MINUTES OF THE BOARD OF STUDIES (BoS) M.Sc. PHYSICS MEETING HELD ON 27th AUGUST 2022 AT 10:30 AM IN THE DEPARTMENT OF PHYSICS RAYALASEEMA UNIVERSITY, KURNOOL.

MEMBERS:

1. **Prof. C.V.KRISHNA REDDY, Chairman, Board of Studies.**
2. **Prof. D.S.V.V.D. PRASAD, Andhra University, Visakhapatnam, Member, Board of Studies.**
3. **Prof.S.VIJAYA BHASKAR RAO, Sri Venkateswara University, Member, Board of Studies.**
4. **Prof.K.KRISHNA REDDY, YogiVemana University, Member, Board of Studies.**
5. **Prof.T.SUBBA RAO, SriKishnadevaraya University, Member, Board of Studies.**
6. **Sri. K.DHANUMJAYA, Vice President, Aditi Solar Pvt., Ltd., GKS, Rishita Elite, ECIL, Hyderabad, Member, Board of Studies.**

ITEM I

To prepare the curriculum of two year M.Sc., Physics Course to be offered in the Choice Based Credit System (CBCS) from 2022-2023 academic year onwards in accordance with NEP-2020.

RESOLUTION

1. It is unanimously resolved to offer two year M.Sc. Physics course on Choice Based Credit System (CBCS) from 2022-2023 Academic year onwards.
2. All core papers are Mandatory.
3. All Compulsory Foundation papers are Mandatory.
4. Elective Foundation, Generic Elective and Open Electivecourses are being offered.
5. Each theory paper consists of five units.
6. Skill Oriented course practical is mandatory.
7. In first and second semester, one audit course is to be introduced having zero credits.
8. Interested students may register for SWAYAM /MOOCs/ NPTEL with the approval of the concerned HoD for the award of the grade as ‘open elective’.
9. Multi-disciplinary Course is mandatory.
10. Question pattern is to be set by following Bloom's Taxonomy so that the degree of cognition can be assessed.Question paper should have two Sections, Section A which contains fill in the blanks, MCQ, short answer questions. No choice will be there. Section B, contains essay questions,with one question from each unit with internal choice.
11. Project Work –in house with various firms/ companies/societies. It consists of four credits with 100 marks in the fourth semester.
12. The theory evaluation consists of 20 Marks for eachInternal Assessment Examination (IAE), in which 75% weightagewill be given to one of the best IAE and 25% weightagewill be given for the second one of IAE.
13. The Practical evaluation is made for 100 marks with 4 credits, in which 30 Marks for Internal Assessment Examination (IAE) and 70 Marks for Semester End Examination (SEE),which is conducted at the end of each semester.
14. Comprehensive viva-voce will be conducted at the end of second & fourth semestershavingone creditwith 50 marks each.
15. The total marks for M.Sc. Physics Course is 2500 marks with98 Credits.

RAYALASEEMA UNIVERSITY::KURNOOL

Pasupula-518 007, A.P., INDIA
(A State University, Accredited with "B" Grade by NAAC)
M.Sc. Physics Syllabus

(Course structure and curriculum for the academic year 2022-2023)

Semester	Components of Study	Course Code	Title of the Course	No. of credits	(Theory) No. of hours per week	Practical/ Project (HRS)	Internal Assessment	Semester End Exams	Total
SEMESTER-I	Mandatory Core	PHY22101	**Classical Mechanics**	04	04	--	**20**	**80**	**100**
		PHY22102	Electromagnetic Theory, Lasers & Nonlinear Optics	04	04		**20**	**80**	**100**
	Compulsory Foundation	PHY22103	**Semiconductor Devices, Analog and Digital Circuits**	04	04		**20**	**80**	**100**
	Elective Foundation	PHY22104	**(A) Materials Science**	04	04		**20**	**80**	**100**
			(B) Integrated Circuit Fabrication Technique						
			(C) Principles of Ultrasonics						
	Practical-I	PHY22105	**General Lab**	04	--	08	**30**	**70**	**100**
	Practical-II	PHY22106	**Electronics Lab**	04	--	08	**30**	**70**	**100**
	Audit Course	PHY22107	**Human values and Professional ethics**	00	--	--	**--**	**00**	**00**
	Sub-total			**24**	**16**	**16**	**140**	**460**	**600**
SEMESTER-II	Mandatory Core	PHY22201	**Statistical and Relativistic Mechanics**	04	04	--	**20**	**80**	**100**
		PHY22202	**Condensed Matter Physics**	04	04		**20**	**80**	**100**
	Generic Elective	PHY22203	**Mathematical Physics**	04	04		**20**	**80**	**100**
	Open Elective	PHY22204	**(A) Fundamentals of 8085,8086 Microprocessors and Interfacing Devices**	04	04		**20**	**80**	**100**
			(B) Sensors and Transducers						
			(C) Nanomaterials and Devices						
	Practical-I	PHY22205	**General Lab**	04	--	08	**30**	**70**	**100**
	Practical-II	PHY22206	**Electronics Lab**	04	--	08	**30**	**70**	**100**
	Audit Course	PHY22207	**Industrial Revolution 4.0**	00	--	--	**--**	**00**	**00**
		PHY22208	**Comprehensive Viva-Voce**	01	00	--	**--**	**50**	**50**
	Sub-total			**25**	**16**	**16**	**140**	**510**	**650**
SEMESTER-III	Mandatory Core	PHY22301	**Introductory Quantum Mechanics**	04	04	--	**20**	**80**	**100**
		PHY22302	**Analytical Techniques**	04	04		**20**	**80**	**100**
	Generic Elective	PHY22303	**(A) Electronics-I (8051 Microcontrollers)**	04	04		**20**	**80**	**100**
			(B) Physics of Advanced Materials						
			(C) Applied Spectroscopy						
	Open Elective	PHY22304	(A) **Numerical Techniques & Computer Programming**	04	04		**20**	**80**	**100**
			(B) Renewable Energy Sources						
			(C) SWAYAM / MOOCs / NPTEL						
	Skill Oriented Course	PHY22305	**Computational Techniques using C-Language and MATLAB**	04	--	08	**30**	**70**	**100**
	Practical-I	PHY22306	**Electronics Lab**	04	--	08	**30**	**70**	**100**
	Sub-total			**24**	**16**	**16**	**140**	**460**	**600**
SEMESTER-IV	Mandatory Core	PHY22401	**Advanced Quantum Mechanics**	04	04	--	**20**	**80**	**100**
		PHY22402	**Atomic and Molecular Physics**	04	04		**20**	**80**	**100**
	Generic Elective	PHY22403	**(A) Electronics-II (Communication Electronics and Digital Signal Processing)**	04	04		**20**	**80**	**100**
			(B) Properties & Characterization of Materials						
			(C) Communication Systems						
	Elective Foundation	PHY22404	**(A) Nuclear And Particle Physics**	04	04		**20**	**80**	**100**
			(B) Vacuum and Thin Film Physics						
			(C) Frontiers Of Physics						
	Multi-Disciplinary Course / Project/Lab	PHY22405	**Practicals**	04	--	08	**30**	**70**	**100**
		PHY22406	**Project work**	04	--	08	**--**	**100**	**100**
		PHY22407	**Comprehensive Viva-Voce**	01	00	--	**--**	**50**	**50**
	Sub-total			**25**	**16**	**16**	**110**	**540**	**650**
Grand Total				**98**	**128**		**530**	**1970**	**2500**

S.NO	NAME		SIGNATURE
1.	Prof. C. V. KRISHNA REDDY	CHAIRMAN	
2.	Prof. D. S.V.V.D. PRASAD	MEMBER	27/8/2022
3.	Prof. S. VIJAYA BHASKAR RAO	MEMBER	27/8/2022
4.	Prof. K. KRISHNA REDDY	MEMBER	27/8/22
5.	Prof. T. SUBBA RAO	MEMBER	27/8/22
6.	Sri. K. DHANUMJAYA,	MEMBER	— Not attended.

