www.youtube.com/watch?v=0iQhirTf2PI 2. https://www.coursera.org/lecture/spectroscopy/introduction–3N5D5 3. https://www.coursera.org/lecture/spectroscopy/infrared–spectroscopy–8jEee 4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 5. https://www.coursera.org/lecture/spectroscopy/nmr–spectroscopy–introduction–XCWRu

COURSE OUTCOMES:

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

CO1	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.	K2
CO2	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.	K2, K3
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	K5
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	K4
CO5	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.	K1, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	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	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	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	3	3	3	3

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	CC11	Semester – III	Course Code: B3PPHC11P
Course Title	PRACTICAL – III		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Basic knowledge in digital electronics, microprocessor and microcontroller Basic knowledge of operating system and computer fundamentals.		
Learning Objectives	To equip the computational skill using various mathematical tools. To apply the software tools to digital electronics, microprocessor and microcontroller. To use microprocessor and Microcontroller in different applications		

List of Experiments	
(Minimum Twelve Experiments)	
- Operational Amplifier-Parameters –Open loop gain, closed loop gain, Input impedance, Output impedance, CMRR. - Operational Amplifier- Sign changer, Adder, Subtractor, Differentiator and Integrator. - Operational Amplifier- Low pass, High pass and Band pass filters. - Operational Amplifier-Clipping and Clamping Circuits. - Simplification of Boolean expression (any 4 expression) using Boolean theorems. - Shift Register-SISO, SIPO (Shift left and right). - Synchronous Counter-Up Counter and Down Counter. - BCD- Adder. - One- bit comparator using gates and Four- bit digital Comparator using IC (7485) . - D/A Conversion- R-2R Binary ladder- Weighted Resistor Network - Multiplexer (4 to 1, 8 to 1, 16 to 1). - Microprocessor 8085- 8 bit Addition, Subtraction, Multiplication and Division. - Microprocessor 8085- Conversion from Decimal to Hexa Decimal and Octal Number. - Microprocessor 8085- Traffic Control System. - Microcontroller 8051 – 8 bit Addition and Subtraction. - Microcontroller 8051– 8 bit Multiplication and Division. - Microcontroller 8051 – Square root of a given number. - C-Program- Solving equations by Newton – Raphson method. - C-Program- Solving equations by Successive Approximation method. - C-Program- Solving equations by Gauss Elimination method. - C-Program- Numerical Differentiation by Euler’s method.	
Text Books	- Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey 2006 - Numerical methods in Science and Engineering – M.K. Venkataraman, National Publishing Co. Madras, 1996 V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice–Hall, New Delhi. - S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, New Delhi.

Reference Books	1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw–Hill). 2. B.F. Gerald and P.O. Wheatly, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.
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COURSE OUTCOMES:

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

CO1	Program with the C Program/ FORTRAN with the C or any other high level language	K1
CO2	Use various numerical methods in describing/solving physics problems.	K4
CO3	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.	K5
CO4	To enhance the problem–solving aptitudes of students using various numerical methods.	K5
CO5	To apply various mathematical entities, facilitate to visualise any complicate tasks.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC12	Semester – III	Course Code: B3PPHC12
Course Title	RESEARCH METHODOLOGY		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Thorough understanding the basic requirements needed before conducting research. They include selecting a suitable research topic, defining the research problem and objectives, reviewing existing literature, choosing an appropriate research design, and following ethical guidelines to ensure reliable and valid results.		
Learning Objectives	The main learning objectives of Research Methodology are to understand the research process, identify and define research problems, select appropriate research methods, collect and analyze data accurately, and prepare ethical, reliable, and well-structured research reports.		

UNITS	Course Details
Unit – I	FOUNDATIONS OF RESEARCH: Understanding the language of research – Problem Identification & Formulation –Concept and Importance in Research – Problem identification – literature survey – various sources – current status of the problem – impact and usefulness of the research topic–role of guide and scholar – Features of a good research.
Unit – II	SAMPLING: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi–stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.
Unit – III	NUMERICAL ANALYSIS: Roots of linear and nonlinear algebraic and transcendental equations – bisection and Newton-Raphson methods – Successive Approximation method. Newton’s forward and backward interpolation – Lagrange’s interpolation –Second order Runge-Kutta method – trapezoidal rule – Simpson’s 1/3 rule.
Unit – IV	INTERPRETATION OF DATA AND PAPER WRITING: Writing a paper and preparing a poster – Layout of a Research Paper, Impact factor of Journals, When and where to publish – Plagiarism and Self–Plagiarism – art of writing synopsis, dissertation and thesis Illustrations and analysis of results.
Unit –V	RESEARCH ETHICS: Introduction to Research ethics – Definition and significance – Theories and principles of ethics – Research misconduct and integrity – Etical decision making in research – case studies on ethical dilemmas – professional and personal ethics – Cultural variability in ethical values – The moral impleications of scientific research.
Text Books	1. J. Anderson, and M. Poole. Assignment and Thesis Writing. 4 th Edition. John Wiley and Sons Inc. (2002) 2. M.K. Venkataraman. Numerical Methods in Science and Engineering. The National Publishing Company, Madras. (1999). 3. M.K. Jain, S.R.K. Iyengar and R.K. Jain , Numerical Methods for Scientific and Engineering Computation. 4 th Edition. New Age International Publishers. New Delhi, India. (2005).

Ref. books	1. E. Balagurusamy. Programming in ANSI C. 6th Edition. Tata McGraw Hill Education Private Limited, New Delhi, India. (2012). 2. K. Ravichandran, K. Swaminathan, and B. Sakthivel. Introduction to Thin Films. Research India Publications. New Delhi. (2013).
Web Resources	1. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5 2. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee 3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview

COURSE OUTCOMES:

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

CO1	Identify research problems, conduct literature surveys using various sources, utilize internet and software tools such as MS Office and MATLAB, and understand the roles of the research guide and scholar.	K2
CO2	Prepare and present scientific reports, research papers, posters, synopses, dissertations, and theses with proper illustrations, data analysis, and effective scientific communication.	K2, K3
CO3	Apply numerical methods to solve engineering and scientific problems involving curve fitting, equations, numerical integrations.	K5
CO4	Develop basic C programming skills by writing programs using data types, operators, control statements, arrays, and standard input/output functions to solve computational problems.	K4
CO5	Explain the working principles, instrumentation, and applications of major research equipment such as UV, VIS, IR, FTIR, XRD, SEM, TEM, STEM, ESR, and NMR used in scientific research.	K1, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	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	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	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	3	3	3	3

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC13	Semester – IV	Course Code: B4PPHC13
Course Title	CONDENSED MATTER PHYSICS		
Credits - 6	Instruction Hours–6		Medium : English
Pre–Requisites	Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.		
Learning Objectives	To describe various crystal structures, symmetry and to differentiate different types of bonding. To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. To critically assess various theories of electrons in solids and their impact in distinguishing solids. Outline different types of magnetic materials and explain the underlying phenomena. Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.		

