# A.D.M. COLLEGE FOR WOMEN (AUTONOMOUS)

**(Accredited With 'A' Grade By NAAC 3rd Cycle)**

***(Affiliated to Bharathidasan University, Tiruchirappalli)***

**NAGAPATTINAM – 611 001**

## PG DEPARTMENT OF PHYSICS

# SYLLABUS

## M.Sc. PHYSICS

**(2023-2024 Batch)**

# M.Sc., PHYSICS

## Preamble

The curriculum for the P.G. Physics for universities and colleges is revised as per Learning Outcomes- based Curriculum Framework (LOCF). The learner centric courses are designed to enable the students to progressively develop a good understanding of the concepts of various domains in physics. Significant modification is the inclusion of the courses to equip students to face challenges in industries and make them employable. Skill development in different spheres and confidence building are given a special focus.

**Programme Educational Objectives(PEO):**

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| **PEO1:** | To impart knowledge in advanced concepts and applications in different fields of Physics. |
| **PEO2:** | To prepare students enter in to professional courses. |
| **PEO3:** | To educate students to occupy important positions in business houses, Industries and organizations. |
| **PEO4:** | To equip students with skills to excel in their future careers. |
| PEO5: | To enable students to take up challenging jobs. |

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| **Programme** | **M. Sc., Physics** |
| **Programme Code** | |
| **Duration** | **PG – 2YEARS** |
| **Programme Outcomes (POs)** | **PO1: Problem Solving Skill**<br>Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.<br>**PO2: Employability Skill**<br>Inculcate contemporary business practices to enhance employability skills in the competitive environment.<br>**PO3: Entrepreneurial Skill**<br>Equip with skills and competencies to become an entrepreneur.<br>**PO4: Contribution to Society**<br>Succeed in career endeavors and contribute significantly to society.<br>**PO 5:Multicultural competence**<br>Possess knowledge of the values and beliefs of multiple cultures and a global perspective. |

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

**M.Sc. PHYSICS**

## COURSE STRUCTURE

**SCHEMEOFEXAMINATIONS– 2023Batch**

| PART | COURSE CODE | TITLE OF THE PAPER | HRS | CREDITS | EXAM DURATION | MAX. MARKS | |
|---|---|---|---|---|---|---|---|
| | | | | | | CIA | EXT |
| | **SEMESTER I** | | | | | | |
| **PART III** | MSPA | CC I - MATHEMATICAL PHYSICS | 6 | 4 | 3 | 25 | 75 |
| | MSPB | CC II - CLASSICAL MECHANICS AND RELATIVITY | 6 | 4 | 3 | 25 | 75 |
| | MSPCY | CP I - PRACTICAL I | 6 | 4 | 3 | 40 | 60 |
| | MSPE1 | EC I - CRYSTAL GROWTH AND THIN FILMS | 4 | 3 | 3 | 25 | 75 |
| | MSPE2 | EC II - COMMUNICATION ELECTRONICS | 4 | 3 | 3 | 25 | 75 |
| **PART IV** | MPAEC1 | AECC I – SOFT SKILL I ANALYTICAL CHARACTERIZATION TECHNIQUE | 2 | 2 | 3 | 25 | 75 |
| | MPSEC1 | SEC I - PROGRAMMING IN PYTHON | 2 | 2 | 3 | 25 | 75 |
| *Extra Credit 1 | MPEC1 | ECC I - ARTIFICIAL INTELLIGENCE | 2 | 2 | 3 | 0 | 100 |
| | | **Total – 7+1** | **30** | **22+2** | | | |

| PART | COURSE CODE | TITLE OF THE PAPER | HRS | CREDITS | EXAM DURATION | MAX. MARKS | |
|---|---|---|---|---|---|---|---|
| | **SEMESTER II** | | | | | | |
| **PART III** | MSPD | CC III - STATISTICAL MECHANICS | 6 | 4 | 3 | 25 | 75 |
| | MSPE | CC IV - QUANTUM MECHANICS | 6 | 4 | 3 | 25 | 75 |
| | MSPFY | CP II - PRACTICAL – II | 6 | 4 | 3 | 40 | 60 |
| | MSPE3 | EC III – BIO-PHYSICS | 4 | 3 | 3 | 25 | 75 |
| | MSPE4 | EC IV - SOLAR ENERGY UTILIZATION | 4 | 3 | 3 | 25 | 75 |
| **PART IV** | MPAEC2 | AECC II – SOFT SKILL II - ELECTRONIC DEVICES AND CIRUCITS | 2 | 2 | 3 | 25 | 75 |
| | MPSEC2 | SEC II - PHYSICS OF NANOSCIENCE | 2 | 2 | 3 | 25 | 75 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | AND TECHNOLOGY | | | | | |
| *Extra Credit 2 | MPEC2 | ECC II – VAC I - RESEARCH PUBLICATION AND ETHICS | 2 | 2 | 3 | 0 | 100 |
| | | **TOTAL – 7+1** | **30** | **22+2** | | | |
| | **INTERNSHIP/INDUSTRIAL ACTIVITY DURING THE SUMMER VACATION AFTER I YEAR** | | | | | | |

| **SEMESTER III** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PART** | **COURSE CODE** | **TITLE OF THE PAPER** | **HRS** | **CREDITS** | **EXAM DURATION** | **MAX. MARKS** | |
| **PART III** | MSPG | CC V- CONDENSED MATTER PHYSICS | 6 | 4 | 3 | 25 | 75 |
| | MSPH | CC VI- ELECTROMAGNETIC THEORY | 6 | 4 | 3 | 25 | 75 |
| | MSPIY | CP III - PRACTICAL – III | 6 | 4 | 3 | 40 | 60 |
| | MSPE5 | EC V - STRUCTURED AND OBJECT ORIENTED PROGRAMMING LAB | 4 | 3 | 3 | 25 | 75 |
| **PART IV** | MPCIM | CIM - SOLID WASTE MANAGEMENT | 4 | 3 | 3 | 25 | 75 |
| | MPAEC3 | AECC III – SOFT SKILL III - MICROPROCESSOR 8085 AND MICROCONTROLLER 8051 | 2 | 2 | 3 | 25 | 75 |
| | MPSEC3 | SEC III -NANOTECHNOLOGY | 2 | 2 | 3 | 25 | 75 |
| | MPIS | INTERNSHIP/INDUSTRIAL ACTIVITY | - | 2 | - | - | - |
| *Extra Credit 3 | MPEC3 | ECC III – VAC II - MEDICAL INSTRUMENTATION | 2 | 2 | 3 | 0 | 100 |
| | | **TOTAL – 7+1** | **30** | **24** | | | |

| **SEMESTER IV** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PART** | **COURSE CODE** | **TITLE OF THE PAPER** | **HRS** | **CREDITS** | **EXAM DURATION** | **MAX. MARKS** | |
| **PART III** | MSPJ | CC VII - NUCLEAR AND PARTICLE PHYSICS | 6 | 4 | 3 | 25 | 75 |
| | MSPK | CC VIII – ADVANCED SPECTROSCOPY | 6 | 4 | 3 | 25 | 75 |
| | MSPLY | CP IV - PRACTICAL – IV NUMERICAL METHODS AND COMPUTER PROGRAMMING | 6 | 4 | 3 | 40 | 60 |

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|---|---|---|---|---|---|---|---|
| | MSPMP | CC IX - PROJECT | 4 | 3 | 3 | 25 | 75 |
| | MSPE4 | EC VI - JAVA PROGRAMMING | 4 | 3 | 3 | 25 | 75 |
| | MPAEC4 | AECC IV – SOFT SKILL IV - LASER PHYSICS AND NON LINEAR OPTICS | 2 | 2 | 3 | 25 | 75 |
| **PART IV** | MPPCS | PCS – DATA ANALYTICS | 2 | 2 | 3 | 25 | 75 |
| PART V | | EXTENSION ACTIVITY | - | 1 | | | |
| | | **Total - 7** | **30** | **23** | | | |
| | | | **120** | **91+6** | | | |

**Grand Total – Credit 91 & Extra Credit 6**

## SEMESTER-I

| Semester-I | MATHEMATICAL PHYSICS | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | **K1-Recalling**<br>**K2-Understanding**<br>**K3-Applying**<br>**K4-Analyzing**<br>**K5-Evaluating**<br>**K6-Creating** | |
| **COURSE OBJECTIVES** | • To equip students with the mathematical techniques.<br>• T understanding theoretical treatment in different courses taught in their program<br>• To extend their manipulative skills to apply mathematical techniques in their fields<br>• To help students apply Mathematics in solving problems of Physics.<br>• To find the solutions for physical problems using linear differential equations. | |

| UNITS | Course Details | |
|---|---|---|
| **UNIT I:**<br><br>**LINEAR VECTOR SPACE** | Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure –linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation | **18 Hrs** |
| **UNIT II:**<br><br>**COMPLEX ANALYSIS** | Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders | **18 Hrs** |
| **UNIT III:**<br><br>**MATRICES** | Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices -Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem – Diagonalization. | **18 Hrs** |

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|---|---|---|
| **UNIT IV:**<br><br>**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. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string.<br>Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions - Application - Laplace equation: Potential problem in a semi - infinite strip. | **18 Hrs** |
| **UNIT V:**<br><br>**DIFFERENTIAL EQUATIONS** | Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and Reciprocity theorem -Sturm-Liouville's type equation in one dimension & their Green's function. | **18 Hrs** |
| **TEXT BOOKS** | 1. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.<br>2. B. D. Gupta, 2009, *Mathematical Physics* ($4^{th}$ edition), Vikas Publishing House, New Delhi.<br>3. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi. | |
| **REFERENCE BOOKS** | 1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,<br>2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.<br>3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.<br>4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi.<br>5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York | |
| **WEB RESOURCES** | 1. www.khanacademy.org<br>2. https://youtu.be/LZnRlOA1_2I<br>3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath<br>4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ<br>5. https://archive.nptel.ac.in/courses/115/106/115106086/ | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO 1** | Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them | K1, K2 |
| **CO 2** | Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration. | **K2, K3** |
| **CO 3** | Analyze characteristics of matrices and its different types, and the process of diagonalization. | **K4** |
| **CO 4** | Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology | **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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | S | S | M | S | S | S | S | M |
| **CO2** | S | S | S | M | M | S | M | S | M | M |
| **CO3** | M | S | M | M | M | M | S | S | S | M |
| **CO4** | S | M | S | S | M | S | S | S | S | S |
| **CO5** | M | M | S | M | S | S | S | M | S | M |

| Semester-I | CLASSICAL MECHANICS AND RELATIVITY | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand fundamentals of classical mechanics.<br>• To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.<br>• To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.<br>• To discuss the theory of small oscillations of a system.<br>• 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 – configuration space – transformation equations – principle of virtual work. | 18 Hrs |
| UNIT II: LAGRANGIAN FORMULATION | D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion. | 18 Hrs |
| UNIT III: HAMILTONIAN FORMULATION | Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field. | 18 Hrs |
| UNIT IV: SMALL OSCILLATIONS | Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule. | 18 Hrs |
| 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 for vector notation and their transformations | 18 Hrs |