RAYALASEEMA UNIVERSITY::KURNOOL

Pasupula-518 007, A.P., INDIA
(AState University, Accreditedwith"B"GradebyNAAC)
M.Sc. Physics Syllabus

(For the students admitted from the academic year 2021 – 22 onwards)

DEPARTMENT OF PHYSICS-TWO YEAR M.Sc., COURSE

AMENDED AS PER NEP-2020

CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from Academic Year 2022-2023)

Department Vision

To become an internationally recognized centre of excellence in academics and research in the area of Physics and related inter-disciplinary fields.

Department Mission

- The Department of Physics since its inception in 1979 has played a pivotal role in the University. This course aims to train the young students with the following objectives
- To impart high quality Science education in a vibrant academic ambience
- To prepare students to take up challenges as a researcher in diverse areas of theoretical and experimental physics
- Excellent laboratory and internet facilities
- Students to take admission to pursue Ph.D. programs in various advanced research areas like Spectroscopy and Advanced Materials.
- During 3rd and 4th semesters, students may opt special papers for the following areas: Condensed Matter Physics, Physics of Advanced Materials and Electronics.

Program Educational Objectives of M.Sc.(Physics)

1. To impart high quality education in Physical Sciences.
2. To prepare students to take up challenges as globally competitive physicists/researchers in diverse areas of theoretical and experimental physics.
3. To make the students technically and analytically skilled.
4. To give exposure to a vibrant academic ambience.
5. To create a sense of academic and social ethics among the students.
6. To prepare them to take up higher studies of interdisciplinary nature.

Program Outcomes of M.Sc.(Physics)

1. The students will obtain good knowledge in Physical Sciences. They will be trained to compete national level tests like UGC-CSIR NET, JEST, GATE, APSET etc., successfully.
2. They will be prepared to take up challenges as globally competitive physicists/researchers in diverse areas of theoretical and experimental physics.
3. They will be technically and analytically skilled enough to pursue their further studies.
4. They will have a sense of academic and social ethics.
5. They will be capable of taking up higher studies of interdisciplinary nature.
6. They will be able to recognize the need for continuous learning and develop throughout for the professional career.

Important notes:

The basic criteria of University Grants Commission (UGC) have been followed in preparing the course structure of this programme.

SYLLABUS TEMPLATE FOR M.Sc. PHYSICS
PROGRAM CODE: PHYRU

Pasupula-518 007, A.P., INDIA
(A State University, Accredited with "B" Grade by NAAC)

RAYALASEEMA UNIVERSITY::KURNOOL

BASED ON NATIONAL EDUCATION POLICY (NEP)-2020

CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from Academic Year 2022-2023)

Program Educational Objectives (PEOs)	
PEO1	The student will have significant prospects in the various fields like academics, industry, research organization, consultancy, defense and entrepreneurial pursuit at national/international level.
PEO2	The student will achieve peer recognition as an individual or team member having specialized knowledge and expertise to identify, formulate, investigate, analyze and implement on the problems in physical sciences.
PEO3	The student will have a solid foundation for academic excellence and quality leadership to meet the challenges in interdisciplinary and multi-disciplinary environment
PEO4	The student will have the ability to adapt, absorb and develop innovative and new technology in physical sciences and related areas through a lifelong learning process.
PEO5	The student will inculcate a value system and work ethically in a multidisciplinary environment, to enhance the advancement in physics in general and contribute significantly through their critical thinking and scientific competence.

ProgramSpecificOutcomes(PSOs)	
PSO1	On completion of the course the students will be able to explain the wide range of physical phenomena with underlying principles with respect to condensed matter physics, nuclear and particle physics both scientifically and in the wider perspective to the community.
PSO2	The current status of physics and associated developments can be understood and explained thoroughly.
PSO3	Show the ability to solve physics related problems and demonstrate the physics phenomenon through experiments.
PSO4	Well qualified to clear national level and state level qualifying examinations for research and teaching at graduate and postgraduate levels.
PSO5	The knowledge acquired during the course would also make the students able to pursue their higher studies as well as to use their knowledge to get into R & D and industrial sector.
PSO6	The knowledge acquired during the course will make the students to think, innovate and help to make an original contribution to the domain knowledge.
PSO7	The inter-disciplinary knowledge gained during the course will help the student to understand a problem in a better way and would be able to address the problem with a complete understanding.

ProgramOutcomes(POs)	
PO1	**Physics knowledge:** The MSc physics programcreates a comprehensive scientific knowledge, and this knowledge will help to understand, explain, and to solve advanced scientific problems.
PO2	**Problem analysis:** Identify, formulated and analyse advanced problems in physics.
PO3	**Design/development of solutions:** Design solutions for complex problems using the knowledge of physics.
PO4	**Conduct investigations of complex problems**: Use methodology and knowledge of physics to design innovative experiments, analyse and interpret the data.
PO5	**Modern tool usage**: To apply modern experimental and theoretical tools of physics along with modern computation technology to predict and model advanced problems in physics.
PO6	**Physics and society**: Apply the knowledge of physics to critically assess and analyse the problems of society.
PO7	**Environment and sustainability**: To ensure that the development in physics maintains and sustains the environment.
PO8	**Ethics**: Apply and commit to professional ethics of physics.
PO9	**Communication**: Effectively communicate the activities of physics to physics community and to society through effective presentation, reports and documentation.
PO10	**Life-long learning:** Recognize the need to engage in independent and life-long learning in the context of scientific/ technological change.

RAYALASEEMA UNIVERSITY::KURNOOL

Pasupula-518 007, A.P., INDIA
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M.Sc. Physics Syllabus
(Course structure and curriculum for the academic year 2022-2023)

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	Mandatory Core	PHY22102	**Electromagnetic Theory, Lasers & Nonlinear Optics**	04	04		**20**	**80**	**100**
	Compulsory Foundation	PHY22103	**Semiconductor Devices, Analog and Digital Circuits**	04	04		**20**	**80**	**100**
	Elective Foundation	PHY22104	**(A) Materials Science** (B) Integrated Circuit Fabrication Technique (C) Principles of Ultrasonics	04	04		**20**	**80**	**100**
	Practical-I	PHY22105	**General Lab**	04	--	08	**30**	**70**	**100**
	Practical-II	PHY22106	**Electronics Lab**	04	--	08	**30**	**70**	**100**
	Audit Course	PHY22107	**Human values and Professional ethics**	00	--	--	**--**	**00**	**00**
	Sub-total			**24**	**16**	**16**	**140**	**460**	**600**
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	Audit Course	PHY22207	**Industrial Revolution 4.0**	00	--	--	**--**	**00**	**00**
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	Multi-Disciplinary Course / Project/Lab	PHY22405	**Practicals**	04	--	08	**30**	**70**	**100**
		PHY22406	**Project work**	04	--	08	**--**	**100**	**100**
		PHY22407	**Comprehensive Viva-Voce**	01	00	--	**--**	**50**	**50**
	Sub-total			**25**	**16**	**16**	**110**	**540**	**650**
Grand Total				**98**	**128**		**530**	**1970**	**2500**

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7. The Multi-disciplinary Course is mandatory.
8. Project Work –in house with various firms/ companies/societies. It consists of four credits with 100 marks in the fourth semester.
9. Comprehensive viva-voce will be conducted at the end of second & fourth semesters having one credit with 50 marks each.
10. The total marks for M.Sc. Physics Course is 2500 marks with 98 Credits.