UNITS	Course Details
Unit– I	CRYSTAL PHYSICS: Types of lattices – Miller indices – Symmetry elements and allowed rotations – Simple crystal structures – Atomic Packing Factor– Crystal diffraction – Bragg's law – Scattered Wave Amplitude – Reciprocal Lattice (sc, bcc, fcc). Diffraction Conditions – Laue equations – Brillouin zone.
Unit – II	LATTICE DYNAMICS: Lattice with two atoms per primitive cell – First Brillouin zone – Group and phase velocities – Quantization of lattice vibrations – Phonon momentum – Inelastic scattering by phonons – Debye's theory of lattice heat capacity – Thermal Conductivity.
Unit – III	THEORY OF METALS AND SEMICONDUCTORS: Free electron gas in three dimensions – Electronic heat capacity –Wiedemann–Franz law – Band theory of metals and semiconductors – Bloch theorem – Kronig–Penney model – Semiconductors – Intrinsic carrier concentration – Temperature Dependence – Mobility – Impurity conductivity – Impurity states – Hall effect .
Unit – IV	MAGNETISM: Diamagnetism – Quantum theory of paramagnetism– Rare earth ion –Hund's rule – Adiabatic demagnetization – Quantum theory of ferromagnetism – Curie point – Heisenberg's interpretation of Weiss field – Ferromagnetic domains – Bloch wall – Spin waves – Quantization – Curie temperature and susceptibility of ferrimagnets– Theory of antiferromagnetism– Neel temperature.
Unit–V	SUPER CONDUCTIVITY EXPERIMENTAL FACTS: Occurrence – Effect of magnetic fields –Meissner effect– Critical field – Critical current – Entropy and heat capacity – Energy gap– Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition – London equation – Coherence length – Isotope effect – Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – Josephson tunneling– DC and AC Josephson effects – High temperature Superconductors – SQUIDS.

Text Books	1. C. Kittel, 1996, <i>Introduction to Solid State Physics</i>, 7th Edition, Wiley, New York.bn 2. Rita John, Solid State Physics, Tata Mc–Graw Hill Publication. 3. A. J. Dekker, <i>Solid State Physics</i>, Macmillan India, New Delhi. 4. M. Ali Omar, 1974, <i>Elementary Solid State Physics – Principles and Applications</i>, Addison – Wesley 5. H. P. Myers, 1998, <i>Introductory Solid State Physics</i>, 2nd Edition, Viva Book, New Delhi.
Ref. books	1. J. S. Blakemore, 1974 ,<i>Solid state Physics</i>, 2nd Edition, W.B. Saunder, Philadelphia 2. H. M. Rosenburg, 1993, <i>The Solid State</i>, 3rd Edition, Oxford University Press, Oxford. 3. J. M. Ziman, 1971, <i>Principles of the Theory of Solids</i>, Cambridge University Press, London. 4. C. Ross–Innes and E. H. Rhoderick, 1976, <i>Introduction to Superconductivity</i>, Pergamon, Oxford. 5. J. P. Srivastava, 2001, <i>Elements of Solid State Physics</i>, Prentice–Hall of India, New Delhi.
Web Resources	1. http://www.physics.uiuc.edu/research/electronicstructure/389/389–cal.html 2. http://www.cmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html 3. https://www.britannica.com/science/crystal 4. https://www.nationalgeographic.org/encyclopedia/magnetism/ 5. https://www.brainkart.com/article/Super–Conductors_6824/

COURSE OUTCOMES:

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

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	K1
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	K1, K2
CO3	Student will be able to comprehend the heat conduction in solids	K3
CO4	Student will be able to generalize the electronic nature of solids from band theories.	K3, K4
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC14	Semester – IV	Course Code: B4PPHC14P
Course Title	PRACTICAL – IV		
Credits – 6	Instruction Hours–6		Medium : English
Pre–Requisites	Basic knowledge in digital electronics, microprocessor and microcontroller Basic knowledge of operating system and computer fundamentals.		
Learning Objectives	To equip the computational skill using various mathematical tools. To apply the software tools to digital electronics, microprocessor and microcontroller. To use microprocessor and Microcontroller in different applications		

List of Experiments (Minimum Twelve Experiments)	
1. Operational Amplifier-Sine Wave Generator- Wien’s Oscillator. 2. Operational Amplifier-Square, Triangular and Ramp Wave Generator. 3. Operational Amplifier-Solving Simultaneous equations. 4. Operational Amplifier- Schmidt triggers (IC 555 Timer). 5. Study of Flip Flops using NAND gates. 6. Simplification of Boolean expressions by Karnaugh Map method. 7. D/A Conversion- Resolution Linearity and Dual Slope. 8. Asynchronous Counter- Up Counter and Down Counter. 9. Study of 0-9 and 0-99 Counter (IC 7490 and 7447). 10. Demultiplexer-(1 to 4, 1 to 8, 1to 16). 11. Microprocessor 8085- 16 bit Addition, 1’s complements Subtraction. 12. Microprocessor 8085- Conversion from Octal, Hexa decimal to Decimal number system. 13. Microprocessor 8085 – Searching a number from the given list. 14. Microprocessor 8085 - DAC interfacing (DAC 0800). 15. Microprocessor 8085- Interfacing of Stepper Motor. 16. Microcontroller 8051 – Factorial of a given number. 17. Microcontroller 8051- Smallest and Biggest number in an array of data. 18. Microcontroller 8051- Arranging an array of data in Ascending and Descending order. 19. C-Program- Numerical Integration by Simpson’s method. 20. C-Program- Numerical Integration by Trapezoidal rule. 21. C-Program- Numerical Differentiation by Runge- Kutta (II Order) method.	
TEXT BOOKS	1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata McGraw Hill Publications (2008) 2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008). 3. V. Vijayendran, 2005, Fundamentals of Microprocessor–8085”, 3rd Edition S. VisvanathanPvt, Ltd. 4. The 8085 Microprocessor, Architecture, Programming and Interfacing – K. Udaya Kumar, S. Uma Shankar, Pearson 5. Fundamentals of Microprocessors and Microcontrollers – B. Ram, DhanpatRai Publications

REFERENCE BOOKS	1. W. A. Tribel, Avtar Singh, “The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi. 2. Microprocessor and Its Application – S. Malarvizhi, Anuradha Agencies Publications 3. Microprocessor Architecture, Program And Its Application With 8085 – R.S. Gaonkar, New Age International (P) Ltd 4. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice– Hall of India, New Delhi. 5. J. Uffrenbeck, “The 8086/8088 Family–Design, Programming and Interfacing, Software, Hardware and Applications”, Prentice–Hall of India, New Delhi.
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COURSE OUTCOMES:

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

CO1	Develop the programming skills of Microprocessor	K5
CO2	Appreciate the applications of Microprocessor programming	K3
CO3	Understand the structure and working of 8085 microprocessor and apply it.	K1, K3
CO4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.	K1, K4
CO5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.	K1, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	CC15	Semester – IV	Course Code: B4PPHC15
Course Title	PROJECT WORK WITH VIVA – VOCE		
Credits - 6	Instruction Hours–6		Medium : English
Learning Objectives	To develop the innovative thinking in project to make application oriented working models for theoretical concepts.		

PROJECT WORK

OUTCOME

- This will bring out innovative ideas from the students

EVALUATION

Viva Voce Examination: 70 Marks

HOD

COE

Elective Papers

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECA
CourseTitle	1. ENERGY PHYSICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Knowledge of conventional energy resources	
Learning Objectives	To learn about various renewable energy sources. To know the ways of effectively utilizing the oceanic energy. To study the method of harnessing wind energy and its advantages. To learn the techniques useful for the conversion of biomass into useful energy. To know about utilization of solar energy.	