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| **TEXT BOOKS** | 1. H. Goldstein, 2002, *Classical Mechanics*, 3rd Edition, Pearson Edu.<br>2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publshing. Co. New Delhi.<br>3. R. Resnick, 1968, *Introduction to Special Theory of Relativity*, Wiley Eastern, New Delhi. |
| **REFERENCE BOOKS** | 1. K. R. Symon, 1971, *Mechanics*, Addison Wesley, London.<br>2. S. N. Biswas, 1999, *Classical Mechanics*, Books & Allied, Kolkata.<br>3. Gupta and Kumar, *Classical Mechanics*, Kedar Nath.<br>4. T.W.B. Kibble, *Classical Mechanics*, ELBS.<br>5. Greenwood, *Classical Dynamics*, PHI, New Delhi. |
| **WEB RESOURCES** | 1. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html<br>2. https://nptel.ac.in/courses/122/106/122106027/<br>3. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/<br>4. 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 OF $CO_S$ WITH POs & PSOs:**

| CO/PO | | PO | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | S | M | S | S | S | M | S | S | M |
| CO2 | M | S | S | S | M | S | M | S | M | S |
| CO3 | S | S | S | M | S | M | S | S | M | M |
| CO4 | S | M | M | M | M | S | M | S | M | M |
| CO5 | M | M | S | M | S | M | S | M | S | S |

| Semester-I | PRACTICAL I | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -40 | External Marks-60 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.<br>• To calculate the thermodynamic quantities and physical properties of materials.<br>• To analyze the optical and electrical properties of materials.<br>• To Acquire knowledge about arc spectrum and applications of laser.<br>• To Improve the analytical and observation ability in Physics Experiments | |

**Course Details**

**(Any Twelve Experiments)**

1. Measurement of Coefficient of linear expansion- Air wedge Method
2. Determination of Rydberg's Constant - Hydrogen Spectrum
3. Measurement of Band gap energy- Thermistor
4. Determination of Planck Constant – LED Method
5. Measurement of Conductivity - Four probe method.
6. Determination of Specific charge of an electron – Thomson's method.
7. Determination of Compressibility of a liquid using Ultrasonics
8. Construction of relaxation oscillator using UJT
9. V- I Characteristics of different colours of LED.
10. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
11. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
12. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer.
13. FET CS amplifier- Frequency response, input impedance, output impedance
14. Study of R-S, clocked R-S and D-Flip flop using NAND gates
15. Study of J-K, D and T flip flops using IC 7476/7473
16. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
17. Study of Arithmetic logic unit using IC 74181.
18. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
19. Construction of Encoder and Decoder circuits using ICs.

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| **TEXT BOOKS** | 1. Practical Physics, Gupta and Kumar, Pragati Prakasan.<br>2. Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences.<br>3. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi.<br>4. Electronic lab manual Vol I, K ANavas, Rajath Publishing.<br>5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition |
| **REFERENCE BOOKS** | 1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.<br>2. An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd<br>3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.<br>4. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.<br>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 matetials. | **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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | S | M | M | M | S | M | S | S | M |
| **CO2** | M | S | M | S | M | S | M | S | M | S |
| **CO3** | S | S | S | S | M | S | S | S | S | M |
| **CO4** | S | M | S | M | S | S | M | S | M | M |
| **CO5** | M | M | S | M | S | M | S | S | S | M |

| Semester-I | EC-I<br>CRYSTAL GROWTH AND THIN FILMS | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To acquire the knowledge on Nucleation and Kinetics of crystal growth<br>• To understand the Crystallization Principles and Growth techniques<br>• To study various methods of Crystal growth techniques<br>• To understand the thin film deposition methods<br>• To apply the techniques of Thin Film Formation and thickness Measurement | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I:<br>CRYSTAL GROWTH KINETICS | Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films | 12Hrs |
| UNIT II:<br>CRYSTALLIZATION PRINCIPLES | Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer. | 12Hrs |
| UNIT III:<br>GEL, MELT AND VAPOUR GROWTH | Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry. | 12Hrs |
| UNIT IV:<br>THIN FILM DEPOSITION | Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition. | 12Hrs |

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|---|---|---|
| **METHODS** | | |

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| **UNIT V: THIN FILM FORMATION** | Thin Film Formation and thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques. | **12Hrs** |
| **TEXT BOOKS** | 1. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition<br>2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008)<br>3. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution" | |
| **REFERENCE BOOKS** | 1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986)<br>2. P. Ramasamy and F. D. Gnanam, 1983, "UGC Summer School Notes".<br>3. P. Santhana Raghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications.<br>4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York<br>5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London. | |
| **WEB RESOURCES** | 1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp<br>2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF<br>3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m<br>4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | | PO | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | S | M | S | M | S | M | S | S | M |
| CO2 | M | S | S | S | M | S | M | S | M | S |
| CO3 | S | S | S | S | M | S | S | S | S | M |
| CO4 | S | M | M | M | M | S | M | S | M | M |
| CO5 | M | M | S | M | S | M | S | M | S | S |

| Semester-I | EC-II<br>COMMUNICATION ELECTRONICS | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE 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<br>• To gain knowledge in the generation and propagation of microwaves<br>• To acquire knowledge about radar systems and its applications and also the working principle of colour television<br>• To learn the working principle of fiber optics and its use in telecommunication | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I:<br>ANTENNAS AND WAVE PROPAGATION | Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere-ground wave propagation. | 12Hrs |
| UNIT II:<br>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) | 12Hrs |
| UNIT III:<br>RADAR AND TELEVISION | Elements of a radar system -radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems - colour TV transmission and reception-CCTV and theatre TV | 12Hrs |
| UNIT IV:<br>OPTICAL FIBER | Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres- -wave guide equations in step index fibres - fibre losses and dispersion-applications | 12Hrs |

| | | |
|---|---|---|
| **UNIT V: SATELLITE COMMUNICATION** | Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters- -INSAT communication satellites | **12Hrs** |

| | |
|---|---|
| **TEXT BOOKS** | 1. Handbook of Electronics by Gupta and Kumar, 2008 edition.<br>2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.<br>3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill (1991). |
| **REFERENCE BOOKS** | 1. Electronic communications – Dennis Roody and Coolen, Prentice Hall of India, IV edition, 1995.<br>2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998<br>3. Dennis Roddy and Coolen, 1995, *Electronics communications,* Prentice Hall of India IV Edition.<br>4. Wayne Tomasi,1998 *"Advanced Electronics communication System"* 4th edition, Prentice Hall of India, 1998<br>5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition. |
| **WEB RESOURCES** | 1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/<br>2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/<br>3. http://nptel.iitm.ac.in/<br>4. http://web.ewu.edu/<br>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 | **K3** |

| | | |
|---|---|---|
| | military- elaborate and compare the working of different picture tube | |
| **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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | S | M | M | M | S | M | S | S | M |
| **CO2** | S | M | S | S | S | S | M | S | M | S |
| **CO3** | S | S | S | S | M | S | S | S | S | M |
| **CO4** | S | M | M | M | M | S | M | S | M | S |
| **CO5** | M | M | S | S | S | M | S | M | S | M |

| Semester-I | AECC-I<br><br>ANALYTICAL CHARACTERIZATION TECHNIQUES | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To provide fundamental features of analytical instrumentation to thestudents.<br>• To impart knowledge about the fundamental properties of the instrumentalanalysis<br>• To experimental and theoretical aspects of the characterization techniques.<br>• To know the basic theory of characterization techniques and application.<br>• To Understand spectral, optical, and thermal characterizations. | |

| UNITS | Course Details | |
|---|---|---|
| UNIT - I | **STRUCTURAL CHARACTERIZATION**<br><br>Principle of X-ray spectrometer technique – Small angle X-ray scattering – X-ray photoelectron spectroscopy – Auger relation of core hole – Application, strength and limitations of X-ray photoelectron spectroscopy | 4 Hrs |
| UNIT – II | **SPECTRAL CHARACTERIZATION:**<br><br>Laser sources – Laser Raman Spectrometer – Radiation sources – Fourier Transform Interferometer – NMR basic principles – NMR spectrometer – ESR basic principles – Instrumentation of ESR | 4 Hrs |
| UNIT – III | **OPTICAL CHARACTERIZATION:**<br><br>Instruments for absorption photometry – Photoluminescence principles – Instrumentation and Application – Ultraviolet absorption spectroscopy – Principle behind IR spectroscopy – Fourier Transform Infrared spectroscopy (FTIR) – Strength of FTIR | 4 Hrs |

| | | |
|---|---|---|
| | spectroscopy | |
| **UNIT – IV** | **THERMAL AND MECHANICAL CHARACTERIZATION:**<br><br>Thermal methods – Thermogravimetric analysis – Differential Thermal analysis – Mechanical principles: Static and Dynamic measurement – Instrumentation of Extensometer analysis – Bending properties of materials – In-Plane Impact testing | **4 Hrs** |
| **UNIT – V** | **MORPHOLOGICAL CHARACTERIZATION:**<br><br>Basic principles – Instrumentations: Scanning Electron Microscopy (SEM) – Operation modes – Transmission Electron Microscopy (TEM) – Scanning Tunneling Microscopy (STM). | **4 Hrs** |
| **TEXT BOOKS** | 1. N. Banwell, Fundamentals of Molecular and Spectroscopy (McGraw Hill, NewDelhi, 2008).<br>2. P. S. Sindu, Molecular Spectroscopy (Newage, New Delhi, 2006).<br>**3.** H. H. Willard and L. L. Merritretal, International Methods of Analysis (CBSPublication, New Delhi, 2008). | |
| **REFERENCES:** | 1. S. Zhang, L. Li and A. Kumar, Materials Characterization Techniques (CRCPress, Bota Racon, 2009).<br>2. E. N. Kaufmann, Characterization of Materials, Volume-I (Wiley, New Jersey,2012).<br>3. M. Sardela, Practical Materials Characterization (Springer, Heidelberg, 2014).<br>4. P. R. Khangaonkar, An Introduction to Material Characterization (Penram,Mumbai, 2008).<br>5. Y.Leng, Materials Characterization: Introduction to Microscopic andSpectroscopic Methods (Wiley, New Jersey, 2008).<br>6. https://nptel.ac.in/courses/113105101 | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | • Understand the various processes of structural characterizations. | K1, K5 |
| **CO2** | • Realize how to use the instruments practically and theoretically. | **K4** |
| **CO3** | • Understand spectral, optical, and thermal characterizations. | **K3** |
| **CO4** | • Use advanced characterizations for analyzing particles. | **K1, K3** |
| **CO5** | • Characterize the sample with appropriate characterization techniques. | **K4** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH POs & PSOs:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | S | M | M | M | S | M | S | S | M |
| **CO2** | M | M | S | S | M | S | M | S | M | S |
| **CO3** | S | S | S | S | M | S | S | S | S | M |
| **CO4** | S | M | M | M | M | S | S | M | M | S |
| **CO5** | M | M | S | M | S | M | S | M | S | S |

| Semester-I | SECI- Programming in Python | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To introduce core programming basics required for science using Python language<br>• To read and write simple Python programs<br>• To develop Python Programs with conditionals and loops<br>• To use Python data Structure – lists, tuples, dictionaries<br>• To introduce the important science modules SymPy, NumPy, SciPy, Pandas and Matplotlib and input/output with files in Python and statistical processing of a data. | |