SEMESTER – I

Semester	Components of Study	Course Code	Title of the Course	No. of credits	(Theory) No. of hours per week	Practical/Project No. of hours per week	Internal Assessment	Semester End Exams	Total
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		PHY22102	**Electromagnetic Theory, Lasers & Nonlinear Optics**	04	04		**20**	**80**	**100**
	Compulsory Foundation	PHY22103	**Semiconductor Devices, Analog and Digital Circuits**	04	04		**20**	**80**	**100**
	Elective Foundation	PHY22104	**(A) Materials Science**	04	04		**20**	**80**	**100**
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	Practical-I	PHY22105	**General Lab**	04	--	08	**30**	**70**	**100**
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	Audit Course	PHY22107	**Human values and Professional ethics**	00	--	--	**--**	**00**	**00**
	Sub-total			**24**	**16**	**16**	**140**	**460**	**600**

MANDATORY CORE

PHY22101: CLASSICAL MECHANICS

OBJECTIVES:

1. To develop familiarity with the physical concepts of mechanics
2. To Facility Hamiltonian Formulation
3. Understand the concepts on Canonical Transformations
4. To understand the concept of central force and dynamics.

OUTCOMES:

1. Understanding the basic laws of mechanics
2. Explain Linear Harmonic Oscillator applications
3. Explain various types of transformations
4. Understanding the rotational kinetic energy of a rigid body and Euler equation of motion.

UNIT – I: LAGRANGIAN MECHANICS

Mechanics of a particle and system of particles, Conservation laws, Constraints and their classifications, Generalized coordinates, Principle of virtual work, D'Alembert's principle. Lagrange's equations: Lagrange's equations from D'Alembert's principle,Simple applications of Lagrange's equation: Linear Harmonic Oscillatory, Simple pendulum. Hamilton's principle, Lagrange's equation from Hamilton's Principle, Extension of Hamilton's principle of non-conservative and non-holonomic system.

UNIT – II: HAMILTONIAN MECHANICS

Legendre transformations, Generalized momentum and cyclic coordinates, Conservation theorems, Hamiltonian function, Hamiltonian equations of motion, Physical significance of Hamiltonian, Routh's procedure. Application of Hamiltonian Formulation: Linear Harmonic Oscillator, Simple pendulum. Principle of least action.

UNIT – III: CANONICAL TRANSFORMATIONS

Equation of Canonical Transformations, Generating functions, Examples of canonical transformations. Poisson and Lagrange brackets, Equations of motion in terms of Lagrange and Poisson brackets, Angular momentum and Poisson brackets.

UNIT – IV: HAMILTON-JACOBI THEORY

Hamilton-Jacobi theory: Hamilton-Jacobi equation, one dimensional harmonic oscillator, Kepler'sproblem: solution by hamilton- jacobi method, Physical significance of the Hamilton's characteristic function. Action angle variables, harmonic oscillator in action angle variables.

UNIT – V: CENTRAL FORCE FIELD AND RIGID BODY DYNAMICS

Reduction to the equivalent one-body problem, motion in a central force field, Inverse square law of force, Kepler's law of motion and its deduction, Rutherford Scattering Cross-Section. General coordinates of Rigid Body, Euler angles, Angular Velocity of a rigid body, Angular momentum and products of inertia, Rotational Kinetic energy of a rigid body and Euler equation of motion.

BOOKS FOR STUDY

1. Classical Mechanics by H. Goldstein (AddiWesely)
2. Classical Mechanics,G. Aruldhas, PHI Learning Pvt. Ltd.

BOOKS FOR REFERENCES

1. Classical Mechanics, J. C. Upadhyaya, Himalaya Publication house.
2. Classical Mechanics, SathyaPrakash, PragathiPrakashan Publications, Meerut.
3. Classical Mechancis, N. C. Rana& P. S. Joag, Tata-McGraw Hill Publications, New Delhi.
4. Introduction to Classical Mechanics, R. G. Takwale and P. S. Puranic.
5. Classical Mechanics, Gupta, Kumar and Sharma, PragathiPrakashan Publication, Meerut.

MANDATORY CORE

PHY22102: ELECTROMAGNETIC THEORY, LASERS AND NONLINEAR OPTICS

OBJECTIVES:

1. To understand the basic ideas of electromagnetic theory
2. To understand the Lasing action and Parametric generation of light
3. Introduction to holography, Fourier optics and Basic optical laws
4. To understand the ray optics in optical communication system.

OUTCOMES:

1. Able to apply Maxwell's equations in homogenous medium
2. To study different types of Laser Systems
3. Understanding the advantages of Fourier transforms and Holography
4. To Differentiate step index fibre and graded index fibre structures and know the applications of fibre optics

UNIT-I: ELECTROMAGNETIC THEORY

Maxwell's equations, Poyinting theorem.Vector and scalar potentials.Maxwell's equations in homogenous medium.Reflection and refraction at a plane boundary of the dielectric medium.Polarization by reflection and total internal reflection.Propagation of electromagnetic waves in conducting medium.Propagation in isotropic dielectric medium.Electromagnetic radiation – Retarded potentials, Radiation from moving point charge and oscillating dipoles.

UNIT-II: LASERS

Einstein coefficients.Amplification in a medium and population inversion.Spatial and temporal coherence. The ruby laser, Helium-Neon laser, four level solid state laser. CO_2 laser, Dye laser, semiconductor laser.

UNIT-III:NON LINEAR OPTICS: Basic Principles, Harmonic generation, Second harmonic generation, Phase matching condition, Third harmonic generation, Optical mixing, Parametric generation of light , Parametric light oscillator, Frequency up conversion, Self focusing of light.

UNIT-IV: HOLOGRAPHY AND FOURIER OPTICS

Introduction to Holography: Basic theory of Holography, Recording and reconstruction of Hologram, Fourier transform Holography, Acoustic and Holographic Microscopy, Pattern recognition and Applications of Holography. Fringe contrast variation.FourierTransformation spectroscopy.Michelson interferometer.Advantages of Fourier transforms. Optical data processing.Diffraction.

UNIT-V: FIBRE OPTICS

Optical fibres.Basic optical laws.Optical fibre modes, fibre types, rays and modes. Distinction between step index fibre and graded index fibre structures. Ray optics and wave representation. Attenuation in fibres.Absorption & scattering losses, radiation losses.Material dispersion.Fibre materials.Applications of fibre optics.

BOOKS FOR STUDY:

1. Introduction to Electrodynamics, D.J. Griffiths, 4 th Edition, Prentice-Hall of India.
2. Lasers and Non Linear Optics.B. B. Laud, New Age International Publishers.
3. Electromagnetic wave and Radiating systems, EC Jordan &K.G.Balmen.

REFERENCE BOOKS:

1. Optical Fiber Communication (SIE) | 5th Edition, Gerd Keiser, McGraw-Hill Education
2. Introduction to Classical and Modern Optics. J. R. Meyer.
3. Contemporary Optics. Ghatak and Thyagarajan, McMillan, India.
4. Introduction to Modern Optics. Grant R. Fowles,Holt,Rinehart and Winston,Inc New York
5. Laser and their Applications, M.J. Beesly, Taylor and Francis.