UNITS	Course Details
Unit– I	INTRODUCTION TO ENERGY SOURCES: Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution.
Unit – II	ENERGY FROM THE OCEANS: Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.
Unit – III	WIND ENERGY SOURCES: Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) – Energy storage–Applications of wind energy.
Unit – IV	ENERGY FROM BIOMASS: Biomass conversion Technologies– wet and dry process– Photosynthesis – Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas– bio gas from waste fuel– properties of biogas–utilization of biogas.
Unit–V	SOLAR ENERGY SOURCES: Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.
Text Books	1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi. 2. S. Rao and Dr. ParuLekar, Energy technology. 3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983). 4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2 nd edition, Tata McGraw–Hill Publishing Co. Lt., New Delhi (1997). 5. Energy Technology by S. Rao and Dr. Parulekar.
Ref. books	1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York. 2. Applied solar energy, A. B. Meinel and A. P. Meinal 3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York.
Web Resources	1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1

	2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/ 3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy 4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/ 5. https://www.acciona.com/renewable-energy/solar-energy/
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COURSE OUTCOMES:

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

CO1	To identify various forms of renewable and non-renewable energy sources	K1
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	K2
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	K3
CO4	Distinguish aerobic digestion process from anaerobic digestion.	K3, K4
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	K2, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECB
CourseTitle	2. CRYSTAL GROWTH AND THIN FILMS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamentals of Crystal Physics	
Learning Objectives	To acquire the knowledge on Nucleation and Kinetics of crystal growth. To understand the Crystallization Principles and Growth techniques. To study various methods of Crystal growth techniques. To understand the thin film deposition methods. To apply the techniques of Thin Film Formation and thickness Measurement	

UNITS	Course Details
Unit– I	CRYSTAL GROWTH KINETICS: Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium – super saturation – Types of Nucleation – Formation of critical Nucleus – Classical theory of Nucleation – Homo and heterogeneous formation of 3D nuclei – rate of Nucleation.
Unit – II	CRYSTALLIZATION PRINCIPLES: Crystallization Principles and Growth techniques Classes of Crystal system – Solvents and solutions – Solubility diagram – Super solubility – expression for super saturation – Metastable zone and introduction period – Solution growth – Low and high temperatures solution growth – Slow cooling and solvent evaporation methods – Constant temperature bath as a Crystallizer.
Unit – III	GEL, MELT AND VAPOUR GROWTH: Gel, Melt and Vapour growth techniques Principle of Gel techniques – Structure and importance of Gel – Methods of Gel growth and advantages – Melt techniques –Czochralski growth –Vapour phase growth – Physical vapour deposition – Chemical vapour deposition.
Unit – IV	THIN FILM DEPOSITION METHODS; Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, Sol Gel spin coating, Spray pyrolysis.
Unit–V	THIN FILM FORMATION: Thin Film Formation and thickness Measurement Nucleation, Film growth and structure – Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement – Interferometry.

Text Books	1. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition 2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008) 3. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution" 4. D. Elwell and H. J. Scheel, "Crystal Growth from High Temperature Solution" 5. Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.
Ref. books	1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986) 2. P. Ramasamy and F. D. Gnanam, 1983, "UGC Summer School Notes". 3. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications. 4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York 5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.
Web Resources	1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp 2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcY7KeTLUuBu3WF 3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m 4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw 5. https://www.electrical4u.com/thermal-conductivity-of-metals/

COURSE OUTCOMES:

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

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
CO2	Understand the Crystallization Principles and Growth techniques	K2, K4
CO3	Study various methods of Crystal growth techniques	K3
CO4	Understand the Thin film deposition methods	K2
CO5	Apply the techniques of Thin Film Formation and thickness Measurement	K3, K4
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECC
Course Title	3. ANALYSIS OF CRYSTAL STRUCTURES	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamentals of crystal structures, symmetry and X-Ray Diffraction techniques	
Learning Objectives	To teach the concept of crystal structures and symmetry, and diffraction theory. To provide students with a background to X-ray generation, scattering theory and experimental diffraction from single crystals. To provide instruction on the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography. To give the students a background to the instrumentation used for powder diffraction and structure refinement using Rietveld method. To teach the different levels of structure exhibited by proteins and nucleic acids and methods used in protein crystallography.	

UNITS	Course details
Unit– I	CRYSTAL LATTICE: Unit cell and Bravais lattices – crystal planes and directions – basic symmetry elements operations – translational symmetries – point groups – space groups – equivalent positions – Bragg's law – reciprocal lattice concept – Laue conditions – Ewald and limiting spheres – diffraction symmetry – Laue groups.
Unit – II	DIFFRACTION: X-ray generation, properties – sealed tube, rotating anode, synchrotron radiation – absorption – filters and monochromators Atomic scattering factor – Fourier transformation and structure factor – anomalous dispersion – Laue, rotation/oscillation, moving film methods– interpretation of diffraction patterns – cell parameter determination – systematic absences – space group determination.
Unit – III	STRUCTURE ANALYSIS: Single crystal diffractometers– geometries – scan modes – scintillation and area detectors –intensity data collection – data reduction – factors affecting X-ray intensities – temperature and scale factor – electron density – phase problem – normalized structure factor– direct method fundamentals and procedures – Patterson function and heavy atom method – structure refinement – least squares method – Fourier and difference Fourier synthesis – R factor – structure interpretation – geometric calculations – conformational studies – computer program packages.
Unit – IV	POWDER METHODS: Fundamentals of powder diffraction – Debye Scherrer method – diffractometer geometries – use of monochromators and Soller slits – sample preparation and data collection – identification of unknowns – powder diffraction files (ICDD) –Rietveld refinement fundamentals – profile analysis – peak shapes – whole pattern fitting – structure refinement procedures – auto-indexing – structure determination from powder data – new developments. Energy dispersive X-ray analysis – texture studies – crystallite size determination – residual stress analysis – high and low temperature and high pressure crystallography (basics only).