| UNITS | Course Details | |
|---|---|---|
| UNIT :1 | **Algorithmic Problem Solving**<br>Algorithms, building blocks of algorithms (statement, state, control flow, functions);<br>Algorithmic problem solving; iteration, recursion. Illustrative Problems: flow chat,finding minimum in a list, factorial of a number. | 4 Hrs |
| UNIT :1I | **Data, Expressions, Statements in Python**<br>Python Strengths and Weakness; Installing Python; IDLE-Spyder – Jupyter; Mutable and Immutable Data Types, Naming Conventions; String Value; String Operations; String Slices; String Operators; String functions. Numeric Data Types; Arithmetic operators and Expressions ; Comments in the Program; | 4 Hrs |
| UNIT :1II | **Data Collection and Language Component of Python**<br>List; Tuples; Sets; Dictionaries; Operations on list, Tuple, Set, Dictionary; Control Flow and Syntax; Indenting; The if statement ; Relational Operators; Logical Operators; Bit-wise operators; The while Loop – break and continue statements; the for Loop; List Comprehension | 4 Hrs |

| | | |
|---|---|---|
| **UNIT :1V** | **Functions in Python**<br>Functions- Introduction; defining your own functions; Parameters; local and global scope; passing collections to a function; variable number of argument; passing functions to a function; Lambda function; map; filter. | **4 Hrs** |
| **UNIT :V** | **Modules for science**<br>Module: Introduction; Standard Modules – sys, math, time, sympy, random.<br>**Handling Scientific Data in Python**<br>Numpy arrays-1-d, multidimensional arrays and matrices; Mathematical operations with arrays; slicing and addressing arrays; Boolean masks; Difference between lists and arrays<br>scipy – Scientific computing libraryof Python – Introduction, Basic functions, Special functions, scipy.integrate, scipy.optimize,scipy.interpolate | **4 Hrs** |
| **Text Book(s)** | David J.Pine, Introduction to Python for Science and Engineering, CRC Press,2019.<br>Robert Johansson, Numerical Python-Scientific Computing and Data science Applications with Numpy, Scipy and Matplotlib, Apress, 2019 | |
| **Reference Book(S)** | 1. Robert sedgewick, Kelvin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter – disciplinary Approach, Pearson India Education Services Pvt.Ltd.,2016<br>2. Nelli, F., Python Data Analytics: with Pandas, Numpy and Matplotlib, Apress,2018<br>3. Jake vander Plas, Python Data Science Handbook – Essential Tools for Working with Data, 'O' Really Media, 2017 | |
| **WEB RESOURCES** | 1. https://www.analyticsinsight.net<br>2. https://tinker.lytopwebsite.<br>3. https://www.learnpython.org.<br>4. https://www.online phython.com | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | Gained knowledge in fundamental aspects of Algorithms, | K1 |
| **CO2** | Equipped to take up related job by Data, Expressions, Statements in Python | **K3** |
| **CO3** | Develop entrepreneurial skills Modules for science | **K5** |
| **CO4** | Skilled to approach the needy Data visualization and Analysis of Data in Python | **K4** |
| **CO5** | Identify the properties of Handling Scientific Data in Python | **K2, K3** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH POs & PSOs:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | S | M | M | M | S | M | S | S | M |
| **CO2** | M | M | S | M | M | S | M | S | M | S |
| **CO3** | S | S | S | S | M | M | S | S | S | M |
| **CO4** | S | M | M | M | M | S | S | M | S | S |
| **CO5** | M | M | S | M | S | M | S | M | S | M |

| Semester-I | ARTIFICIAL INTELLIGENCE | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To introduce Artificial Intelligence & machine learning for biology students<br>• To facilitate students to learn<br>• To apply AI tools for solving research issues in physics<br>• To understand the basics of robotic process automation<br>• To develop automated solutions for research problems in biology | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: | Artificial Intelligence (AI): Introduction to AI – Fundamentals – Need for AI –Foundations of AI – AI environment | 4 Hrs |
| UNIT II: | Application domains of AI – AI tools – Challenges and Future of AI. | 4 Hrs |
| UNIT III: | SEARCH STRATEGIES: Breadth-First Search - Uniform Cost Search - Depth-First Search - Depth-Limited Search - Iterative Deepening Search - Bidirectional Search - Heuristic Search Techniques - A* Search - AO* Algorithm | 4 Hrs |
| UNIT IV: | Robotic Process Automation (RPA): Fundamentals of RPA – Programming basics from RPA perspective – Applying RPA – RPA development methodology – Architecture of RPA. | 4 Hrs |
| UNIT V: | Introduction - Automation debugging – Automation library - Activities Packages – Basic automation tasks - Text and image automation – Data tables in RPA – | 4 Hrs |
| TEXT BOOKS | 1. Stuart J Russell and Peter Norvig, ―Artificial Intelligence - A Modern Approach‖, Third Edition, Prentice Hall of India/ Pearson Education, New Delhi, 2015.<br>2. Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Tata McGraw Hill Publishing Company, New Delhi, 2014. | |

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|---|---|
| **REFERENCE BOOKS** | 1. Eugene Charniak and Drew McDermott, ―Introduction to Artificial Intelligence‖, Pearson Education, New Delhi, 2010.<br>2. Nils J Nilsson, ―Principles of Artificial Intelligence‖, Narosa Publishing House, New Delhi, 2000. |
| **WEB RESOURCES** | 1. https://onlinecourses.swayam2.ac.in/cec20_cs10/preview<br>2. https://nptel.ac.in/courses/106/105/106105077/ |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | Know what is artificial intelligence | K1, K2 |
| **CO2** | Learn the search strategies using AI | **K2, K3** |
| **CO3** | Learn basics of Python programming | **K4** |
| **CO4** | Understand the robotic process automation | **K4, K5** |
| **CO5** | Understand automation tasks and debugging | **K2, K5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | S | S | M | S | S | S | S | M |
| **CO2** | S | S | S | M | M | S | M | S | M | M |
| **CO3** | M | S | M | M | M | M | S | S | S | M |
| **CO4** | S | M | S | S | M | S | S | S | S | S |
| **CO5** | M | M | S | M | S | S | S | M | S | M |

**SEMESTER-II**

| SEMESTER-II | STATISTICAL MECHANICS | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics<br>• To identify the relationship between statistic and thermodynamic quantities<br>• To comprehend the concept of partition function, canonical and grand canonical ensembles<br>• To grasp the fundamental knowledge about the three types of statistics<br>• To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: PHASE TRANSITIONS | Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis. | 18 Hrs |
| UNIT II: STATISTICAL MECHANICS AND THERMODYNAMICS | Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox. | 18 Hrs |
| UNIT III: CANONICAL AND GRAND CANONICAL ENSEMBLES | Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations. | 18 Hrs |

| | | |
|---|---|---|
| **UNIT IV:**<br>**CLASSICAL AND**<br>**QUANTUM**<br>**STATISTICS** | Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation. | **18 Hrs** |
| **UNIT V:**<br>**REAL GAS**,<br>**ISING MODEL AND**<br>**FLUCTUATIONS** | Cluster expansion for a classical gas - Virial equation of state<br>– Calculation of the first Virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one dimension. Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation | **18 Hrs** |

| | |
|---|---|
| **TEXT BOOKS** | 1. S. K. Sinha, 1990, Statistical *Mechanics*, Tata McGraw Hill, New Delhi.<br>2. B. K. Agarwal and M. Eisner, 1998, *Statistical Mechanics,* Second Edition New Age International, New Delhi.<br>3. J. K. Bhattacharjee, 1996, *Statistical Mechanics*: An Introductory Text, Allied Publication, New Delhi. |
| **REFERENCE BOOKS** | 1. R. K. Pathria, 1996, *Statistical Mechanics,* 2nd edition, Butter WorthHeinemann, New Delhi.<br>2. L. D. Landau and E. M. Lifshitz, 1969, *Statistical Physics,* Pergamon Press, Oxford.<br>3. K. Huang, 2002, *Statistical Mechanics,* Taylor and Francis, London<br>4. W. Greiner, L. Neise and H. Stoecker, *Thermodynamics and Statistical Mechanics,* Springer Verlang, New York.<br>5. A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata. |
| **WEB RESOURCES** | 1. https://byjus.com/chemistry/third-law-of-thermodynamics/<br>2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html<br>3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics<br>4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble<br>5. https://en.wikipedia.org/wiki/Ising_model |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition | K5 |
| **CO2** | To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc.<br>Describe the peculiar behaviour of the entropy by mixing two gases<br>Justify the connection between statistics and thermodynamic quantities | **K4** |
| **CO3** | Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function | **K1** |
| **CO4** | To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics. | **K4, K5** |
| **CO5** | To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model | **K3** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate** | | |

**MAPPING OF $CO_S$ WITH POs & PSOs:**

| **CO/PO** | | **PO** | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | S | M | M | M | S | M | S | S | M |
| **CO2** | M | M | S | M | M | S | M | M | M | S |
| **CO3** | S | S | M | S | M | M | S | S | M | M |
| **CO4** | S | M | M | M | S | S | S | M | S | S |
| **CO5** | S | M | S | M | S | M | S | S | S | M |

| SEMESTER-II | QUANTUM MECHANICS | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To develop the physical principles and the mathematical background important to quantum mechanical descriptions.<br>• To describe the propagation of a particle in a simple, one-dimensional potential.<br>• To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.<br>• To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature<br>• To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation. | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: BASIC FORMALISM | Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation | 18 Hrs |
| 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 – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator | 18 Hrs |
| 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 | 18 Hrs |
| UNIT IV: APPROXIMATION METHODS | Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB | 18 Hrs |

| | | |
|---|---|---|
| | approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator. | |
| **UNIT V: ANGULAR MOMENTUM** | Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle. | **18 Hrs** |
| **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.<br>2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.<br>3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011. | |
| **REFERENCE BOOKS** | 1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.<br>2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.<br>3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.<br>4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.<br>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<br>2. http://www.feynmanlectures.caltech.edu/III_20.html<br>3. http://web.mit.edu/8.05/handouts/jaffe1.pdf<br>4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_ 1.pdf<br>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 OF $CO_S$ WITH POs & PSOs:**

| CO/PO | | PO | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | S | M | M | M | S | M | S | S | M |
| CO2 | M | M | S | M | M | S | M | M | M | S |
| CO3 | S | S | M | S | M | M | S | S | M | M |
| CO4 | S | M | M | M | S | S | S | M | S | S |
| CO5 | S | M | S | S | M | M | S | S | M | S |

| SEMESTER-II | PRACTICAL II | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -40 | External Marks-60 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.<br>• To calculate the thermodynamic quantities and physical properties of materials.<br>• To analyze the optical and electrical properties of materials.<br>• To observe the applications of FET and UJT.<br>• To study the different applications of operational amplifier circuits.<br>• To learn about Combinational Logic Circuits and Sequential Logic Circuits | |

| Course Details |
|---|
| **(Any Twelve Experiments)**<br><br>1. Determination of Stefan's constant of radiation from a hot body<br>2. Measurement of Coefficient of linear expansion- Air wedge Method<br>3. Measurement of Susceptibility of liquid - Quincke's method<br>4. B-H curve using CRO<br>5. Measurement of Magnetic Susceptibility - Guoy's method<br>6. Determination of Solar constant<br>7. Determination of Thickness of thin film. - Michelson Interferometer<br>8. Molecular spectra – CN bands<br>9. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser<br>10. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility<br>11. Interpretation of vibrational spectra of a given material<br>12. Determination of I-V Characteristics and efficiency of solar cell.<br>13. IC 7490 as scalar and seven segment display using IC7447<br>14. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter<br>15. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.<br>16. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193 |