COMPULSORY FOUNDATION

PHY22103: SEMICONDUCTOR DEVICES, ANALOG AND DIGITAL CIRCUITS

OBJECTIVES:

1. Characteristics, parameters of JFET and Concept of CMOS
2. Understanding the Op-Amp configurations
3. To study the Waveform generators
4. To identify the differences between Combinational and Sequential Logic

OUTCOMES:

1. Application of UJT as a Relaxation oscillator.
2. Basic ideals on Filters (Low pass, high pass and Band pass).
3. Applying the PCM transmission techniques.
4. Identify the fundamentals of digital electronics circuits.

UNIT-I: SEMICONDUCTOR DEVICES

Introduction to P-N junction diode, diffusion capacitance and reverse recovery time.Zener diode, temperature sensing diode and Applications. Special diodes: Schottky diode, Varicap diode and Tunnel diodes. FET-Characteristics of n-channel, p-channel JFETs. MOSFET-Characteristics of enhancement and depletion mode MOSFETs.Characteristics of CMOS and CMOS inverter.Construction, operation and applications of SCR, TRIAC, UJT. Introduction to optoelectronic devices: LED, Laser diode.

UNIT-II: BASICS OF OPERATIONAL AMPLIFIER

Introduction to operational amplifier (Op-Amp), Block diagram of Op-Amp 741. Characteristics of Op Amp: dc offset voltage, offset current, CMMR and Slew rate. Experimental techniques to measure Op-Amp Characteristics. Open and closed loop configurations. Op-Amp configurations: Inverting and non-inverting amplifiers, voltage and current followers, differential amplifier.

UNIT-III: APPPLICATIONS OF OPERATIONAL AMPLIFIER

Mathematical Operations: Addition, subtraction & multiplication. Log and Antilog amplifiers, Sample and hold circuit, precision half and full-wave rectifier circuits, integrator, differentiator and comparator circuits. Waveform generators: Wien-bridge, Phase shift, Colpitts and Hartley oscillators, Instrumentation amplifier.

UNIT-IV: FUNDAMENTALS OF DIGITAL ELECTRONICS

Basic logic gates, Boolean and De morgan's laws, logic simplification using karnaugh map, Multiplexer and De-multiplexer. Decoders: BCD- to- Decimal, BCD-to- 7 segment, Half- and Full adders, Half and Full Substractors.

UNIT-V: FLIP-FLOPSAND COUNTERS

Flip-flops: RS- flip flop, D- flip flop, JK- flip flop and JK- Master Slave flip flop. **Counters:** 4-bit asynchronous ripple counter and Mod-5 synchronous counterand applications.

BOOKS FOR STUDY:

1. Electronic Devices and Circuit Theory, Robert Boylstead and Nashelsky, PHI.
2. Principle of Electronics by V K Mehta and Rohit Mehta, S.Chand publication.

REFERENCE BOOKS:

1. Electronic Devices and Circuits, David A Bell, PHI, New Delhi.
2. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, Pearson.
3. An Introduction to Operational Amplifiers and their applications, S V Subrahmanyam and Y Narasimha Murthy, Macmillan Publishers.
4. Operational Amplifiers and Linear Integrated Circuits, Robert F Coughlin and Frederick F Driscoll, PHI.
5. Fundamentals of Digital Circuits- Anand Kumar, PHI

ELECTIVE FOUNDATION

PHY22104 (A): MATERIAL SCIENCE

OBJECTIVES:

1. To understand the different theories of magnetic materials
2. To understand the concept of Superconducting materials
3. To understand the concept of Dielectric materials
4. To discuss Fabrication of Nanomaterials and CNT

OUTCOMES:

1. Explain Hysteresis behaviour, Ferrites and Garnets
2. Distinguish between Type-I & Type-II superconductors
3. Explain the Sources of polarizability
4. To explain the concept of Quantum size effect in Nanoparticles

UNIT-I: MAGNETIC MATERIALS

Heisenberg Model- exchange energy- origin of domains- Hysteresis behavior. Anti-ferromagnetism- Two sub-lattice model – Ferrimagnetism – Neel's theory of ferrimagnetism – Ferrites and Garnets. Basic principles of magnetic bubble memories.

UNIT – II: SUPERCONDUCTIVITY

Concept of zero resistance, Magnetic behavior, distinction between a perfect conductor and superconductor.Meissner effect–isotope, effect–specific heat behavior. Type-I & Type-II superconductors Two-fluid model.Super fluidity,Expression for entropy difference between normal and superconducting states.London's equations.Penetration depth.BCS theory.Josephson junctions - SQUIDS and its applications.Applications of superconductors.High TC superconductors, Preparation, Properties.

UNIT – III: DIELECTRIC MATERIALS

Dielecric constants and polarizability. Clausius-Mossotti relation. Sources of polarizability - electronic,ionic and dipolar polarizability.Frequency dependence of polarizability and dielecricconstant.Temperature dependane of dielectric properties, Ferro electricity-general properties and classification of representative ferroelectric materials.

UNIT-IV: SYNTHESISOF NANO MATERIALS

Introduction- basic principles of nanomaterials Synthesis of nanostructured materials, Top-Down approach-Ball-Milling, Bottom up-Vapour phase deposition techniques-Physical vapour deposition (PVD), Chemical vapour deposition (CVD) methods. Chemical Methods-Sol Gel method.Elementary ideas of Quantum wells, Quantum wires and Quantum dots.

UNIT –V: NANO DEVICES

Introduction, Nanomagnets, CNT:Types of CNTs, Single walled carbon Nanotubes (SWNT), Multi walled carbon Nanotubes (MWNT) Synthesis of Carbon nanotubes: Electric Arc discharge, Chemical vapour deposition, laser ablation, Properties of CNT: Electrical, Magnetic, Mechanical, Vibrational properties, Applications.

BOOKS FOR STUDY:

1. Materials Science, V.Rajendran, Tata McGraw-Hill publishing Company limited, New Delhi.
2. Solid State Physics-S. O. Pillai. , New Age International publishers (NAIP), New Delhi.

BOOKS FOR REFERENCE:

1. Introduction to Solid State Physics- C. Kittel. JW&S, VII Ed. , NY.
2. Electronic Processes in Materials- L. W.Azaroff and J. J. Brophy, MGH, NY.
3. Nano the Essentials, T Pradeep, McGraw-Hill Education (India) Pvt Limited.
4. Science of Engineering Materials- C. M. SrivastavaandC.Srinivasan, John Wiley & Sons.
5. Solid State Physics-A. J. Dekker, Mac Millan&Co Ltd. London.

ELECTIVE FOUNDATION

PHY22104 (B): IC FABRICATION TECHNOLOGY

OBJECTIVES - This course enables the students:
1. To learn about the wafer preparation methods, various deposition techniques
2. To study the concepts of crystal growth techniques.
3. To understand the details of oxidation, impurity distribution and photomasking.

OUTCOMES - After the completion of this course, students will be:
1. Understandthe preparation of silicon ingot.
2. Students would develop P-type and N-type silicon crystal growth using Czochralski and Bridgmen techniques.
3. In depth understanding of film thermal and anodic oxidation, diffusion process, etc.
4. Students would be aware the photomaksing, etc.

UNIT – I: IC FABRICATION TECHNOLOGY

Wafer preparation: Silicon crystal growth, Czochralski and Bridgmen techniques. Wafer orientation, Sawing and polishing, Crystal orientation, Doping of crystals during growth.

UNIT – II: EPITAXIAL DEPOSITION:

Epitaxial deposition: Introduction theory, Growth of an Epitaxial layer, evaluation of Epitaxial layers.