Unit-V	PROTEIN CRYSTALLOGRAPHY: Globular and fibrous proteins, nucleic acids – primary, secondary, tertiary and quaternary structures – helical and sheet structures –Ramachandran map and its significance – crystallization methods for proteins – factors affecting protein crystallization – heavy atom derivatives – methods used to solve protein structures – anomalous dispersion methods.
Text Books	1. Azaroff, L.V., "Elements of X-Ray Crystallography", Techbooks, New York, 1992. 2. Blundell, T.L. and Johnson, L., "Protein Crystallography", Academic Press, New York, 1986. 3. Cullity, B.D. and Stock, S.R. "Elements of X-ray Diffraction", Pearson, 2014. 4. H.L. Bhat, Introduction to Crystal Growth Principles and Practice CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015. 5. B.R. Pamplin, Crystal Growth, Pergamon Press, Oxford, 1975.
Ref. books	1. Glusker, J.P. and Trueblood, K.N. Crystal Structure Analysis: A Primer", Oxford University, Press, New York, 1994. 2. Ladd, M.F.C. and Palmer, R.A., "Structure Determination by X-ray Crystallography", Plenum Press, New York, 3rd Edition, 1993. 3. Stout, G.H. and Jensen, L. "X-ray Structure Determination, A Practical Guide", Macmillan, New York, 1989. 4. Woolfson, M.M. "An Introduction to X-ray Crystallography" Cambridge University Press, New York, 1997. 5. Sam Zhang, Lin Ki, Ashok Kumar, Materials Characterization Techniques, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009
Web Resources	1. https://archive.nptel.ac.in/courses/112/106/112106227/ 2. https://archive.nptel.ac.in/courses/104/108/104108098/ 3. https://www.digimat.in/nptel/courses/video/102107086/L11.html 4. https://onlinecourses.nptel.ac.in/noc19_cy35/preview 5. https://nptel.ac.in/courses/104/104/104104011/

COURSE OUTCOMES:

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

CO1	Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	K2
CO2	Gain a working knowledge of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination	K1,K3
CO3	Get an exposure to crystal structure determination using program packages	K1,K4
CO4	Understand the instrumentation used for powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method	K2, K4
CO5	Get an insight into the structural aspects of proteins and nucleic acids, crystallization of proteins and methods to solve protein structures	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECD
Course Title	4. MATERIALS SCIENCE	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge on different types of materials	
Learning Objectives	To gain knowledge on optoelectronic materials. To learn about ceramic processing and advanced ceramics. To understand the processing and applications of polymeric materials. To gain knowledge on the fabrication of composite materials. To learn about shape memory alloys, metallic glasses and nanomaterials	

UNITS	Course details
Unit– I	OPTOELECTRONIC MATERIALS: Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain.. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.
Unit – II	CERAMIC MATERIALS: Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, alumina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics
Unit – III	POLYMERIC MATERIALS: Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.
Unit – IV	COMPOSITE MATERIALS: Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.
Unit–V	NEW MATERIALS: Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications –bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior – nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes
Text Books	1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007 2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008. 3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice– Hall India, New Delhi(For units 2,3,4 and 5) 4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw–Hill 5. M. Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha

	Agencies
Ref. 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/ https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSE OUTCOMES:

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

CO1	Acquire knowledge on optoelectronic materials	K1
CO2	Be able to prepare ceramic materials	K3
CO3	Be able to understand the processing and applications of polymeric materials	K2, K3
CO4	Be aware of the fabrication of composite materials	K5
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	K1
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECE
Course Title	5. PHYSICS OF NANOSCIENCE AND TECHNOLOGY	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge in Solid State Physics	
Learning Objectives	Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale. To provide the basic knowledge about nanoscience and technology. To learn the structures and properties of nanomaterials. To acquire the knowledge about synthesis methods and characterization techniques and its applications.	

UNITS	Course Details
Unit– I	FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY: Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology — Classification of Nanomaterials – Metal and Semiconductor Nanomaterials – 2D, 1D, 0D nanostructured materials – Quantum dots – Quantum wires – Quantum wells – Surface effects of nanomaterials.
Unit – II	PROPERTIES OF NANOMATERIALS: Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant – Mechanical behavior: Elastic properties – strength – ductility –superplastic behavior – Optical properties: – Surface Plasmon Resonance – Quantum size effects – Electrical properties – Conductivity, Ferroelectrics and dielectrics – Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
Unit – III	SYNTHESIS AND FABRICATION: Physical vapour deposition – Chemical vapour deposition – sol–gel – Wet deposition techniques – electrochemical deposition method – Plasma arching – Electrospinning method –ball milling technique – pulsed laser deposition – Nanolithography: photolithography –Nanomanipulator.
Unit – IV	CHARACTERIZATION TECHNIQUES: Powder X–ray diffraction – X–ray photoelectron spectroscopy (XPS) – UV–visible spectroscopy – Photoluminescence – Scanning electron microscopy (SEM) – Transmission electron microscopy (TEM) –Scanning probe microscopy (SPM) – Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.
Unit–V	APPLICATIONS OF NANOMATERIALS: Sensors: Nanosensors based on optical and physical properties – Electrochemical sensors – Nano–biosensors. Nano Electronics: Nanobots–display screens – GMR read/write heads –Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification –Medicine: Imaging of cancer cells – biological tags – drug delivery – photodynamic therapy – Energy: fuel cells –rechargeable batteries –supercapacitors– photovoltaics.
Text Books	1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw–Hill Publishing Co. (2012). 2. 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)
Ref. books	1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press (2004). 2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007) 4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012) 5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. ParagDiwan and AshishBharadwaj (2005) Vol. IV – Nanoelectronics Pentagon Press, New Delhi.
Web Resources	1. www.its.caltec.edu/feyman/plenty.html 2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm 3. http://www.understandingnano.com 4. http://www.nano.gov 5. http://www.nanotechnology.com

COURSE OUTCOMES:

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

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	K1, K2
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	K1
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	K2, K3
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	K4
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECF
Course Title	6. DIGITAL COMMUNICATION	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Exposure to Fourier transform, pulse modulation, multiplexing, noises in communication signals	
Learning Objectives	To understand the use of Fourier, transform in analyzing the signals. To learn about the quanta of transmission of information. To make students familiar with different types of pulse modulation. To have an in depth knowledge about the various methods of error controlling codes. To acquire knowledge about spread spectrum techniques in getting secured communication.	

UNITS	Course Details
Unit– I	SIGNAL ANALYSIS: Fourier transforms of gate functions, delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting – Convolution –Graphical representation – Convolution theorem – Time Convolution theorem –Frequency Convolution theorem –Sampling theorem.
Unit – II	INFORMATION THEORY: Communication system – Measurement of information – Coding – Bandot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel– Effects of noise– Capacity of noise in a channel – Shannon Hartley theorem – Redundancy.
Unit – III	PULSE MODULATION: Pulse amplitude modulation – natural sampling – Instantaneous sampling – Transmission of PAM Signals –Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM –Effects of noise –Companding – Advantages and application
Unit – IV	ERROR CONTROL CODING: Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RS Coding, Convolutional Coding, Coding Grain Viterbi Coding
Unit–V	SPREAD SPECTRUM SYSTEMS: Pseudo Noise sequences, generation and Correlation properties, direct sequence spread spectrum systems, frequency HOP Systems, processing gain, anti-jam and multipath performance
Text Books	1. B.P. Lathi, <i>Communication system</i> , Wiley Eastern. 2. George Kennedy, <i>Electronic Communication Systems</i> , 3 rd Edition, McGraw Hill. 3. Simon Haykin, <i>Communication System</i> , 3 rd Edition, John Wiley & Sons. 4. George Kennedy and Davis, 1988, <i>Electronic Communication System</i> , Tata McGraw Hill 4 th Edition. 5. Taub and Schilling, 1991, “ <i>Principles of Communication System</i> ”, Second edition Tata McGraw Hill.