17. Construction of square wave generator using IC 555 – Study of VCO
18. BCD to Excess- 3 and Excess 3 to BCD code conversion
19. Study of binary up / down counters - IC 7476 / IC7473
20. Study of synchronous parallel 4-bit binary up/down counter using IC 74193
21. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493
22. Construction of Multiplexer and Demultiplexer using ICs.

| | |
|---|---|
| **TEXT BOOKS** | 1. Practical Physics, Gupta and Kumar, Pragati Prakasan<br>2. Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences<br>3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.<br>4. Electronic lab manual Vol I, K ANavas, Rajath Publishing<br>5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition |
| **REFERENCE BOOKS** | 1. An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd<br>2. Advanced Practical Physics, S.P Singh, Pragati Prakasan<br>3. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. ltd<br>4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing<br>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 OF $CO_S$ WITH POs & PSOs:**

| CO/PO | | PO | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | S | M | M | M | S | M | S | S | M |
| CO2 | M | M | S | M | M | S | M | M | M | S |
| CO3 | S | S | M | S | M | M | S | S | M | M |
| CO4 | S | M | M | M | S | S | S | M | S | S |
| CO5 | M | M | S | M | M | S | S | M | M | M |

| SEMESTER-II | EC III-BIO PHYSICS | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand the physical principles involved in cell function maintenance.<br>• To understand the fundamentals of macromolecular structures involved in propagation of life.<br>• To understand the biophysical function of membrane and neuron.<br>• 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.<br>• To understand the physical principles behind the various techniques available for interrogating biological macromolecules. | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: | **CELLULAR BIOPHYSICS**<br>Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells. | 12 Hrs |
| UNIT II: | **MOLECULAR BIOPHYSICS**<br>Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins<br>Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation.<br>Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions. | 12 Hrs |
| UNIT III: | **MEMBRANE AND NEURO BIOPHYISCS**<br>Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels.<br>Nervous system: Organization of the nervous system –Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation. | 12 Hrs |

| | | |
|---|---|---|
| **UNIT IV:** | **RADIATION BIO PHYSICS**<br>X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer. | **12 Hrs** |
| **UNIT V:** | **PHYSICAL METHODS IN BIOLOGY**<br>Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis. | **12 Hrs** |
| **TEXT BOOKS** | 1. The cell: A molecular approach, Geoffrey M. Cooper, ASM Press, 2013.<br>2. Biophysics, VasanthaPattabhi, N. Gautham, Narosa Publishing, 2009<br>3. Biophysics, P. S. Mishra VK Enterprises, 2010.<br>4. Biophysics, M. A Subramanian, MJP Publishers, 2005.<br>5. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006. | |
| **REFERENCE BOOKS** | 1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008).<br>2. Essential cell biology by Bruce Albert et al (Garland Science)<br>3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983).<br>4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media).<br>5. Biological spectroscopyby Iain D. Campbell, Raymond A. Dwek | |
| **WEB RESOURCES** | 1. General Bio:http://www.biology.arizona.edu/DEFAULT.html<br>2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm<br>3. Electrophoresis:http://learn.genetics.utah.edu/content/labs/gel/<br>4. Online biophysics programs: http://mw.concord.org/modeler/<br>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 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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | M | S | M | S | S | S | M | M |
| **CO2** | S | M | S | M | M | S | M | M | M | S |
| **CO3** | M | S | S | S | M | M | M | S | S | M |
| **CO4** | M | M | M | M | S | M | S | S | M | S |
| **CO5** | S | M | S | M | S | S | M | S | M | S |

| SEMESTER-II | EC IV - SOLAR ENERGY UTILIZATION | Course Code: |
|---|---|---|
| Instruction Hours:4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To impart fundamental aspects of solar energy utilization.<br>• To give adequate exposure to solar energy related industries<br>• To harness entrepreneurship skills<br>• To understand the different types of solar cells and channelizing them to the different sectors of society<br>• 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. | 12 Hrs |
| 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. | 12 Hrs |
| UNIT III: SOLAR HEATERS | Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems. | 12 Hrs |
| 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. | 12 Hrs |
| 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.<br>Industrial visit – data collection and analysis - presentation | 12 Hrs |
| TEXT BOOKS | 1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.<br>2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", Mc Graw-Hill, 2010.<br>3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems", Academic Press, London, 2009 | |

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| | 4. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002<br>Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997. | |
| **REFERENCE BOOKS** | 1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)<br>2. Solar energy thermal processes – John A.Drife and William. (1974)<br>3. John W. Twidell& Anthony D.Weir, 'Renewable Energy Resources,2005<br>4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes,<br>4th Edition, john Wiley and Sons, 2013<br>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<br>2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read<br>3. www.nptel.ac.in/courses/112105051<br>4. www.freevideolectures.com<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | M | M | S | M | S | S | S | M | M |
| CO2 | S | M | S | M | M | S | M | M | M | S |
| CO3 | M | S | S | S | M | M | M | S | S | M |
| CO4 | M | M | M | M | S | M | S | S | M | S |
| CO5 | S | M | S | M | S | S | M | S | M | S |

| SEMESTER-II | AECC II - ELECTRONIC DEVICES AND CIRCUITS | Course Code: MPAEC2 |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand the characteristics of semiconductor diodes, transistors andtheir operations.<br>• To learn the performance of special devices like SCR, TRIAC and DIAC.<br>• To gain knowledge on small-signal amplifiers at low frequency.<br>• To learn the VI characteristics of semiconductor diodes in detail.<br>• To appreciate the small signal amplifier at low frequency. | |

| UNITS | Course Details | |
|---|---|---|
| UNIT – I | **SEMICONDUCTOR DIODES:**<br><br>p-n Junction Diode: Theory of p-n junction diode - Energy band diagram of p-n diode - VI characteristics - Static and dynamic resistances - Diode equivalent circuits - Diode logic circuits and diode clipper circuits. Zener Diode: VI characteristics - Breakdown mechanism - Zener diode as a voltage regulator. Backward diode: VI characteristics | 4 Hrs |
| UNIT – II | **SPECIAL PURPOSE DEVICES:**<br><br>Tunnel Diode - Photo Diode - Varactor Diode - Schottky Diode – Operation - VI characteristics applications - Principle of operation and characteristics of SCR. SCR specification - SCR control circuits -The TRIAC and DIAC. | 4 Hrs |
| UNIT – III | **TRANSISTOR:**<br><br>Characteristics - Current components Current gain: $\alpha$ and $\beta$ - Variation of transistor parameter with temperature and current level - Operating point - Hybrid model - h-parameter equivalent circuits. DC and AC analysis of singlestage CE - Emitter follower and CB amplifiers - AC and DC load | 4 Hrs |

| | | |
|---|---|---|
| **UNIT – IV** | **FIELD EFFECT TRANSISTOR & UJT:**<br><br>JFET& MOSFET- Construction and operation - Noise performance of FET - Biasing of JFET's and MOSFET's - Low Frequency single stage JFET amplifiers - FET as voltage variable resistor and active load -UJT- characteristics - parameters and specification - UJT as relaxation Oscillator. | **4 Hrs** |
| **UNIT – V** | **SMALL SIGNAL AMPLIFIERS AT LOW FREQUENCY:**<br><br>Analysis of BJT and FET multistage amplifier - DC and RC coupled amplifiers - Frequency response of single stage - multistage amplifiers - Analysis of differential amplifiers - Miller's theorem. | **4 Hrs** |
| **TEXT BOOKS** | 1. D. A. Bell, Electronic Devices and Circuits (Oxford University Press, Oxford,2008).<br>2. S. Salivahanan, N. S. Kumar and A. Vallavaraj, Electronic Devices andCircuits (McGraw Hill, New Delhi, 2016).<br>3. J. Millman, C. Halkias and C. D. Parikh, Integrated Electronics: Analog andDigital Circuits and Systems (McGraw Hill, New Delhi, 2017). | |
| **REFERENCES:** | 1. S. L. Gupta and V. Kumar, Hand Book of Electronics (Pragati Prakashan,Meerut, 2013).<br>2. S. M. Sze, Y. Li and K. K. Ng, Physics of Semiconductor Devices (Wiley, NewJersey, 2021).<br>3. G. S. N. Raju, Electronic Devices and Circuits (I.K. International Publications,New Delhi, 2008).<br>4. B. V. Rao and K. R. Rajeswari, Electronic Devices and Circuits (Pearson, NewDelhi, 2007).<br>5. B. P. Singh and R. Singh, Electronic Devices and Circuits (Pearson, New York,2012).<br>6. K. L. Kishore, Electronic Devices and Circuits (BS Publisher, Hyderabad,2016).<br>7. A. K. Maini and V. Agarwal, Electronic Devices and Circuits (Wiley, New Delhi,2009).<br>8. T. L. Floyd, Electronic Devices (Pearson, New Delhi, 2021).<br>9. M. Lakshmanan and K. Murali, Chaos in Nonlinear Oscillators (WorldScientific, Singapore, 1996).<br>10. J. C. Sprott and W. J. C. Thio, Elegant Circuits: Simple Chaotic Oscillators (World Scientific, Singapore, 2022). | |

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|---|---|---|
| **WEB RESOURCES** | 1. https://nptel.ac.in/courses/108108112<br>2. https://archive.org/download/ElectronicDevicesAndCircuitTheory/Electronic%20Devices%20and%20Circuit%20Theory.pdf | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | • Know the VI characteristics of semiconductor diodes in detail. | K1 |
| **CO2** | • Acknowledge the operation and characteristics of particular electronicsdevices with a specific purpose. | **K3** |
| **CO3** | • Comprehend the characteristics, operation and stability of transistor. | **K5** |
| **CO4** | • Understand the construction and operation of FET & UJT. | **K4** |
| **CO5** | • Appreciate the small signal amplifier at low frequency. | **K2, K3** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | S | S | M | S | S | S | M | S |
| **CO2** | S | M | S | M | M | S | M | M | M | S |
| **CO3** | M | S | S | S | M | S | S | S | S | M |
| **CO4** | M | M | S | M | S | M | S | S | M | M |
| **CO5** | S | M | S | M | S | S | M | S | S | M |

| SEMESTER-II | SEC II - PHYSICS OF NANOSCIENCE AND TECHNOLOGY | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.<br>• To provide the basic knowledge about nanoscience and technology.<br>• To learn the structures and properties of nanomaterials.<br>• 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 -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots- Surface effects of nanomaterials. | 4 Hrs |
| UNIT II: PROPERTIES OF NANOMATERIALS | Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - Optical properties: - Surface Plasmon Resonance - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism. | 4 Hrs |
| UNIT III: SYNTHESIS AND FABRICATION | Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching- ball milling technique-pulsed laser deposition - Nanolithography: photolithography– Nanomanipulator. | 4 Hrs |
| UNIT IV: CHARACTERIZATION TECHNIQUES | Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM). | 4 Hrs |
| UNIT V: APPLICATIONS OF NANOMATERIALS | Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors. Nano Electronics: Nanobots - display screen - 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. | 4 Hrs |
| TEXT BOOKS | 1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).<br>2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer | |

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| | Ahmad, Narosa Publishing House Pvt Ltd., (2010).<br>3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012). |
| **REFERENCE BOOKS** | 1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004).<br>2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA<br>3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007)<br>4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012)<br>5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi. |
| **WEB RESOURCES** | 1. www.its.caltec.edu/feyman/plenty.html<br>2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm<br>3. http://www.understandingnano.com<br>4. http://www.nano.gov<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | M | S | M | S | S | S | M | M |
| **CO2** | S | M | S | M | M | S | M | S | M | S |
| **CO3** | S | S | S | S | M | S | S | S | S | M |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | M | M | S | M | S | M | S | S | S | M |
| **CO5** | S | M | S | M | S | S | M | S | M | M |

| SEMESTER-II | ECC II – VAC I<br>RESEARCH PUBLICATION AND ETHICS | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To provide the fundamental knowledge on basics of research ethics, researchintegrity and publication ethics.<br>• To expose research misconduct and predatory publications.<br>• To explore citation databases, open access publications, research metrics(citations, h-index, Impact Factor, etc.) | |
| UNIT – I | **PHILOSOPHY AND ETHICS:**<br><br>Introduction to philosophy: definition - Nature and scope - Concept - Branches –Ethics: Definition - Moral philosophy - Nature of moral judgements and reactions. | 4 Hrs |
| UNIT – II | **SCIENTIFIC CONDUCT:**<br><br>Ethics with respect to science and research –<br>Intellectual honesty and researchintegrity –<br>Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)<br>– Redundant Publications: duplicate and overlapping publications, salami slicing<br>– Selective reporting and misrepresentation of data. | 4 Hrs |
| UNIT – III | **PUBLICATION ETHICS:**<br><br>Publication ethics: definition, introduction and importance – Conflicts of interest<br>– Publication misconduct: definition, concept, problems that lead to unethical behavior and vice – versa, types – Violation of publication ethics, authorship and contributorship – Identification of publication misconduct, complaints andappeals – Predatory publisher and journals. | 4 Hrs |

| | | |
|---|---|---|
| **UNIT – IV** | **OPEN ACCESS PUBLISHING AND PLAGIARISM TOOLS:**<br><br>Open access publications and initiatives – SHERPA/RoMEO online resource to check publisher copyright & self – archiving policies – Software tool to identify predatory publications developed by SPPU – Journal finger / journal suggestion tolls viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.<br>Use of plagiarism software like Turnitin, Urkund and other open source software tools. | **4 Hrs** |
| **UNIT – V** | **DATABASES AND RESEARCH METRICS:**<br><br>Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc.<br>Research Metrics: Impact Factor of journal as per journal Citations Report, SNIP,SJR, IPP, Citation score – Metrics: h-index, g index, i10 Index, altmetrics. | **4 Hrs** |
| **TEXT BOOKS** | 1. K. Ravichandran, A. T. Ravichandran, M. Ayyanar and P. Kavitha, *Research Methodology and Publication Ethics* (**J**azym Publications, Tiruchirappalli, 2022).<br>2. N. H. Steneck, *Introduction to the Responsible Conduct of Research* (Office of Research Integrity, Maryland, 2007).<br>3. P. Oliver, *Student's Guide to Research Ethics* (Open University Press, United Kingdom, 2003). | |
| **REFERENCES:** | 1. A. E. Shamoo and D. B. Resnik, *Responsible Conduct of Research* (Oxford University Press, Oxford, 2003).<br>2. A. B.H. Dursaton and M. Poole, *Thesis and Assignment Writing* (Wiley Eastern, New York, 1997).<br>3. B. Gustavii, *How to Write and Illustrate Scientific Papers?* (Cambridge University Press, Cambridge, 2008).<br>4. K. S. Bordens and B. B. Abbott, *Research Design and Methods* (McGraw Hill,New York, 2008).<br>*5.* A. M. Graziano and M. L. Raulin, *Research Methods – A Process of Inquiry*<br>i. (Pearson, New York, 2020). | |
| **WEB RESOURCES** | 1. https://ori.hhs.gov/sites/default/files/rcrintro.pdf<br>2. https://www.enago.co.kr/academy/wp-content/uploads/2018/05/Research_Ethics.pub_V2.pdf | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | • Know about the publication ethics and publication misconducts. | K1, K2 |
| **CO2** | • Understand the research ethics and research integrity. | **K1** |
| **CO3** | • Understand research misconduct and predatory publications. | **K2, K3** |
| **CO4** | • Differentiate citation databases, open access publication and researchmetrics. | **K4** |
| **CO5** | • Use plagiarism and open source software tools. | **K3** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | M | M | M | M | M | S | S | M | M |
| **CO2** | S | M | S | M | M | S | M | S | M | S |
| **CO3** | S | M | S | S | M | S | S | S | S | M |
| **CO4** | M | M | S | M | S | M | S | S | S | S |
| **CO5** | S | M | S | M | S | S | S | S | S | S |

## SEMESTER-III

| SEMESTER-III | CONDENSED MATTER PHYSICS | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To describe various crystal structures, symmetry and to differentiate different types of bonding.<br>• To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.<br>• To critically assess various theories of electrons in solids and their impact in distinguishing solids.<br>• Outline different types of magnetic materials and explain the underlying phenomena.<br>• 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 – Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Madelung constant - Types of crystal binding (general ideas). | 18 Hrs |
| UNIT II: LATTICE DYNAMICS | Lattice with two atoms per primitive cell - First Brillouin zone - Quantization of lattice vibrations - Debye's theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes. | 18 Hrs |
| 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 - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - de Hass-van Alphen effect . | 18 Hrs |

| | | |
|---|---|---|
| **UNIT IV: MAGNETISM** | Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature. | **18 Hrs** |
| **UNIT V: Superconductivity** | **Experimental facts:** Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors.<br><br>**Theoretical Explanation:** Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime- Nature of paring and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS. | **18 Hrs** |
| **TEXT BOOKS** | 1. C. Kittel, 1996, *Introduction to Solid State Physics,* 7th Edition, Wiley, New York.<br>2. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication.<br>3. A. J. Dekker, *Solid State Physics*, Macmillan India, New Delhi. | |
| **REFERENCE BOOKS** | 1. J. S. Blakemore, 1974 , *Solid state Physics,* 2nd Edition, W.B. Saunder, Philadelphia<br>2. H. M. Rosenburg, 1993, *The Solid State,* 3rd Edition, Oxford University Press, Oxford.<br>3. J. M. Ziman, 1971, Principles *of the Theory of Solids*, Cambridge University Press, London.<br>4. C. Ross-Innes and E. H. Rhoderick, 1976, *Introduction to Superconductivity,* Pergamon, Oxford.<br>5. J. P. Srivastava, 2001, *Elements of Solid State Physics,* Prentice-Hall of India, New Delhi. | |
| **WEB SOURCES** | 1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html<br>2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html<br>3. https://www.britannica.com/science/crystal<br>4. https://www.nationalgeographic.org/encyclopedia/magnetism/<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | M | M | M | S | S | M | M | M |
| **CO2** | S | M | S | M | M | S | M | S | M | S |
| **CO3** | S | M | S | S | M | S | S | S | S | M |
| **CO4** | M | M | S | S | S | M | S | M | S | M |
| **CO5** | S | M | S | M | S | S | M | S | S | S |

| SEMESTER-III | ELECTROMAGNETIC THEORY | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables<br>• To understand Biot – Savart's law and Ampere's circuital law<br>• To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws<br>• To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves<br>• To grasp the concept of plasma as the fourth state of matter | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I:<br><br>ELECTROSTATICS | Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems.<br><br>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. | 18 Hrs |
| UNIT II:<br><br>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. | 18 Hrs |

| | | |
|---|---|---|
| **UNIT III:**<br>**MAXWELL**<br>**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. | **18 Hrs** |
| **UNIT IV:**<br>**WAVE**<br>**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.<br>Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole | **18 Hrs** |
| **UNIT V:**<br>**ELEMENTARY**<br>**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. | **18 Hrs** |
| **TEXT BOOKS** | 1. D. J. Griffiths, 2002, *Introduction to Electrodynamics,* 3rd Edition, Prentice-Hall of India, New Delhi.<br>2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, *Foundations of Electromagnetic Theory,* 3rd edition, Narosa Publishing House, New Delhi.<br>3. J. D. Jackson, 1975, *Classical Electrodynamics,* Wiley Eastern Ltd. New Delhi. | |
| **REFERENCE BOOKS** | 1. W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism,* Addison Wesley, London.<br>2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications,* 5th Edition, WCB McGraw-Hill, New York.<br>3. B. Chakraborty, 2002, *Principles of Electrodynamics,* Books and Allied, Kolkata.<br>4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi.<br>5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA. | |
| **WEB SOURCES** | 1. http://www.plasma.uu.se/CED/Book/index.html<br>2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html<br>3. http://www.thphys.nuim.ie/Notes/em-topics/em- | |

| | | |
|---|---|---|
| | topics.html<br>4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | M | M | M | S | S | S | S | S | M | M |
| CO2 | S | S | S | M | M | S | M | S | M | S |
| CO3 | S | M | S | S | S | S | S | S | S | S |
| CO4 | M | M | S | S | M | M | S | M | S | M |
| CO5 | S | M | S | M | S | S | M | M | S | S |

| SEMESTER-III | PRACTICAL III<br>MICROPROCESSOR AND<br>PROGRAMMING IN C++ | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To develop programming skills in microprocessor and C++ programming to solve somemathematical problems and learn their applications. | |
| | **A. Microprocessor (8085)**<br>1. Finding the largest and smallest numbers in a data array.<br>2. Arranging a set of numbers in ascending and descending orders.<br>3. Study of multibyte decimal addition and subtraction.<br>4. Study of seven segment display.<br>5. Study of DAC interfacing (DAC 0900).<br>6. Study of ADC interfacing (ADC 0809).<br>7. Study of programmable interrupt controller (IC 8259).<br>8. Traffic control system.<br>9. Digital clock.<br>10. Generation of square and sine waves using DAC 0800.<br>11. Digital thermometer (temperature controller).<br>12. Control of stepper motor using microprocessor.<br>**B. C++ Programming**<br>1. Least-squares curve fitting – Straight-line fit.<br>2. Least-squares curve fitting – Exponential fit.<br>3. Real roots of one-dimensional nonlinear equations - Newton Raphson method.<br>4. Complex roots of one-dimensional nonlinear equations - Newton-Raphson method.<br>5. Interpolation – Lagrange method.<br>6. Numerical integration – Composite trapezoidal rule.<br>7. Numerical integration – Composite Simpson's 1/3 rule.<br>8. Solution of a second-order ODE – Euler method.<br>9. Solution of a first-order ODE – Fourth-order Runge-Kutta method.<br>10. Gaussian random number generation – Box and Muller method.<br>11. Calculation of mean and standard deviation of a set of uniform random numbers.<br>12. Computation of eigenvalues of linear harmonic oscillator by numerically solvingSchrödinger equation. | |