UNIT – III: OXIDATION

Introduction, equipment for thermal oxidation, oxidation process, oxide evaluation, recent advances in oxidation technology, oxide thickness determination, oxidation function, redistribution of dopant atoms during thermal oxidation, anodic oxidation.

UNIT - IV: IMPURITY

Introduction and redistribution, the idea of diffusion, diffusion process, diffusion analysis, ion implementation,

UNIT – V: PHOTOMASKING

Introduction – generation of photomask. Metallization: Metallization of requirements, vacuum deposition, deposition techniques, vacuum deposition cycle.

Books for Study

1. Instrumentation Measurement and Analysis by Nakra and Choudary, 4th Edition, Tata McGraw-Hill, 1985.
2. Instrumentation – Devices and Systems by Rangan, Sarma and Mani, 2nd Edition, Tata McGraw-Hill, 1997.
3. Measurement of Systems Applications and Design by Earnest O.Doeblin, 7th Edition, McGraw-Hill, 1990.
4. A course in Electrical; and Electronic Measurements and Instrumentation by A.K. Sawhney, 3rd Edition, DhanpatRai& Company, 2016.
5. Electronic Instrumentation and Measurements Techniques, Cooper and Albert D. Helfriek, 3rd Edition, Pearson India Education, 2016.
6. Applied Electronics by G.K. Mithal, 20th Edition, Khanna Publishers, 1997.
7. Principles of Industrial Instrumentation by D. Patranabis, Tata McGraw-Hill, 1976.
8. Semiconductor device fundamentals by Robert F. Pierret, Addision Wesley Longman, 1996.

ELECTIVE FOUNDATION

PHY22104 (C): PRINCIPLES OF ULTRASONICS

OBJECTIVES:

1. The course gives an introduction of ultrasonic and its properties and production of Ultrasonic by various methods.
2. The course also describes the propagation of ultrasonic in different media and Describes the measurement of ultrasonic velocities using various techniques.
3. The course discusses different methods in non-destructive testing and its applications.
4. The course discusses the applications of both low and high intensity ultrasonic in Various Fields.

OUTCOMES:

1. Students will be able to know the concept of different ranges of frequencies and
2. Ultrasonic waves and its production and properties by various methods.
3. They also able to learn the concept of propagation of ultrasonic waves in different liquid
4. Media with binary and ternary mixtures. They will be able to know the concept Viscoelasticity.
5. They able to measure ultrasonic velocities and absorption coefficients in liquids by Using various instruments.
6. They able to understand non-destructive testing methods and applications and learn applications of low and high intensities ultrasonic in the medical field, imaging, process control.

UNIT I: Introduction of ultrasonics, basic principles of ultrasonic waves, properties, production of ultrasonics i. Magnetostriction method. ii. Piezoelectric method. Detection of ultrasonic waves, basic design of ultrasonic transducer.

UNIT II: Propagation of ultrasonics velocity of plane wave in a medium, absorption of plane longitudinal waves in gases and low viscosity liquids where relaxation effects are absent. Viscoelasticity: Viscoelasticity of a medium, molecular picture of viscoelastic relaxation, propagation of shear wave in a visco elastic medium, The Maxwell model.

UNIT III: Measurements of ultrasonic velocities and absorption coefficients in liquids. i. DSA 5000 M (Density and Sound Velocity Meter) ii. The ultrasonic Interferometer iii. Pulse-echo technique iv. Optical diffraction method, Cavitation process, cleaning technique.

UNIT 1V: Non-destructive testing, different methods in non-destructive testing and applications of ultrasonic waves using non-destructive testing, flaw detection, applications of ultrasonics in medical field.

UNIT-V:

Low intensity ultrasonic application andhigh intensity ultrasonic applications in mechanical, chemical and metallurgical area. Applications of ultrasonics: Ultrasonic imaging, process control.

Reference Books:

1. Fundamental of ultrasonics - Jock Blitz
2. Ultrasonics- the low and high intensity applications - Dale Ensminger
3. Engineering Physics -1 - Dr. D. Tirupati Naidu & M. Veeranjaneyulu
4. Molecular Acoustics - A. J. Matheson

SEMESTER-II

Semester	Components of Study	Course Code	Title of the Course	No. of credits	(Theory) No. of hours per week	Practical/Project No. of hours per week	Internal Assessment	Semester End Exams	Total
SEMESTER-II	Mandatory Core	PHY22201	**Statistical and Relativistic Mechanics**	04	04	--	**20**	**80**	**100**
	Mandatory Core	PHY22202	**Condensed Matter Physics**	04	04		**20**	**80**	**100**
	Generic Elective	PHY22203	**Mathematical Physics**	04	04		**20**	**80**	**100**
	Open Elective	PHY22204	**(A) Fundamentals of 8085,8086 Microprocessors and Interfacing Devices**	04	04		**20**	**80**	**100**
			(B) Sensors and Transducers						
			(D) Nanomaterials and Devices						
	Practical-I	PHY22205	**General Lab**	04	--	08	**30**	**70**	**100**
	Practical-II	PHY22206	**Electronics Lab**	04	--	08	**30**	**70**	**100**
	Audit Course	PHY22207	**Industrial Revolution 4.0**	00	--	--	**--**	**00**	**00**
		PHY22208	**Comprehensive Viva-Voce**	01	00	--	**--**	**50**	**50**
	Sub-total			**25**	**16**	**16**	**140**	**510**	**650**

MANDATORY CORE

PHY22201: STATISTICAL AND RELATIVISTIC MECHANICS

OBJECTIVES:

1. To introduce the concept of phase space, ensemble.
2. To discuss about different types of partition functions.
3. To understand MB,BE and FD statistical distributions.
4. To understand the basic idea of the postulates of relativistic mechanics.

OUTCOMES:

1. Explain different types of ensembles I. e. , micro canonical, canonical and grand canonical ensembles were discussed
2. The concept of liquid helium and its transformations from normal fluid to super fluid are discussed.
3. The application of BE distribution and BE condensation are discussed
4. Understanding the concept of relativity

UNIT I :ENSEMBLES

Basic postulates of statistical mechanics, Phase space, probability, density distribution in phase space, Liouville's theorem, concept of ensemble, ensemble average, classification of ensemble: micro canonical, canonical and grand canonical ensembles. Expression for the entropy of a system, entropy of an ideal Boltzmann gas using micro canonical ensemble, Gibb's paradox, sackur-tetrode equation.

UNIT II: PARTITION FUNCTIONS

Partition functions for, micro Canonical, canonical and grand-canonical ensembles – Boltzmann equipartition theorem- Partition function for a system of particles, Partition function for translational,rotational,vibrational and electronic energies.

UNIT-III: CLASSICAL STATISTICS AND HEAT CAPACITIES

Maxwell- Boltzmann statistics, Maxwell- Boltzmann distribution of velocities.Calculation of mean values – Equipartition of Energy.Dulong and Petit's law – Einstein and Debye's theories of heat capacities- Liquid Helium – Two Fluid model of Liquid Helium II- Super Fluid Phase of He.

UNIT IV: QUANTUM STATISTICS

Quantum statistics - Bose- Einstein distribution – Bose- Einstein Condensation – Thermodynamic properties of an Ideal Bose- Einstein Gas– Fermi - Dirac Distribution-Black body radiation and the Planck's radiation law.

UNIT V: RELATIVISTIC MECHANICS

Introduction: postulates of relativistic mechanics. Minkowski space, Geometrical representation of Lorentz transformation of space and time.Application to Lorentz transformation.Geometrical representation of simultaneity, length-contraction and time dilation.Space like and time like intervals.Relativistic classification of particle,Basic ideas of general theory of relativity.