Ref. books	1. John Proakis, 1995, <i>Digital Communication</i> , 3 rd Edition, McGraw Hill, Malaysia. 2. M. K. Simen, 1999, <i>Digital Communication Techniques, Signal Design and Detection</i> , Prentice Hall of India. 3. Dennis Roddy and Coolen, 1995, <i>Electronics communications</i> , Prentice Hall of India IV Edition. 4. Wave Tomasi, 1998, “ <i>Advanced Electronics communication System</i> ” 4 th Edition Prentice Hall, Inc. 5. M.Kulkarni, 1988, “ <i>Microwave and Radar Engineering</i> ”, Umesh Publications.
Web Resources	1. http://nptel.iitm.ac.in/ 2. http://web.ewu.edu/ 3. http://www.ece.umd.edu/class/enee630.F2012.html 4. http://www.atcourses.com/Advanced%20Topics%20in%20Digital%20Signals 5. http://nptel.iitm.ac.in/courses/117101051.html

COURSE OUTCOMES:

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

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	K1, K3
CO2	Apply different information theories in the process of study of coding of information, storage and communication	K3
CO3	Explain and compare the various methods of pulse modulation techniques	K4
CO4	Apply the error control coding techniques in detecting and correcting errors–able to discuss, analyze and compare the different error control coding	K3, K4
CO5	Apply, discuss and compare the spread spectrum techniques for secure communications	K3, k5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECG
Course Title	7. ASTROPHYSICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamental knowledge about electromagnetic spectrum, wave nature of light and about the universe and the galaxy where we live in.	
Learning Objectives	To impart knowledge on the physical universe and its evolution. To make the student to understand fundamental principles and techniques of astronomy and astrophysics. To make the student to study electromagnetic radiation from stars, atomic spectra and classification of stars. To provide information about the properties and the evolution of stars. To render information about astronomical instrumentation.	

UNITS	Course Details
Unit– I	OBSERVATIONAL ASTRONOMY: The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multiwavelength)
Unit – II	PROPERTIES OF STARS: Brightness (luminosities, fluxes and magnitudes); colours (black body radiation, the Planck, Stefan–Boltzmann and Wien’s laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman & Balmer series etc, Doppler effect); Hertzsprung–Russell diagram; the main sequence (stellar masses ,binary systems, Kepler’s laws, mass–luminosity relations); distances to stars (parallax, standard candles, P–L relationships, ms–fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).
Unit – III	THE LIFE AND DEATH OF STARS: Energy source (nuclear fusion, p–p chain, triple–alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure hydro static equilibrium, equation of state); evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants (white dwarfs, neutron stars, black holes, degeneracy pressure, Schwarzschild radius, escape velocities).
Unit – IV	GALAXIES: Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter ; active galaxies and quasars.
Unit–V	COSMOLOGY: Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (black body radiation); big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox); cosmological models (critical density, geometry of space, the fate of the Universe); dark energy and the accelerating Universe.
Text Books	1. Zeilik & Gregory, Introductory Astronomy & Astrophysics, 4 th edition (Saunders College Publishing) 2. Morison, I., Introduction to Astronomy and Cosmology, (Wiley) 3. Kutner, M.L., Astronomy: A Physical Perspective (Cambridge University Press) 4. Green, S.F. & Jones, M.H., An Introduction to the Sun and Stars (Cambridge)

	University Press)
Ref. books	5. Jones, M.H. & Lambourne, R.J.A., An Introduction to Galaxies & Cosmology (Cambridge University Press) 6. Carroll, B.W. & Ostlie, D.A., An Introduction to Modern Astrophysics (Pearson) 7. Shu, F.H., The Physical Universe, An Introduction to Astronomy, (University Science Books) 8. Motz, L. & Duveen, A., The Essentials of Astronomy, (Colombia University Press)
Web Resources	1. https://www.coursera.org/courses?query=astrophysics 2. https://www.space.com 3. https://www.britanica.com 4. https://science.nasa.gov 5. https://merriam-webster.com

COURSE OUTCOMES:

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

CO1	Recall and understand the electromagnetic radiation from celestial objects. Analyze the wave nature of light in the form of ray diagram. Apply the knowledge of phenomenon of diffraction and assess, how diffraction limits the resolution of any system having a lens or mirror. Distinguish between reflecting and refracting telescopes and their usage.	K1 K2 K3 K4 K5
CO2	Correlate luminosity, flux and magnitude, related to the brightness of a star. Analyze the evolution of stars using HR diagram. Apply and examine the various laws related to temperature of a star. Assess the distance of stars, measured using trigonometric parallax method. Understand the position of star in the celestial sphere. Distinguish between sidereal and universal time.	K1 K2 K3 K4 K5
CO3	Define nuclear fusion, which is the fundamental energy source of stars. Analyze, how neutrinos are born during the process of nuclear fusion in the sun. Recall and explain the CNO cycle – the main source of energy of hotter stars. Comprehend stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and blackholes, using evidence and presently accepted theories	K1 K2 K3 K4
CO4	Remember and illustrate the structure of our Milky way galaxy. Classify the types of galaxies. Understand the presence of dark matter in the universe. Explain, how quasars and active galaxies are powered by supermassive black holes which produce copious luminosity.	K1 K2 K3 K4
CO5	Explain cosmology, a branch of astronomy that involves the origin and evolution of the universe, from the Big Bang to today and on into the future. Define Hubble's law of cosmic expansion. Analyze and assess the big bang nucleosynthesis universe that explains the relative	K1 K2 K3 K4 K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECH
Course Title	8. BIO PHYSICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamental concepts of Physics and Biology	
Learning Objectives	To understand the physical principles involved in cell function maintenance. To understand the fundamentals of macromolecular structures involved in propagation of life. To understand the biophysical function of membrane and neuron. To understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions. To understand the physical principles behind the various techniques available for interrogating biological macromolecules..	

UNITS	Course Details
Unit– I	CELLULAR BIOPHYSICS: Architecture of animal cell – Animal cell types - Life Cycle of cells – Phases of the cell cycle - Prokaryotic and Eukaryotic cell – Cell size and shape – Electrical activities of cardiac cells - Molecular mechanisms of Vesicular traffic- Electrical activities of neuronal cells.
Unit – II	MOLECULAR BIOPHYSICS: Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins. Nucleic acid structure: nucleosides and nucleotides, RNA structure and DNA structure - Nature of cancer cells – Transport of ions through the cell membrane.
Unit – III	ULTRASONIC TESTING AND IMAGING: Determination of ultrasonic velocity in liquid – Non-Destructive testing - Ultrasonic Non-Destructive Testing –Advantages – Disadvantages – Ultrasonic Testing methods: Pulse Echo method Through transmission method – Resonance method – Medical Applications: Ultrasonic imaging – A, B and C scan display modes – Sonogram.
Unit – IV	LASER BASED DIAGNOSTIC METHODS AND RADIATION BIO PHYSICS: Laser based blood cell counter – Laser doppler blood flow meter - Fiber endoscope. Medical X-ray Imaging – Advantages and disadvantages - Gamma Radiation in the treatment of cancer cells - : Molecular effects of gamma radiation, Effects on cell and organelles – UV radiation - UV Phototherapy - UV Sterilization.
Unit–V	PHYSICAL METHODS IN BIOLOGY: Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis – CT scan & MRI scan Instrumentation.
Text Books	1. Biomedical Instrumentation, Dr. M. Arumugam, Anuradha Publications, 2011. 2. The cell: A molecular approach, Geoffrey M. Cooper, ASM Press, 2013. 3. Biophysics, Vasantha Patabhi, N. Gautham, Narosa Publishing, 2009