| | |
|---|---|
| **REFERENCES:** | 1. Nagoorkani, *8085 Microprocessor and its Applications* (McGraw Hill, New Delhi,2017).<br>2. Stroustrup, *Programming: Principles and Practice Using C++* (Addison Wesley,Massachusetts, 2014). |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | • Acquire hands-on knowledge of Microprocessor programming | **K1, K5** |
| **CO2** | • Understand DAC and ADC interfacing. | **K2, K3** |
| **CO3** | • Gain Knowledge of Traffic control systems. | **K3** |
| **CO4** | • Acquire hands-on knowledge of C++ Programming. | **K3, K4** |
| **CO5** | • Determine the eigenvalues of the harmonic oscillator numerically. | **K5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | S | M | S | M | M | S | M | M |
| **CO2** | S | S | S | M | M | S | M | S | M | S |
| **CO3** | S | S | S | S | S | S | S | S | M | S |
| **CO4** | M | M | S | S | M | S | S | M | S | M |
| **CO5** | S | M | S | M | M | S | M | M | S | S |

| SEMESTER-III | EC V- Structured and Object Oriented Programming Lab | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To impart the basic constructs in structured programming and object – oriented programming paradigms.<br>• To inculcate the insights and benefits in accessing memory location by implementing real world problems.<br>• To solve real world problems through appropriate programming paradigms<br>• To learn various elements of objects-oriented programming paradigm; Propose solutions through inheritance and polymorphism.<br>• To application of modular programming approach; create user defined data types and idealize the role of pointers. | |
| Indicative Experiments | | |
| | 1. Programs using basic control structures, branching and looping<br>2. Experiment the use of 1-D, 2-D arrays and Strings and Functions<br>3. Demonstrate the application of pointers<br>4. Experiment structures and unions<br>5. Programs on basic Object-Oriented Programming constructs<br>6. Demonstrate various categories of inheritance<br>7. Program to apply kinds of polymorphism<br>8. Develop generic templates and standard template Libraries | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | Understand different programming language | **K1** |
| **CO2** | Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers. | **K2** |
| **CO3** | Comprehend various elements of objects-oriented programming paradigm; Propose solutions through inheritance and polymorphism; | **K3** |
| **CO4** | constructs and decision – making statements; manipulate data as a group. | **K3, K4** |
| **CO5** | Identify the appropriate programming techniques | **K2, K5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | S | M | S | M | S | M | M | S | M | M |
| **CO2** | S | M | S | M | M | S | M | S | M | S |
| **CO3** | S | S | S | S | S | S | M | S | M | S |
| **CO4** | S | M | S | M | M | S | S | M | S | S |
| **CO5** | S | M | S | M | M | S | M | M | S | M |

| SEMESTER-III | CIM-SOLID WASTE MANAGEMENT | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To gain basic knowledge in solid waste management procedures<br>• To gain industry exposure and be equipped to take up a job.<br>• To harness entrepreneurial skills.<br>• To analyze the status of solid waste management in the nearby areas.<br>• To sensitize the importance of healthy practices in waste managements | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: | **SOLID WASTE MANAGEMENT**<br>Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste. | 12 Hrs |
| UNIT II: | **SOLID WASTE CHARACTERISTICS**<br>Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation | 12 Hrs |
| UNIT III: | **TOOLS AND EQUIPMENT**<br>Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique | 12 Hrs |
| UNIT IV: | **ECONOMIC DEVELOPMENT**<br>SWM for economic development and environmental protection Linking SWM and climate change and marine litter. | 12 Hrs |
| UNIT V: | **INDUSTRIAL VISIT**<br>SWM Industrial visit – data collection and analysis - presentation | 12 Hrs |
| TEXT BOOKS | 1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).<br>2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006).<br>3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BSP /BS Publications Books (.(2020) | |

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|---|---|---|
| **REFERENCE BOOKS** | 1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012<br>2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2<br>3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237<br>4. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 20061SBN-I3: 978-8131709122<br>5. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693 | |
| **WEB SOURCES** | 1. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648<br>2. https://testbook.com/learn/environmental-engineering-solid-waste-management/<br>3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB<br>4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28<br>5. https://amzn.eu/d/5VUSTDI | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | Gained knowledge in solid waste management | K1 |
| **CO2** | Equipped to take up related job by gaining industry exposure | **K5** |
| **CO3** | Develop entrepreneurial skills | **K3** |
| **CO4** | Will be able to analyze and manage the status of the solid wastes in the nearby areas | **K4** |
| **CO5** | Adequately sensitized in managing solid wastes in and around his/her locality | **K5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | S | S | M | S | M | M | S | M | S |
| CO2 | S | M | S | M | M | S | S | S | M | S |
| CO3 | S | S | S | S | M | S | M | S | M | S |
| CO4 | S | M | S | M | M | S | S | M | S | S |
| CO5 | S | M | S | M | M | S | M | S | M | M |

| SEMESTER-III | AECC III-<br>MICROPROCESSOR 8085 AND MICROCONTROLLER 8051 | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To provide an understanding of the architecture and functioning of microprocessor 8085A<br>• To the methods of interfacing I/O devices and memory to microprocessor<br>• To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051<br>• To Get knowledge of architecture and working of 8051 Microcontroller.<br>• To understand the different applications of microprocessor and microcontroller. | |

| | Course Details | |
|---|---|---|
| UNIT I: | **8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING**<br>Instruction set - Addressing modes - Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer. | 4 Hrs |
| UNIT II: | **8085 INTERFACING APPLICATIONS**<br>Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature an strain). | 4 Hrs |
| UNIT III: | **8051 MICROCONTROLLERHARDWARE**<br>Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory. | 4 Hrs |

| | | |
|---|---|---|
| **UNIT IV:** | **8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING**<br><br>Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming. | **4 Hrs** |
| **UNIT V:** | **INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD**<br>8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface- Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities(Temperature an strain). | **4 Hrs** |
| **TEXT BOOKS** | 1. A. NagoorKani, Microprocessors & Microcontrollers, RBA Publications (2009).<br>2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009).<br>3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013). | |
| **REFERENCE BOOKS** | 1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)<br>2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008).<br>3. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.<br>4. J. Uffrenbeck, “The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications”, Prentice-Hall of India, New Delhi.<br>5. W. A. Tribel, Avtar Singh, “The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications”, Prentice-Hall of India, New Delhi. | |
| **WEB SOURCES** | 1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html<br>2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/<br>3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/ | |

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|---|---|---|
| | 4. http://www.circuitstoday.com/8051-microcontroller<br>5. https://www.elprocus.com/8051-assembly-language-programming/ | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | Gain knowledge of architecture and working of 8085 microprocessor. | K1 |
| **CO2** | Get knowledge of architecture and working of 8051 Microcontroller. | **K1** |
| **CO3** | Be able to write simple assembly language programs for 8085A microprocessor. | **K2, K3** |
| **CO4** | Able to write simple assembly language programs for 8051 Microcontroller. | **K3, K4** |
| **CO5** | Understand the different applications of microprocessor and microcontroller. | **K3,K 5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | S | S | M | S | M | M | S | M | S |
| **CO2** | S | M | S | M | M | S | S | S | M | M |
| **CO3** | M | S | S | S | M | S | M | S | S | S |
| **CO4** | S | S | S | M | S | S | S | M | S | S |
| **CO5** | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-III | SEC III -NANOTECHNOLOGY | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • The main objectives of this course is to learn about the basics of Nano-science & Nano-technology & its applications<br>• Analyze the morphology and size of the nanoparticles using various analytical techniques<br>• To Understand different methods of synthesis of nanomaterials using<br>• To various physical, chemical and biological approaches<br>• To Learn the fundamentals properties of Nano-materials/ quantum dots/Wells/Wires | |

**Course Details**

| | | |
|---|---|---|
| UNIT I: | **OVERVIEW OF NANO-SCIENCE**<br>Definition of Nano, Nano revolution of the 20th century – emergence and challenges of nano-science and nano-technology- Atomic Structure and atomic size, - large surface to volume ratio, surface effects on the properties. | 4 Hrs |
| UNIT II: | **DIFFERENT CLASSES OF NANO-MATERIALS**<br>One dimensional, Two dimensional and Three dimensional nanostructured materials. Quantum dots, Wells and Wires - Bucky Balls and Carbon Nanotubes. | 4 Hrs |
| UNIT III: | **SYNTHESIS OF NANO-MATERIALS**<br>Top down (Nanolithography, CVD, PVD, Ball milling) – bottom up (sol gel processing, chemical deposition, Spin coating, spray pyrolysis) | 4 Hrs |
| UNIT IV: | **CHARACTERIZATION**<br>Powder X-ray diffraction - Debye-Scherrer technique - Indexing the powder pattern - Calculation of particle size using Scherer method - Lattice constant calculations.Microscopic Analysis: Scanning Electron Microscope (SEM) - EDAX analysis - Principle of Transmission Electron Microscopy (TEM). | 4 Hrs |
| UNIT V: | **CONTEMPORARY ISSUES**<br>Carbon Nanotubes for energy storage – Nano-materials in waste water treatment- catalytic process - Dye-sensitized solar cells- Biosensors – Gas sensor and its types. | 4 Hrs |
| Text Book(s) | 1.Nano-crystals: Synthesis, Properties and Applications - C.N.R. Rao, P.J. Thomas and G.U. Kulkarni, Springer (2007)<br>2.Nanostructured Materials and Nanotechnology - Hari Singh Nalwa, Academic Press, 2002 | |

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|---|---|
| **Reference Books** | 1. Energy for a sustainable world by L. Freris, D. Infield, Wiley, 2008.<br>2. Nano-materials for Sustainable Energy by Quan (Ed.), Springer, 2016.<br>3. Nano-materials in Energy Devices by Jun Hieng Kait CRC Press, 2017.<br>4. Advanced nano-materials and their applications in renewable energy by J. Louise, L. S.Bashir, 2015. |
| **WEB RESOURCES** | http://www.ncpre.iitb.ac.in/slotbooking/SOP/62SOP.pdf<br>https://en.wikipedia.org/wiki/Nanomaterials<br>https://www.nano.gov/you/nanotechnology-benefit |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | 1) Understand the fundamentals properties of Nano-materials/ quantum dots/Wells/Wires | K1 |
| **CO2** | 2) Analyze the morphology and size of the nanoparticles using various analytical techniques | **K1** |
| **CO3** | 3) Evaluate the potential applications of Nano-materials | **K2, K3** |
| **CO4** | 4) Understand different methods of synthesis of nanomaterials using various physical, chemical and biological approaches | **K3, K4** |
| **CO5** | 5) Understand the fundamentals properties of Nano-materials/ quantum dots/Wells/Wires | **K3,K 5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | S | S | M | S | M | M | S | M | S |
| **CO2** | M | S | M | M | S | S | S | M | S | M |
| **CO3** | M | S | S | S | M | S | M | S | S | S |
| **CO4** | M | S | M | M | S | S | M | S | M | S |
| **CO5** | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-III | ECC III – VAC II<br>MEDICAL INSTRUMENTATION | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To introduce the basic knowledge on biomedical instrumentation.<br>• To know about measurement of certain important electrical and non-electricalparameters.<br>• To have a basic knowledge in life assisting and therapeutic devices.<br>• Understand the Bio potential recorders.<br>• To explain the medical assistance/techniques and therapeutic equipments. | |
| Course Details | | |
| UNIT – I | **HUMAN PHYSIOLOGICAL SYSTEMS AND BIO-POTENTIAL ELECTRODES**<br><br>Transport of ions through the cell membrane – Resting and action potentials – Bio-electric potentials – Design of Medical instruments – Components of the biomedical instrument system – Half cell potential – Types of electrodes –Micro electrodes – Depth and needle electrodes – Surface electrodes – Transducers – Active transducers – magnetic induction type transducers (only). | 4 Hrs |
| UNIT – II | **BIO-SIGNAL ACQUISITION AND PHYSIOLOGICAL ASSISTDEVICES**<br><br>Required conditions for physiological signal amplifiers – Isolation amplifiers – ECG Isolation Amplifier Circuit – Medical preamplifier design – Bio-signal analysis – Physiological Assist Devices: Pacemakers – Typical ranges of pacemaker parameters - External and implanted pacemakers (comparison) – Ventricular asynchronous pacemakers - Defibrillators – DC Defibrillator – Oxygenators –Bubble oxygenators. | 4 Hrs |