BOOKS FOR STUDY:

1. Statistical Mechanics - B. K. Agarwal and M. Eisner, NAI, New Delhi.
2. Statistical Mechanics and properties of Matter - E.S.RGopal, MacMillan Co.,ND

BOOKS FOR REFERENCE:

1. Relativistic Mechanics – Satyaprakash, PragathiPrakashan, Meerut.
2. Statistical and Thermal Physics - F. Reif.
3. Statistical Physics –Bhattacharjee.
4. Elementary Statistical Mechanism,-Gupta and Kumar,PragatiPrakashan.
5. Elementary Statistical Mechanics - C. Kittle

MANDATORY CORE

PHY22202: CONDENSED MATTER PHYSICS

OBJECTIVES:

1. To understand the crystal structures by diffraction methods.
2. To discuss the concept of quantization of Lattice vibration energy.
3. To find the Direct and indirect band gap semiconductors, concept of Hall Effect.
4. Understand the Imperfections in Crystals

OUTCOMES:

1. Explain the types in crystal structures
2. Explain the applications to Lattice Vibrations
3. Understand the formation of energy bands in solids
4. Abe to explain the defects in crystals

UNIT – I: STRUCTURE OF CRYSTALS

Crystal systems, Bravias lattices, Miller indices.Relation between inter-planar spacing and lattice spacing, Reciprocal lattice and structural factor. X- ray diffraction - Laue diffraction, Bragg's law. Powder diffraction - Experimental determination of structure of cubic crystals by powder diffraction technique. Crystal structures of materials: SCC, BCC, FCC, HCP parameterscalculation.

UNIT – II: LATTICE VIBRATIONS

Mono and diatomic one dimensional infinitely long lattice, vibrational spectra, infrared absorption in ionic crystals, vibrational spectra of finite lattice, quantization of lattice vibrations, phonons, properties, experimental measurement of dispersion relation. elastic properties, stress and strain, elastic moduli.

UNIT–III: ELECTRON THEORY OF SOLIDS

Introduction, Postulates of Classical free electron theory, Expression for electrical conductivity and Drift velocity, Expression for Thermal conductivity, Wiedemann-Franz law-Lorentz number, Hall Effect, Formulation of Boltzmann transport equation, Relaxation time approximation.

UNIT–IV: BAND THEORY OF SOLIDS

Sommerfield model - its consequences. Electron-lattice interaction (Quantitative only),Motion of electron in periodic potential, Bloch function**,** Kroning-Penny model, Formation of energy bands in solids, Concept of effective mass, Brillouinzones:One Dimensional, Two Dimensional and Three Dimensional, Direct and indirect band gap semiconductors.

UNIT-V: **IMPERFECTIONS IN CRYSTALS**

Classification of imperfections – Point defects -Schottky and Frenkel defects -Expressions for equilibrium defect concentrations - Diffusion - Ionic conductivity in alkali halides -Kirkendall effect - Line defects - Dislocations - Edge and Screw dislocations - Burger vector.

BOOKS FOR STUDY:

1. Solid State Physics, M.A.Wahab, Narosa Publishing House.
2. Introduction to Solid State Physics – C. Kittel, Wiley,8thedition,London.

REFERENCE BOOKS:

1. Solid State Physics –S. O. Pillai, New Age international.
2. Solid State Physics: Theory, applications& problems- S. L. Kakani and C.Hemarajan, S chand and sons, 4thedition
3. Solid State Physics – A. J.Dekkar, pan Macmillan, London.
4. Elementary Solid State Physics: Principles and applications – M. Ali Omar,Addison Wesley series, University of Michigan.
5. X-ray Diffraction – B E Warren, Dover publications, INC, Newyork.

GENERIC ELECTIVE

PHY22203: MATHEMATICAL PHYSICS

OBJECTIVES:

1. To understand the concept of tensor and group theory.
2. To understand the partial differentiation & complex variables
3. To discuss the relationship between beta and gamma functions
4. To understand the Fourier Transforms &Laplace Transform

OUTCOMES:

1. Explain the differences between matrices and determinants.
2. Identify different special mathematical functions
3. Use Fourier transform to obtain the Fourier series of periodic functions in physics.
4. Apply transform methods to solve elementary differential equations of interest in physics

UNIT – I: TENSORS AND GROUP THEORY

Tensors: Introduction: Notations and Conventions-the rank of a tensor-Contra-variant and co-variant tensors-Tensor Algebra: addition, subtraction, contraction, inner product and outer product, Symmetry and anti-symmetric tensors. Application of tensor: Stress, Strain, Piezo- electricity and elasticity tensors.

Group Theory: Isomorphism and Homomorphism, the group of symmetry of an equilateral triangle, group of symmetry of a square. Representation of groups: Reducible and Irreducible representation, Character representation, Construction of character tables.

UNIT- II: PARTIAL DIFFERENTIATION

Partial differentiations: Method of separation of variables, equation of vibrating string, solution of wave equation by D'Alembert's method, one dimensional heat flow. two dimensional heat flow Laplace equation in polar co-ordinates and transmission line equation.

UNIT: III COMPLEX VARIABLES

Complex Variables: Functions, complex differentiation- Analytic function- Cauchy-Reimann equations-Derivatives of elementary function. Complex integration: Cauchy's theorem-Cauchy integral formula-Taylor's and Laurent's theorem- Singular point- Residues: Calculations of residues and Residue theorem.

UNIT – IV: SPECIAL FUNCTIONS

Definitions of Beta and gamma functions and their properties- different forms of beta and gamma functions-relationship between beta and gamma functions. Solutions of differential equations:Bessel's function of first and second kind (recurrence formula, generating function and orthogonality relations only)- Legendre's equations-Laguerre and Hermite polynomials (recurrence formula, generating function and Rodrigue's formulae only).

UNIT – V: FOURIER AND LAPLACE TRANSFORMS

Fourier Transforms: Fourier transforms and its inverse transform- Linearity and shifting properties - Fourier sine and cosine transforms. Convolution theorem.

Laplace Transform: Definition and notation- Inverse Laplace transforms- Linearity and shifting and derivative properties-Convolution theorem- Evaluation of Integrals- Application to Integral and differential equations**.**

BOOKS FOR STUDY:

1. Matrices and Tensors- A. W. Joshi, New International (P) Ltd. , New Delhi.
2. Mathematical Physics- H. K. Das, S. Chand& Company Ltd. , New Delhi**.**

BOOKS FOR REFERENCE:

1. A Text book of Mathematical Physics- Suresh Chandra, Narosa Publishing house, New York.
2. Elements of Group Theory for Physicists- A. W. Joshi, New International (P) Ltd. , New Delhi.
3. Special function- bell.
4. Introduction to mathematical physics, charlic Harper, PHI, New Delhi.
5. Laplace Transforms- MurraySpiegle, schaum's series, McGrawHill,NY.

OPEN ELECTIVE

PHY22204 (A): FUNDAMENTALS OF 8085, 8086 MICROPROCESSORS AND INTERFACING DEVICES

OBJECTIVES

1. 1. To discuss INTEL 8085 microprocessor
2. 2. To discuss INTEL 8086 microprocessor
3. 3. To understand the DAC and ADC
4. 4. To understand the concept of Peripheral Interfacing Devices

OUTCOMES

5. 1. Explain Architecture of 8085 Microprocessor
6. 2. Explain Architecture of 8086 microprocessor and Memory organization
7. 3. Find the specifications and applications of ADC & DAC
8. 4. Discussion on Microprocessor Applications, Peripheral Interfacing programs
9.