	4. Biophysics, P. S. Mishra VK Enterprises, 2010. 5. Biophysics, M. A Subramanian, MJP Publishers, 2005. 6. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.
Ref. books	1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008). 2. Essential cell biology by Bruce Albert et al (Garland Science) 3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983). 4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media). 5. Biological spectroscopy by Iain D. Campbell, Raymond A. Dwek
Web Resources	1. General Bio: http://www.biology.arizona.edu/DEFAULT.html 2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm 3. Electrophoresis: http://learn.genetics.utah.edu/content/labs/gel/ 4. Online biophysics programs: http://mw.concord.org/modeler/ 5. https://blanco.biomol.uci.edu/WWWResources.html

COURSE OUTCOMES:

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

CO1	Understand the structural organization and function of living cells and should be able to apply the cell signaling mechanism and its electrical activities.	K2, K3
CO2	Comprehension of the role of biomolecular conformation to function.	K1
CO3	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	K2, K5
CO4	To know the effects of various radiations on living systems and how to prevent ill effects of radiations.	K1, K5
CO5	Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	K4

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

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECI
Course Title	9. NONLINEAR DYNAMICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Basics of linear and nonlinear waves and Basics of communication systems	
Learning Objectives	To school the students about the analytical and numerical techniques of nonlinear dynamics. To make the students understand the concepts of various coherent structures. To train the students on bifurcations and onset of chaos. To educate the students about the theory of chaos and its characterization. To make the students aware of the applications of solitons, chaos and fractals.	

UNITS	Course Details
Unit– I	GENERAL: Linear waves–ordinary differential equations(ODEs)–Partial differential equations(PDEs)– Methods to solve ODEs and PDEs.– Numerical methods – Linear and Nonlinear oscillators–Nonlinear waves–Qualitative features
Unit – II	COHERENT STRUCTURES: Linear and Nonlinear dispersive waves –Solitons – KdB equation – Basic theory of KdB equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis – Perturbation methods–Solitons in Optical fibres– Applications.
Unit – III	BIFURCATIONS AND ONSET OF CHAOS: One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dynamical system – Strange attractors – Routes to chaos.
Unit – IV	Nonlinear dynamical systems –Integrable systems –Solitary waves –The Scott Russell Phenomena—Soliton – Kortewig–deVries (Kdv) equation (no derivation) Non Integrable systems –Chaos –Bifurcation theory –Period doubling cascades – Strange attractions– Controlling of Chaos– applications – Tsunamis (basic idea)
Unit–V	APPLICATIONS: Soliton based communication systems – Soliton based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.
Text Books	1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns. Springer, 2003. 2. A. Hasegawa and Y. Kodama, Solitons in Optical Communications. Oxford Press, 1995. 3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455. 4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, 2003. ISBN: 9780387001777. 5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.

Ref. books	1. G. Drazin and R. S. Johnson. Solitons: An Introduction. Cambridge University Press, 1989. 2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific, 1989. 3. S. Strogatz. Nonlinear Dynamics and Chaos. Addison Wesley, 1995. 4. HaoBai–Lin, Chaos (World Scientific, Singapore, 1984). 5. Kahn, P. B., Mathematical Methods for Scientists & Engineers (Wiley, NY, 1990)
Web Resources	1. https://www.digimat.in/nptel/courses/video/108106135/L06.html 2. http://digimat.in/nptel/courses/video/115105124/L01.html 3. https://www.digimat.in/nptel/courses/video/108106135/L01.html 4. http://complex.gmu.edu/neural/index.html 5. https://cnls.lanl.gov/External/Kac.php

COURSE OUTCOMES:

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

CO1	Gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	K1, K4
CO2	Understand the concepts of different types of coherent structures and their importance in science and technology.	K2
CO3	Learn about simple and complex bifurcations and the routes to chaos	K1, K2
CO4	Acquire knowledge about various oscillators, characterization of chaos and fractals.	K1
CO5	To analyze and evaluate the applications of solutions in telecommunication, applications of chaos in cryptography, computations and that of fractals.	K3, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECJ
Course Title	10. ADVANCED OPTICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Knowledge of ray properties and wave nature of light.	
Learning Objectives	To know the concepts behind polarization and could pursue research work on application aspects of laser. To impart an extensive understanding of fiber and non-linear optics. To study the working of different types of LASERS. To differentiate first and second harmonic generation. Learn the principles of magneto-optic and electro-optic effects and its applications.	

UNITS	Course Details
Unit– 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
Unit – II	LASERS: Basic principles – Spontaneous and stimulated emissions - Einstein’s Coefficient– Basic Components of Laser –Laser action, Pumping methods - Types of lasers and its applicatoions - Solid state lasers - Nd:YAG laser – Gas lasers: He–Ne laser – CO ₂ laser – Semiconductor laser - Lasers in Welding, heat treatment, cutting – Medical applications.
Unit – III	FIBER OPTICS: Principle and propagation of light in optical fibers - Numerical aperture and acceptance angle – Types of optical fibers – Double crucible technique of fiber drawing – splicing, loss in optical fiber – attenuation, dispersion, bending – Fiber optical communication system – light sources – detectors – fiber optic sensor – temperature and displacement – Endoscope.
Unit – IV	NON-LINEAR OPTICS: Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light
Unit–V	MAGNETO–OPTICS AND ELECTRO–OPTICS: Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton–mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect
Text Books	1. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3 rd Edition, New Age International (P) Ltd. 2. AjoyGhatak, 2017, Optics, 6 th 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,
Ref. books	1. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4 th 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, 4 th 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

COURSE OUTCOMES:

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

CO1	Discuss the transverse character of light waves and different polarization phenomenon	K1
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K2
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	K3, K4
CO4	Identify the properties of nonlinear interactions of light and matter	K4
CO5	Interpret the group of experiments which depend for their action on an applied magnetism and electric field	K5

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

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECK
Course Title	11. ADVANCED SPECTROSCOPY	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge of group theory, abstract thinking ability, lasers, chemical bonds and molecular structures.	
Learning Objectives	Helps students understand and appreciate spectroscopy as a sufficiently broad field in which many sub disciplines exist. Make them appreciate each of these specific techniques with numerous implementations. To realize the progress in this field that is rapid, resulting in improved instrument capabilities and an ever-widening range of applications. To apply group theory in spectroscopy to shed light on molecular symmetry and determine important physical parameters.	