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|---|---|---|
| **UNIT – III** | **BIO-POTENTIAL RECORDERS:**<br><br>Bio signal Recorders: Characteristics of the recording system – Electrocardiography (ECG) – Physiological nature of ECG waveform – ECG Recording setup - Echocardiography – Electroencephalography (EEG) – Origin of EEG – Simple block diagram of EEG recording setup – Electroretinography (ERG). | **4 Hrs** |
| **UNIT – IV** | **OPERATION THEATRE EQUIPMENT:**<br>Surgical diathermy- Shortwave diathermy – Ventilators – Pressure limited ventilators – Anesthesia machine – Blood flow meters – Electromagnetic blood flowmeter – Cardiac Output measurements – Fick's method – Spirometer – Gas analyzers – Infrared $CO_2$ analyzer – pH meter – Oxymeters. | **4 Hrs** |
| **UNIT – V** | **SPECIALIZED MEDICAL EQUIPMENTS:**<br><br>Blood Cell counters – Automatic blood cell counter – Digital thermometer – Audiometers – X-rays tube – X-ray machine – Angiography – Bio-telemetry – Elements of Biotelemetry system- Design of Bio-telemetry system-Physiological effects of 50Hz current passage – Micro shock and macro shock – Magnetic Resonance Imaging – principle – MRI Instrumentation. | **4 Hrs** |
| **TEXT BOOKS** | 1. M. Arumugan, *Biomedical Instrumentation* (AnuradaAgencies, Chennai, 1992).<br>2. R. S. Khandpur, *Handbook on Biomedical Instrumentation* (McGraw Hill, NewDelhi, 2014).<br>3. J. G. Webster and A. J. Nimunkar, *Medical Instrumentation Application and Design* (Wiley, Singapore, 1999). | |
| **REFERENCES:** | 1. L. Cromwell, F. J. Weibell and E. A. Pfeiffer, *Biomedical Instrumentation andMeasurements* (Pearson, New Delhi, 2016).<br>2. J. J. Carr and J. M. Brown, *Introduction to Biomedical Equipment Technology* (Pearson, New Delhi, 2001). | |
| **WEB RESOURCES** | 1. https://nptel.ac.in/courses/108105101<br>2. https://nptel.ac.in/courses/102105090 | |

**COURSE OUTCOMES:**

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

| | | |
|---|---|---|
| **CO1** | • Gain knowledge on various sensing and measurement devices of electricalorigin. | K1 |
| **CO2** | • Understand the Bio potential recorders. | **K1** |
| **CO3** | • Learn modern methods of imaging techniques and their analysis. | **K2, K3** |
| **CO4** | • Explain the medical assistance/techniques and therapeutic equipments. | **K3, K4** |
| **CO5** | • Recognize the significance of biomedical instrumentation field of study. | **K3,K 5** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | S | S | M | S | M | M | S | M | S |
| **CO2** | M | S | M | S | M | M | M | S | S | M |
| **CO3** | M | S | S | S | M | S | M | S | S | S |
| **CO4** | M | S | M | M | S | S | M | S | M | S |
| **CO5** | S | M | S | S | M | S | S | M | M | S |

# SEMESTER-IV

| SEMESTER-IV | NUCLEAR AND PARTICLE PHYSICS | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • Introduces students to the different models of the nucleus in a chronological order<br>• Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles<br>• Provides students with details of nuclear decay with relevant theories<br>• Exposes students to the Standard Model of Elementary Particles and Higgs boson | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: | **NUCLEAR MODELS**<br>Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrapole moment - Bohr and Mottelson collective model – rotational and vibrational bands. | 18 Hrs |
| UNIT II: | **NUCLEAR FORCES**<br>Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism. | 18 Hrs |
| UNIT III: | **NUCLEAR REACTIONS**<br>Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula. | 18 Hrs |

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|---|---|---|
| **UNIT IV:** | **NUCLEAR DECAY**<br>Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules. | **18 Hrs** |
| **UNIT V:** | **ELEMENTARY PARTICLES**<br>Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson. | **18 Hrs** |
| **TEXT BOOKS** | 1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011)<br>2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)<br>3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996)<br>4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)<br>S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968) | |
| **REFERENCE BOOKS** | 1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973)<br>2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).<br>3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002)<br>4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001)<br>B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi. | |
| **WEB SOURCES** | 1. http://bubl.ac.uk/link/n/nuclearphysics.html<br>2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia.org/article/Nuclear_Forces<br>3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/<br>4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | M | S | S | M | S | M | S | M | S |
| CO2 | M | S | M | M | S | S | S | M | S | M |
| CO3 | S | M | S | S | M | S | M | S | M | S |
| CO4 | M | S | M | M | S | S | M | S | M | S |
| CO5 | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-IV | ADVANCED SPECTROSCOPY | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | ➢ To comprehend the theory behind different spectroscopic methods<br>➢ To know the working principles along with an overview of construction of different types of spectrometers involved<br>➢ To explore various applications of these techniques in R &D.<br>➢ Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.<br>➢ Understand this important analytical tool | |

| UNITS | Course Details | |
|---|---|---|
| UNIT I: | **MICROWAVE SPECTROSCOPY**<br>Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra- Stark effect- Problems. | **18 Hrs** |
| UNIT II: | **INFRA-RED SPECTROSCOPY**<br>Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of $H_2O$ and $CO_2$ -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications | **18 Hrs** |

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|---|---|---|
| **UNIT III:** | **RAMAN SPECTROSCOPY**<br>Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of $H_2O$ and $CO_2$ -Mutual exclusion principle- determination of $N_2O$ structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS | **18 Hrs** |
| **UNIT IV:** | **RESONANCE SPECTROSCOPY**<br>Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance-Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan<br>Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom ) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR | **18 Hrs** |
| **UNIT V:** | **UV SPECTROSCOPY**<br>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 - Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications | **18 Hrs** |
| **TEXT BOOKS** | 1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.<br>2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.<br>3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.<br>4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.<br>5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds ($7^{th}$ Edition), New Age International Publishers. | |
| **REFERENCE BOOKS** | 1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.<br>2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.<br>3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and | |

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|---|---|
| | Hall, New York.<br>4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.<br>5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink. |
| **WEB SOURCES** | 1. https://www.youtube.com/watch?v=0iQhirTf2PI<br>2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5<br>3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee<br>4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview<br>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 OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | S | M | S | S | M | S | M | S | M | S |
| CO2 | M | S | M | M | S | S | S | M | S | M |
| CO3 | S | M | S | S | M | S | M | S | M | S |
| CO4 | M | S | M | M | S | S | M | S | M | S |
| CO5 | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-IV | Practical – IV -NUMERICAL METHODS AND COMPUTER PROGRAMMING (FORTRAN/C) | Course Code: |
|---|---|---|
| Instruction Hours: 6 | Credits: 4 | Exam Hours: 3 |
| Internal Marks -40 | External Marks-60 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • The aim and objective of the course on Computational Practical is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as C/FORTRAN<br>• To equip the computational skill using various mathematical tools.<br>• To apply the software tools to explore the concepts of physical science.<br>• To approach the real time activities using physics and mathematical formulations. | |
| | Course Details | |

**(Minimum of Twelve Experiments from the list)**

1. Lagrange interpolation with Algorithm, Flow chart and output.
2. Newton forward interpolation with Algorithm, Flow chart and output.
3. Newton backward interpolation with Algorithm, Flow chart and output.
4. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
5. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
6. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
7. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart and output.
8. Numerical solution of ordinary first-order differential equations by the Runge- Kutta method with Algorithm, Flow chart and output.
9. Finding Roots of a Polynomial - Bisection Method –
10. Finding Roots of a Polynomial - Newton Raphson Method –
11. Solution of Simultaneous Linear Equation by Gauss elimination method.
12. Solution of Ordinary Differential Equation by Euler
13. Runge Kutta Fourth Order Method for solving first order Ordinary Differential Equations
14. Newton's cotes formula
15. Trapezoidal rule
16. Simpson's 1/3 rule
17. Simpson's 3/8 rule
18. Boole's rule
19. Gaussian quadrature method (2 point and 3 point formula)

Giraffe's root square method for solving algebraic equation

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|---|---|
| **TEXT BOOKS** | 1. Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey 2006<br>2. Numerical methods in Science and Engineering - M.K. Venkataraman, National Publishing Co. Madras, 1996<br>3. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice-Hall, New Delhi.<br>4. M.K. Jain, S.R. Iyengar and R.K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Ed. New Age International, New Delhi.<br>5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, New Delhi. |
| **REFERENCE BOOKS** | 1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw-Hill).<br>2. B.F. Gerald and P.O. Wheately, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.<br>3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York.<br>4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison - Wesley, London.<br>5. V. Rajaraman,Programming in FORTRAN/ Programming in C, PHI, New Delhi. |

**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** |
| **CO6** | Process, analyze and plot data from various physical phenomena and interpret their meaning | **K4** |
| **CO7** | Identify modern programming methods and describe the extent and limitations of computational methods in physics | **K1** |

| | | |
|---|---|---|
| **CO8** | Work out numerical differentiation and integration whenever routine are not applicable. | **K5** |
| **CO9** | Apply various interpolation methods and finite difference concepts. | **K4** |
| **CO10** | Understand and apply numerical methods to find out solution of algebraic equation using different methods under different conditions, and numerical solution of system of algebraic equation. | **K1, K4** |
| **K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate** | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | M | S | M | S | M | S | M | S | |
| **CO2** | M | S | M | M | S | S | S | M | S | M |
| **CO3** | S | S | M | S | M | S | M | S | M | S |
| **CO4** | M | S | M | M | S | S | M | S | M | S |
| **CO5** | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-IV | EC VI-Java Programing | Course Code: |
|---|---|---|
| Instruction Hours: 4 | Credits: 3 | Exam Hours: 3 |
| Internal Marks - 25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • Enable the students to learn the basis functions, principles and concepts of advanced java programming.<br>• Provide knowledge on concepts needed for distributed Application Architecture.<br>• 3. Learn JDBC, Servlet packages, JQuery , Java Server Pages and JAR file format.<br>• To Apply and anlyze Java in Database<br>• To design interactive applications using Java Servlet, JSP and JDBC | |

| COURSE DETAILS | | |
|---|---|---|
| Unit: I | **BASICS OF JAVA**<br>Java Basics Review: Components and event handling- Threading concepts – Networking features – Media techniques | 12 Hrs |
| Unit: II | **REMOTE METHOD INVOCATION**<br>Remote Method Invocation-Distributed Application Architecture-Creating stubs and skeletons-Defining Remote objects-Remote Object Activation-Object Serilization-Java Spaces. | 12 Hrs |
| Unit: III | **DATABASE**<br>Java in Database-JDBC principles-database access-Interacting-database search-Creating multimedia databases – Database support In web applications. | 12 Hrs |
| Unit: IV | **SERVLETS**<br>Java Servlets: Java Servlet and CGI programming- A simple java Servlet-Anatomy of a java Serlet-Readingdata from a client-Reading http request header-sending data to a client and writing the http response header-working with cookies.<br>Java Server Pages:JSP Overview-Installation-JSP tags-Components of a JSP page-Expressions-Scriptlets-Directives-Declarations-A complete example. | 12 Hrs |
| Unit: V | **ADVANCED TECHNIQUES** | 12 Hrs |