UNIT - I: INTEL 8085 MICROPROCESSOR

Pin out configuration and signals of 8085 Microprocessor. Functional block diagram and explanation of blocks of 8085 Microprocessor. Register architecture of 8085 Microprocessor. De-multiplexing and generating control signals. Memory, I/O and Interrupt structures of 8085 Microprocessor. Addressing modes: direct, register, register indirect and immediate addressing modes. Instruction Set of 8085 microprocessor.

UNIT –II: INTEL 8086 MICROPROCESSOR

Pin out configuration and signals of 8086 Microprocessor. Functional block diagram of 8086 Microprocessor. Explanation of blocks of 8086 Microprocessor. Register architecture of 8086 Microprocessor. Maximum mode and Minimum Mode operation of 8086 Microprocessor. Memory organization and memory map of 8086 Microprocessor.

UNIT –III: INSTRUCTION SET OF 8086 MICROPROCESSOR

I/O and Interrupts of 8086 Microprocessor: Hardware interrupt, Non-mask able interrupt, Software interrupt, Internal interrupt and Reset. Various addressing modes of 8086: Register Addressing mode, Immediate Addressing mode, Register indirect addressing mode, Direct Addressing mode, Indexed Addressing mode, Base Relative Addressing mode, Base Indexed addressing mode. Instruction set of 8086 microprocessor. Simple programs (Addition, Subtraction, Multiplication and division) of 8086 microprocessor.

UNIT - IV: DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS

Digital to analog conversion – Variable resistor network and R/2R ladder.Resolution and Accuracy, Block Diagram of DAC-0800 and its specifications.Analog to digital conversion – Digital Ramp method, Dual slope, Successive Approximation technique and Flash techniques.Resolution and Accuracy, ADC-0804 specifications and applications.

UNIT- V: BASICS OF PERIPHERAL DEVICES AND INTERFACING

Programmable Serial Interface 8251, Programmable Peripheral Interface 8255, Programmable Interval Timer 8254, Programmable Interrupt Controller 8259, DMA Controller 8237.

BOOKS FOR STUDY

1. Microprocessor, Architecture, Programming and Applications with the 8085, Ramesh S Gaonkar, Penram International.
2. Microprocessors and Interfacing, Douglas V Hall and SSSP Rao, McGraw Hill.

BOOKS FOR REFERENCE

1. Microprocessors and Microcomputer based system design, Mohammed Rafiquzzaman, Universal Book Stall, New Delhi.
2. Digital Systems-Principles and Applications, Ronald J Tocci and Neal S Widmer, Pearson / PHI.
3. Digital fundamentals, Floyd and Jain, Pearson.
4. Microprocessor-Based Laboratory experiments and Projects by A.K. Mukhopadhyay, I.K.International publishing house PVT., Ltd.
5. The Intel Microprocessors 8086/8088, Pentium, Pentium 4, Architecture, Programming and Interfacing-Barry B. Brey, Pearson Education

OPEN ELECTIVE

PHY22204 (B):SENSORS AND TRANSDUCERS

OBJECTIVES - This course enables the students:

1. To understand the fundamentals of sensors and transducers and opto-electronic devices.
2. To learn the principles of transducers, gauges, LEDs, FETs, filters and amplifiers.
3. To learn the characteristics of LVDT, photodiode, couplers, detectors and amplifiers.

OUTCOMES - After the completion of this course, students will be:

1. The students able to construct transistor, FET.
2. The students will able to understand the concepts of optoelectronic devices.
3. They can understand the device structure and characteristics of photovoltaic cell, LED, LCD and photodiode.
4. In depth understanding of filters, detectors and amplifiers.

UNIT – I: General Introduction to sensors/transducers

Definition of a transducer/sensor.Role of a transducer in a generalized measurement system.Classification of transducers.Classification of transducers.Significant parameters of transducer. Temperature scales. Mechanical temperature sensors.Platinum resistance thermometer.Thermistors.Thermocouples.

UNIT –II: Displacement and strain transducers

Displacement transducers - Variable resistance, inductance and capacitance. Linear voltage differential Transformer (LVDT) Strain - Definition, Principal of working of strain gauges. Gauge factor. Types of strain gauges.Materials for strain gauges.Temperature compensation. Application

UNIT –III: Opto - electronic transducers

Photoemission tube.Photomultiplier cell.Photoconductive cell.Photovoltaic cell (solar cell). Photodiode, Photo – transistor, Photo FET, Light emitting diode. Liquid crystal display.Optoelectronic couplers.Laser diode.

UNIT –IV: Single conditioners (Filters & Detectors)

Filters – Integrators, Differentiators and active filters. Detectors: Peak Detectors sample and hold circuits. Phase sensitive detector and precision rectifiers and applications

UNIT –V: Single conditioners (Amplifiers)

Amplifiers – chopper stabilized DC amplifiers. Instrumentation amplifiers. Logarithmic and anti-logarithmic amplifiers Isolation amplifiers, Lock in amplifiers and applications

Books for Study

1. Instrumentation Measurement Analysis, Nakra and Chaudary, 4th Edition, Tata McGraw-Hill, 1985.
2. Instrumentation - Devices and Systems, Rangan, Mani and Sharma, 2nd Edition, Tata McGraw Hill, 1983.
3. A course in Electrical and Electronic Measurements and Instrumentation, AK Sawhney, 4th Edition, DhanpatRai& Company, 2016.
4. Instrumental Methods of Analysis, Willard, Meritt, Dean and Seattle, 7th Edition, Van Nostrand,1981.
5. Hand Book of Biomedical Instrumentation, RS Khandpur, 3rd Edition, Tata McGraw-Hill, 1987.
6. Fundamentals of Electronic Devices, David A. Bell, 5th Edition, Oxford University Press, 2008.
7. An introduction to Operational amplifiers, SV Subramanyam, 2nd Edition, Macmillan India,1980.

OPEN ELECTIVE

PHY22204 (C):NANOMATERIALS AND DEVICES

OBJECTIVES- This course enables the students belong to other subjects:

1. To know the fundamentals of nanomaterials – One, two dimensional.
2. To learn about the quantum confinement, properties of nanomateials.
3. To obtain knowledge on the preparation of nanomaterials.
4. To know the concepts of properties and characterization of nano devices.

OUTCOMES- After the completion of this course, students of the non-physics stream will be:

1. Able to get knowledge on nanomaterials.
2. Exposed to the knowledge on various types of nanomaterials preparations.
3. The students will able to get the knowledge on nano devices and its working.

UNIT-1: INTRODUCTION TO NANOMATERIALS

Introduction to Nanomaterials -Zero, One and Two Dimensional Nanomaterials Quantum confinement, Density of states, Dependence of dimensionality – Physical and chemical properties.

UNIT –II: SYNTHESIS OF NANOMATERIALS

Introduction to Bottom –up and Top- down approaches, Ball milling –Inert Gas condensation – Physical vapour deposition -, Molecular Beam Epitaxy – Sputtering – Pulsed laser Deposition –Chemical vapour deposition - Sol Gel – Hydrothermal Synthesis

UNIT- III: NANO –CARBON

Carbon molecules: Nature of the carbon bond –New Carbon structure –carbon clusters –Small carbon clusters – Discovery of C_{60} –Structure of C_{60} and its properties –Synthesis of buckyballs and Applications.

UNIT- IV: CARBON NANOTUBES

Carbon Nanotubes: Fabrication –Structure - Electrical Properties – Mechanical properties – Applications of carbon Nanotubes, Graphene: Fabrication – Structure – Electrical Properties – Mechanical properties – Applications.