UNITS	CourseDetails
Unit– I	MOLECULAR SPECTROSCOPY AND GROUP THEORY: Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class– Lagrange’s theorem statement and proof – Symmetry operations and symmetry elements – Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations–Unitary representations – Schur’s lemmas – Great orthogonality theorem – point group –Simple applications : Symmetry operations of water and ammonia– Construction of character table for C _{2v} (water) and C _{3v} (ammonia) molecules
Unit – II	LASER SPECTROSCOPY: Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission– ultra short pulses– laser cooling –Single and multi–mode lasers– Laser tunability– Fluorescence spectroscopy with lasers– Laser Raman Spectroscopy – Non–linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research
Unit – III	MOSSBAUER SPECTROSCOPY: Basic idea of Mossbauer spectroscopy – Principle– Mossbauer effect– Recoilless emission and absorption– Chemical shift –Effect of electric and magnetic fields – hyperfine interactions– instrumentation–Applications: understanding molecular and electronic structures
Unit – IV	XRAY PHOTOELECTRON SPECTROSCOPY: Principle – XPS spectra and its interpretation– ECSA–EDAX– other forms of XPS – chemical shift –Applications :– stoichiometric analysis– electronic structure– XPES techniques used in astronomy, glass industries, paints and in biological research
Unit–V	MOLECULAR MODELLING: Determination of force constants– force field from spectroscopic data–normal coordinate analysis of a simple molecule (H ₂ O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from

	spectroscopic data– molecular modelling using data from various spectroscopic studies
Text Books	1. William Kemp, 2019, Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition. 2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi. 3. D.N. Satyanarayana, 2001, <i>Vibrational Spectroscopy and Applications</i>, New Age International Publication. 4. B.K. Sharma , 2015, <i>Spectroscopy</i>, Goel Publishing House Meerut. 5. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
Ref. books	1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink. 2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol.I., Chapman and Hall, New York. 3. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi. 4. David. L. Andrews, Introduction to Laser Spectroscopy, Springer, 2020 5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition) New Age International Publishers.
Web Resources	1. Fundamentals of Spectroscopy – Course (nptel.ac.in) 2. http://mpbou.edu.in/slm/mscche1p4.pdf 3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 4. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWru 5. https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html

COURSE OUTCOMES:

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

CO1	Comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations. Apply mathematical theory while working with symmetry operations. To use group theory as a tool to characterize molecules.	K1, K2
CO2	Align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	K3
CO3	Understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	K2, K3
CO4	Assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	K3, K4
CO5	Employ IR and Raman spectroscopic data along with other data for structural investigation of molecules. Analyze thermodynamic functions and other parameters to evolve molecular models.	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECL
Course Title	12. CHARACTERIZATION OF MATERIALS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamentals of Heat and Thermodynamics, Basics of Optical systems, Microscopic systems, Electrical measurements and Fundamentals of Spectroscopy.	
Learning Objectives	To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA. To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes. To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.	

UNITS	Course details
Unit– I	THERMAL ANALYSIS: Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)– cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.
Unit – II	MICROSCOPIC METHODS: Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy – phase contrast microscopy – differential interference contrast microscopy – fluorescence microscopy – confocal microscopy — digital holographic microscopy – oil immersion objectives – quantitative metallography – image analyzer.
Unit – III	ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY: SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis– Scanning tunneling microscopy (STEM) – Atomic force microscopy (AFM) – Scanning new field optical microscopy.
Unit – IV	ELECTRICAL METHODS AND OPTICAL CHARACTERISATION: Two probe and four probe methods– van der Pauw method – Hall probe and measurement – scattering mechanism – C–V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C–V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.
Unit–V	X–RAY AND SPECTROSCOPIC METHODS: 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) –Rutherford Back Scattering (RBS) analysis– application – Powder diffraction – Powder diffractometer –interpretation of diffraction patterns – indexing – phase identification – residual stress analysis – Particle size, texture studies – X–ray fluorescence spectroscopy – uses.

Text Books	1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990. 2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979. 3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991 4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002. 5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
Ref. books	1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice–Hall, (2001). 2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley–Liss, Inc. USA, (2001). 3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009). Volumes 49 – 51, (2009). 4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986). 5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)
Web Resources	1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf 2. http://www.digimat.in/nptel/courses/video/113106034/L11.html 3. https://nptel.ac.in/courses/104106122 4. https://nptel.ac.in/courses/118104008 5. https://www.sciencedirect.com/journal/materials-characterization

COURSE OUTCOMES:

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

CO1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	K1, K3
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	K2
CO3	The working principle and operation of SEM, TEM, STM and AFM.	K2, K3
CO4	Understood Hall measurement, four –probe resistivity measurement, C–V, I–V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	K3, K4
CO5	The theory and experimental procedure for x– ray diffraction and some important spectroscopic techniques and their applications.	K4, K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern**Maximum Marks: 70 Marks****Exam Duration: 3 Hrs****Part-A** 10×2=20 Marks Answer ALL Questions (Two questions from each unit)**Part-B** 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)**Part-C** 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)**HOD****COE**

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECM
Course Title	13. MEDICAL PHYSICS	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Fundamentals of physiological concepts, Basics of instruments principle,	
Learning Objectives	To understand the major applications of Physics to Medicine. To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance. 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. To introduce the ideas of Radiography. To form a good base for further studies like research.	

UNITS	Course Details
Unit– I	X-RAYS AND TRANSDUCERS: Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer
Unit – II	BLOOD PRESSURE MEASUREMENTS: Introduction –□sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro–neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).
Unit – III	RADIATION PHYSICS: Radiation Units – Exposure – Absorbed Dose – 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: 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: Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter
Text Books	Dr. K. Thayalan , <i>Basic Radiological Physics</i> , Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003. Curry, Dowdey and Murry, <i>Christensen’s Physics of Diagnostic Radiology: – LippincotWilliams and Wilkins</i> , 1990.

	FM Khan, <i>Physics of Radiation Therapy</i>, William and Wilkins, 3rd ed, 2003. D. J. Dewhurst, <i>An Introduction to Biomedical Instrumentation</i>, 1st ed, Elsevier Science, 2014. R.S. Khandpur, <i>Hand Book of Biomedical Instrumentations</i>, 1st ed, TMG, New Delhi, 2005.
Ref. books	Muhammad Maqbool, <i>An Introduction to Medical Physics</i>, 1st ed, Springer International Publishing, 2017. Daniel Jiráček, František Vítek, <i>Basics of Medical Physics</i>, 1st ed, Charles University, Karolinum Press, 2018 Anders Brahme, <i>Comprehensive Biomedical Physics</i>, Volume 1, 1st ed, Elsevier Science, 2014. K. Venkata Ram, <i>Bio-Medical Electronics and Instrumentation</i>, 1st ed, Galgotia Publications, New Delhi, 2001. John R. Cameron and James G. Skofronick, 2009, <i>Medical Physics</i>, John Wiley Interscience Publication, Canada, 2nd edition.
Web Resources	https://nptel.ac.in/courses/108/103/108103157/ https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692 https://www.technicalsymposium.com/alllecturenotes_biomed.html https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78 https://www.modulight.com/applications-medical/

COURSE OUTCOMES:

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

CO1	Learn the fundamentals, production and applications of X-rays.	K1
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, ECG, ENG and basic principles of MRI.	K2
CO3	Apply knowledge on Radiation Physics	K3
CO4	Analyze Radiological imaging and filters	K4
CO5	Assess the principles of radiation protection	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

	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

	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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	EC	Course Code: BPPHECP
Course Title	14. SOLAR ENERGY UTILIZATION	
Credits – 6	Instruction Hours – 6	Medium : English
Pre-Requisites	Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types	
Learning Objectives	To impart fundamental aspects of solar energy utilization. To give adequate exposure to solar energy related industries. To harness entrepreneurship skills. To understand the different types of solar cells and channelizing them to the different sectors of society. To develop an industrialist mindset by utilizing renewable source of energy.	