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|---|---|---|
| | JAR file format creation – Internationalization – Swing Programming – Advanced java techniques. | |
| **Text Books** | 1. 1<br>2. Jamie Jaworski, "Java Unleashed" , SAMS Techmedia publications, 1999.<br>3. 2<br>4. Campione, Walrath and Huml, "The Java Tutorial", Addison Weslet, 1999. | |
| **Reference Books** | 1. Jim Keogh" The complete Reference J2EE", Tata McGrawHill Publishing Company Ltd, 2010.<br>2. 2<br>3. David Sawyer McFarland, "JavaScript And JQuery-The Missing Manual", Oreilly Publications, 3rd Edition, 2011.<br>4. 3<br>5. Deitel and Deitel, "Java How to Program", Third Edition, PHI/Pearson Educatin Asia. | |
| **WEB RESOURCES** | 1. https://www.javatpoint.com/servlet-tutorial<br>2. https://www.tutorialspoint.com/java/index.htm<br>3. https://onlinecourses.nptel.ac.in/noc19_cs84/preview | |

COURSE OUTCOMES:

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

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1. | Understand the advanced concepts of Java Programming | **K1,K2** |
| 2. | Understand JDBC and RMI concepts | **K2, K3** |
| 3. | Apply and anlyze Java in Database | **K3,K4** |
| 4. | Handle different event in java using the delegation event model, event listener and class | **K5** |
| 5. | Design interactive applications using Java Servlet, JSP and JDBC | **K5,K6** |
| **K1**-Remember; **K2** – Understand; **K3**-Apply; **K4** – Analyze**; K5**-Evaluate**; K6**-Create | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| CO/PO | PO | | | | | PSO | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| CO1 | M | M | S | M | S | M | S | M | S | S |
| CO2 | S | S | M | M | S | M | S | S | | S |
| CO3 | S | S | M | S | M | S | M | S | M | S |
| CO4 | M | S | M | S | M | M | S | M | S | M |
| CO5 | S | M | S | M | M | S | M | S | M | S |

| SEMESTER-IV | AECC IV- LASER PHYSICS AND NON-LINEAR OPTICS | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To understand the basic theory of laser action and apply them to classify and explain the fundamentals of laser,<br>• To explain the concept of Q-switching and illustrate the working of various advanced lasers available,<br>• To describe the basic Physics of nonlinear optics<br>• To demonstrate differnt NLO phenomena<br>• To illustrate the application of lasers in various fields. | |

| COURSE DETAILS | | |
|---|---|---|
| Unit: I | **Conventional lasers**<br>Spontaneous and Stimulated Emission - Einstein Coefficients – Levels of laser action: Two level – Three level – Four level lasers – Types of lasers (outline only) – Solid State Lasers: Ruby laser and Nd:YAG laser – Gas lasers : He-Ne laser and $CO_2$ laser – Liquid laser : Dye laser – Liquid $Eu^{3+}$ laser – Semiconductor laser | 4 Hrs |
| Unit: II | **Advanced lasers**<br>General description of Q-Switching – Production of Q-Switching : Electro-optic Shutter (Kerr effect and Pockels effect) – Mechanical and Saturable absorber Shutters – Peak power emitted during the pulse – Theory of Giant Pulse dynamics – Laser amplifiers – Mode locking – Ultrafast lasers – Fiber optic lasers | 4 Hrs |
| Unit: III | **Basics of Nonlinear Optics**<br>Wave propagation in an anisotropic crystal – Polarization response of materials to light –Harmonic generation – Second | 4 Hrs |

| | | |
|---|---|---|
| | harmonic generation – Sum and difference frequency generation – Phase matching – Third harmonic generation – Terahertz – Bi-stability. | |
| **Unit: IV** | **Nonlinear Absorption and Refraction**<br>Fundamentals of multi-quantum photoelectric effect – Theory of Two photon process – Experiment evidences of 2PA materials – Multi and Three photon process – Stimulated Raman scattering – Intensity dependent refractive index – Self-focusing of light – Phase Conjugated Optics – Photorefractive effect. | **4 Hrs** |
| **Unit: V** | **Applications of Lasers**<br>Materials processing with lasers : Drilling, Cutting, and Welding – Nuclear fusing with lasers – Communication by lasers – Principle of holography Laser range finders – Laser Gyro – LASIK – Optical computing. | **4 Hrs** |
| **TEXT BOOKS** | 1. **Richard L. Sutherland**, *Handbook of Nonlinear Optics*, (Marcel Decker Inc, New York,2003).<br>2. **K.R. Nambiar**, Lasers: *Principles, Types and Applications* (New Age Inter-nationalPublishers Ltd, New Delhi, 2014). | |
| **Reference** | 1. **B.B. Laud**, *Lasers and Nonlinear Optics,* 3rd Edn. (New Age International Pvt. Ltd., NewDelhi, 2011).<br>2. **R.W. Boyd**, *Nonlinear Optics, 2nd* Edn. (Academic Press, New York, 2003).<br>3. **W.T. Silfvast**, *Laser Fundamentals* (Cambridge University Press, Cambridge, 2003).<br>4. **Y.R. Shen**, *The Principles of Nonlinear Optics*, (Wiley & Sons, New Jersey, 2003). | |
| **WEB RESOURCES** | 1. https://science.nasa.gov/ems/<br>2. https://imagine.gsfc.nasa.gov/educators/gammarayburs ts/imagine/index.html | |

COURSE OUTCOMES:

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

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1. | • The course on Lasers and Nonlinear Optics covers the wide aspects of laser Physics alongwith nonlinear optics | **K1,K2** |
| 2. | • Describes the fundamentals of Lasers and their induced NLO behavior in materials | **K2, K3** |
| 3. | • Illustrates the outline of application of lasers in various sectors | **K3,K4** |
| 4. | • Gives idea to apply theories on NLO for practical applications | **K5** |
| 5. | • The course on Lasers and Nonlinear Optics covers the wide aspects of laser Physics alongwith nonlinear optics | **K5,K6** |
| **K1**-Remember; **K2** – Understand; **K3**-Apply; **K4** – Analyze**; K5**-Evaluate**; K6**-Create | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | S | M | M | S | M | S | M | S | M |
| **CO2** | S | S | M | M | S | M | S | S | | S |
| **CO3** | S | S | M | S | M | S | M | S | M | S |
| **CO4** | M | S | M | S | M | M | S | M | S | M |
| **CO5** | S | S | M | S | M | S | | S | S | M |

| SEMESTER-IV | DATA ANALYTICS | Course Code: |
|---|---|---|
| Instruction Hours: 2 | Credits: 2 | Exam Hours: 3 |
| Internal Marks -25 | External Marks-75 | Total Marks: 100 |
| CognitiveLevel | K1-Recalling<br>K2-Understanding<br>K3-Applying<br>K4-Analyzing<br>K5-Evaluating<br>K6-Creating | |
| COURSE OBJECTIVES | • To learn the different types of data terminologies<br>• To effectively learn the various aspects of data science<br>• To understand the role of Big data in AI, ML and other fields<br>• To know about various applications of Big Data filed.<br>• To understand the importance of data science | |

**COURSE DETAILS**

| | | |
|---|---|---|
| Unit: I | Introduction – Data – Information – Data Terminologies – Database – Data Mining – Data Warehouse – Data Evolution Roadmap – Big Data – Definition – Type of Data - Numeric – Categorical – Graphical – High Dimensional Data — Data Classification – Hot Data – Cold Data – Warm Data – Thick Data – Thin Data | 4 Hrs |
| Unit: II | Classification of digital Data:Structured, Semi-Structured and Un-Structured-Data Sources - Time Series –Transactional Data – Biological Data – Spatial Data – Social Network Data | 4 Hrs |
| Unit: III | Data Science: Data Science-A Discipline – Data Science vs Statistics, Data Science vs Mathematics, Data Science vs Programming Language, Data Science vs Database, Data Science vs Machine Learning. | 4 Hrs |
| Unit: IV | Data Analytics - – Relation: Data Science, Analytics, Big Data Analytics. Data Science Components: Data Engineering, Data Analytics-Methods and Algorithm, Data Visualization | 4 Hrs |
| Unit: V | Big Data: Digital Data-an Imprint: Evolution of Big Data – What is Big Data – Sources of Big Data. | 4 Hrs |
| TEXT | 1. V. Bhuvaneswari, T. Devi, “Big Data Analytics: Scitech Publisher , 2018 | |

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|---|---|
| **BOOKS** | 2. Han Hu, Yonggang Wen, Tat-Seng, Chua, XuelongLi,"Toward Scalable Systems forBig Data Analytics: A Technology Tutorial", IEEE, 2014. |
| **Reference** | 1. Big Data Analytics, RadhaShankarmani, M. Vijayalakshmi, Wiley, 2nd Edition (2016)<br>2. Big Data Analytics, VenkatAnkam, PacktPublicatins, (2016) |
| **WEB RESOURCES** | 1. https://ocw.mit.edu/resources/res-ll-005-mathematics-of-big-data-and-machine-learning-january-iap-2020/<br>2. https://onlinecourses.nptel.ac.in/noc20_cs92/preview<br>3. https://onlinecourses.swayam2.ac.in/arp19_ap60/preview |

COURSE OUTCOMES:

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

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1. | After completing this course, the student will be able to understand the various data terminologies | **K1,K2** |
| 2. | Understand the importance of data science | **K2, K3** |
| 3. | The concepts of Big data and related aspects | **K3,K4** |
| 4. | The potential of Big data in AI and ML and other fields | **K5** |
| 5. | To know about various applications of Big Data filed | **K5,K6** |
| **K1**-Remember; **K2** – Understand; **K3**-Apply; **K4** – Analyze**; K5**-Evaluate**; K6**-Create | | |

**MAPPING OF $CO_S$ WITH $PO_S$& $PSO_S$:**

| **CO/PO** | **PO** | | | | | **PSO** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **CO1** | M | S | M | M | S | M | S | M | S | M |
| **CO2** | S | S | M | M | S | M | S | S | | S |
| **CO3** | S | S | M | S | M | S | M | S | M | S |
| **CO4** | M | S | M | S | M | M | S | M | S | M |
| **CO5** | S | S | M | S | M | S | | S | S | M |