UNITS	Course Details
Unit– I	HEAT TRANSFER & RADIATION ANALYSIS: Conduction, Convection and Radiation – Solar Radiation at the earth’s surface – Determination of solar time – Solar energy measuring instruments.
Unit – II	SOLAR COLLECTORS: 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: Types of solar water heater – Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.
Unit – IV	SOLAR ENERGY CONVERSION: Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo – electric conversion – process flow of silicon solar cells– different approaches on the process–texturization, diffusion, Antireflective coatings, metallization.
Unit–V	NANOMATERIALS IN FUEL CELL APPLICATIONS: Use of nanostructures and nanomaterials in fuel cell technology – high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage. Industrial visit – data collection and analysis – presentation
Text Books	1. Solar energy utilization –G.D. Rai –Khanna publishers – Delhi 1987. 2. Maheshwar Sharon, Madhuri Sharon, Carbon “Nano forms and Applications”, McGraw–Hill, 2010. 3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems Academic Press, London, 2009 4. Tiwari G.N, “Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
Ref. 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.
Web Resources	1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb 2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read 3. www.nptel.ac.in/courses/112105051 4. www.freevidelectures.com 5. http://www.e-booksdirectory.com

COURSE OUTCOMES:

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

CO1	Gained knowledge in fundamental aspects of solar energy utilization	K1
CO2	Equipped to take up related job by gaining industry exposure	K3
CO3	Develop entrepreneurial skills	K5
CO4	Skilled to approach the needy society with different types of solar cells	K4
CO5	Gained industrialist mindset by utilizing renewable source of energy	K2, K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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).

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

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

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
30	70	100	

Question Paper Pattern

Maximum Marks: 70 Marks

Exam Duration: 3 Hrs

Part-A 10×2=20 Marks Answer ALL Questions (Two questions from each unit)

Part-B 5×4=20 Marks Answer ALL Questions (Either or Type-Two questions from each unit)

Part-C 3×10=30 Marks Answer Any Three Questions (Three out of Five-one question from each unit)

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	SEC1	Course Code: B4PPHSE1
Course Title	ENTREPRENEURIAL DEVELOPMENT	
Credits – 3	Instruction Hours – 3	Medium : English
Learning Objectives	To instruct the characteristics essential for entrepreneurial and the role of entrepreneurial in economic development. To encourage rural entrepreneurs. To know the special schemes offered by the government.	

UNITS	Course Details
Unit– I	CONCEPT OF ENTREPRENEURSHIP: Meaning – Definition – characteristics – functions – role of entrepreneurs in economic development – classification of entrepreneurs – factors affecting entrepreneurial growth – entrepreneurship development programmes.
Unit – II	PROJECT: Project appraisal – Project formulation – Project identification – sources of ideas – preliminary evaluation and testing of ideas. Entrepreneurial opportunities for physical science: Microprocessor – crystal – solar panels – semiconductor devices – mobile servicing – computer servicing.
Unit – III	LICENSING: Licensing procedures to start an industrial unit – procedures to start small and women entrepreneurs – import and export substitutions oriented items – new procedures.
Unit – IV	GOVERNMENT SUBSIDISED LOAN SCHEMES: District industrial centre (DIC) – Definition of MSME– Classification – Types of Schemes, Objectives , Key Benefits and How to apply – Unemployed Youth Employment Generation Programme UYEGP – Prime Minister Employment Generation Programme PMEGP – New Entrepreneur Cum Enterprise Development Programme NEEDS, Ineligibility list for NEEDS. Centre for Entrepreneurship Development and Incubation (CEDI), NIT, Triruchirapalli, Indian Institute of Food Processing Technology (IIFPT), Thanjavur.
Unit–V	GOVERNMENT MSME INCENTIVE SCHEMES Objectives and Key Benefits–Capital subsidy – Additional Capital subsidy: Thrust Sector Enterprises, List of thrust sectors, Micro Manufacturing Enterprises, select category of entrepreneurs and scaling up – Operational Improvement: Low Tension Power Tariff(LTPT) subsidy, Payroll subsidy, generator subsidy, Promotion of Energy Audit and Conservation of Energy(PEACE) – Skill training and employment scheme. Statutory: Reimbursement of stamp duty and registration charges – Value Addition: Scheme for acquiring Quality certification (Q– Cert), Subsidy for Asset creation for intellectual property, Reimbursement of Hall Rent.
Text Books	1.Entrepreneurial development – C. Gupta, N. P. Srinivasan, Sultan Chand and sons 2.Dynamics of entrepreneurial development and Management – Vasant Desai,

	Himalaya Publishing House. 3.Scheme Booklet for MSMEs in Government of Tamil Nadu – with effect from 16 th February 2021.
Ref. books	1. Entrepreneurship development principles, policies and programme – P. Saravanel.

COURSE OUTCOMES:

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

CO1	Understand the concept of entrepreneurship.	K1
CO2	Get awareness about the source of project appraisal	K2
CO3	Understand the legal requirements for licensing procedures.	K3
CO4	Know the incentives and subsidies of state and central governments	K4
CO5	Get the idea of entrepreneurial opportunities of physical science	K5
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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

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

HOD

COE

(For the candidates admitted 2026 – 2027 onwards)

Course	SEC2	Course Code: B4PPHSE2
Course Title	EMPLOYABILITY SKILLS	
Credits – 3	Instruction Hours – 3	Medium : English
Learning Objectives	To develop the personality development and to improve the skills needed for the employment opportunities.	

UNITS	Course Details
Unit– I	PERSONALITY DEVELOPMENT: Knowing yourself – Positive thinking – Physical fitness – Emotional Intelligence – Skills to develop emotional intelligence.
Unit – II	RESUME WRITING: Resume writing – purpose of a resume – How long should my resume job? – Types of Resume – Chronological Resume, Functional Resume, Combination Resume, Infographic Resume, Resume with profile, Targeted Resume, mini Resume, Non-traditional resume – Things to do – Formats of Resume – Job Application or covering letter.
Unit – III	GROUP DISCUSSION: Introduction – Types of Group discussions – Difference between group discussion and panel discussion debate – personality traits – Advantages of Group discussion – Dos and Don'ts.
Unit – IV	INTERVIEW SKILLS: Introduction – Types of interviews – Preparatory steps for job interview– Interview skills – punctuality – Think before you speak – clarity – being confident – Listening – Expressing optimism – Body language – Showing interest – Communication skills – Expressing gratitude.
Unit–V	PROFESSIONAL SKILLS: Creativity at work place – Ethical values – Capacity building, Developing interpersonal relationship –Leadership and team building – Decision making – Stress and Time management
Text Books	1) ICTACT – Soft skills and Industry awareness – Tamil Nadu state council for Higher Education, Department of Higher Education – ICT Academy of Tamil Nadu, Chennai. 2) Soft Skills: An integrated approach to maximize personality, GajendraS.Chauhan, Sangeetha Sharma, Wiley India.

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

CO1	Acquire the knowledge about the personality development.	K2
CO2	Gain the knowledge about various types of resumes and resume writing.	K2
CO3	Able to face the first step of interview on gaining the group discussion skills	K3
CO4	Acquire interview skills and understand about body language.	K4
CO5	Gain the professional skills for employability and leadership.	K3
K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate;		

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

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

HOD**COE**