UNIT –V: NANO DEVICES

Introduction – Nanofabrication –Photo- Lithography – Pattern transfer – Introduction to MEMS –Single Electron Transistor – Solar Cells – Light Emitting diodes –Gas Sensors- Microbatteries – Field emission display devices – Fuel Cells.

Books for Study

1. Nanomaterials: Synthesis, Properties and Applications – Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, 2002.
2. Introudction to Nanotechnology – Charles P. Poole Jr and Frant J. Owens, Wiley Interscience, 2003.
3. Nanopracticles from Theroy to Applications edited by Gunter Schmid, Wiley VCH, 2004.
4. Nanoelectronics and Nanosystems by K. Glosekotter and J. Dienstuthi (Springer), 2004.

SEMESTER-III

Semester	Components of Study	Course Code	Title of the Course	No. of credits	(Theory) No. of hours per week	Practical/Project No. of hours per week	Internal Assessment	Semester End Exams	Total
SEMESTER-III	Mandatory Core	PHY22301	**Introductory Quantum Mechanics**	04	04	--	20	80	100
		PHY22302	**Analytical Techniques**	04	04		20	80	100
	Generic Elective	PHY22303	**(A) Electronics-I (8051 Microcontrollers)**	04	04		20	80	100
			(B) Physics of Advanced Materials						
			(C) Applied Spectroscopy						
	Open Elective	PHY22304	(A) **Numerical Techniques & Computer Programming**	04	04		20	80	100
			(B) Renewable Energy Sources						
			(C) SWAYAM / MOOCs / NPTEL						
	Skill Oriented Course	PHY22305	**Computational Techniques using C-Language and MATLAB**	04	--	08	30	70	100
	Practical-I	PHY22306	**Electronics Lab**	04	--	08	30	70	100
	Sub-total			24	16	16	140	460	600

MANDATORY CORE

PHY22301: INTRODUCTORY QUANTUM MECHANICS

OBJECTIVES:

1. To bring out the limitations and failures of classical mechanics and to discuss need of quantum mechanics. To discuss basic postulates of quantum mechanics
2. To introduce quantum mechanical tunnelling and its application to alpha particle decay
3. To introduce row and column vectors, Dirac's bracket notations and to introduce the concept of Ladder operators.
4. To introduce a different commutation relation among angular momentum operators and to discuss Clebsch-Gordon coefficients.

OUTCOMES:

1. Explain the differences between Schrödinger's time dependent and time independent equations.
2. Identify different operator's formalism, Eigen values and Eigen functions.
3. Applying Heisenberg formulation to find the position and momentum equations of linear harmonic oscillator.
4. Importance of Eigen functions and Eigenvalues of AM operators.

UNIT- I: PRINCIPLES OF QUANTUM MECHANICS

Limitations of classical Mechanics, Difficulties with classical theories of black body radiation and origin of quantum theory of radiation. Schrödinger wave equation: development of the Schrödinger time independent and time dependent wave equation, solution of the time dependent Schrödinger equation, concept of stationary states. Physical significance of wave function (ψ).

UNIT- II: OPERATOR FORMALISM: Introductiontoquantum mechanicalOperators.Definition of Operators.Hermitian and unitary operators.operator algebra, eigen values and eigen vectors. Expectation values of operators, Postulates of quantum mechanics. orthogonal, normalized and orthonormal functions

UNIT- III: ONE DIMENSIONAL PROBLEMS AND SOLUTIONS

Potential step – Reflection and Transmission at the interface. Potential well: Square well potential with rigid walls, Square well potential with finite walls. Potential barrier: Penetration of a potential barrier (tunnelling effect). Radioactive Emission of Alpha particle.Periodic potential and Harmonic oscillator. Energy eigen functions and eigen values. Polynomial (Schrödinger)solutions.

UNIT- IV: MATRIX FORMULATION

Matrix representation of wave functions and linear operators.The concept of row and column matrices.Matrix algebra.Hermitian operators - definition.Dirac's bra and ket notation.Expectation values.Heisenberg (operator) representation of the harmonic oscillator.Ladder operators and their significance.

UNIT- V: ANGULAR MOMENTUM

Angular momentum operators: Definition. Eigen functions and eigenvalues of AM operators.Matrix representation of angular momentum operators. System with spin half(1/2). Spin angular momentum, Pauli's spin matrices. Clebsch-Gordon coefficients. Rigid Rotator: Eigen functions and Eigenvalues.

BOOKS FOR STUDY:

1. Quantum Mechanics. Vol 1, Albert Messiah, North-Holland Pub. Co. , Amsterdam.
2. A Text Book of Quantum Mechanics. P. M. Mathews and K. Venkatesam, Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. Introduction to Quantum Mechanics. R. H. Dicke and J. P. Witke, Addison-Wisley Pub. Co. Inc., London.
2. Quantum Mechanics. S. L. Gupta, V. Kumar, H. V. Sarama and R. C. Sharma, Jai PrakashNath& Co, Meerut.
3. Quantum Mechanics. L. I. Schiff, McGraw Hill Book Co. , Tokyo.
4. Quantum Mechanics. V. K. Thankappan.
5. Quantum Mechanics. B. K. Agarwal and HariPrakash.

MANDATORY CORE

PHY22302: ANALYTICAL TECHNIQUES

OBJECTIVES:

1. To discuss advanced spectroscopic and microscopic techniques
2. Comparison of NMR Instrumentation
3. To understand the concepts of ESR
4. To understand the Mössbauer Spectroscopy and NQR techniques

OUTCOMES:

1. Understanding the different characterization techniques
2. To explain the theory and applications of NMR
3. To interpret and apply ESR spectra
4. To explain the Nature of chemical bonds and structural information

UNIT – I : MICROSCOPY, DIFFRACTION AND COMPOSITION :

Crystal structures by transmission Electron Diffraction, Scanning Electron Microscopy, and Atomic force microscopy. Composition analysis by X ray probe microanalysis (EDAX),X-PhotoelectronSpectroscopy (XPS) and Secondary ion mass spectroscopy (SIMS) Theory, Instrumentation and applications.

Neutron Diffraction : Theory of Neutron diffraction : Scattering of Neutrons by Solids and liquids, Magneticscattering, Neutron spectrometer, application:Neutron diffraction of MnO.

UNIT- II: NUCLEAR MAGNETIC RESONANCE:

Magneticproperties of nuclei, theory of NMR spectroscopy, instrumentation, chemical shift and its origin, spin-lattice and spin-spin relaxation, shielding.coupling constant, NMR signals in compounds, NMR imaging, Application:CH_3CHO and C_2H_5OH.

UNIT – III: ELECTRON SPIN RESONANCE:

Theory of ESR spectroscopy, Comparison of NMR and ESR, Instrumentation, Interpretation of ESR spectra and DPPH, Hyperfine splitting, Determination of g-factor, ESR spectra of Methyl radical (CH_3) and p-nitrobenzoate anion, Application to ESR spectra of Mn^{2+} and Cu^{2+} ions, Limitations of ESR, Double resonance in ESR: Electron Nuclear Double Resonance (ENDOR) and Electron Double Resonance (ELDOR).

UNIT – IV: MÖSSBAUER SPECTROSCOPY

Recoil-less emission and absorption of γ- rays, Resonance fluorescence, Mössbauer effect, Mössbauer spectrometer, Isomer shift, Quadrupole Interaction, Magnetic hyperfine interaction, Applications of Mössbauer spectroscopy.

UNIT-V: NQR SPECTROSCOPY

NQR Spectroscopy: The quadrupole nucleus, Principle of NQR, transitions for axially and nonaxially symmetric Systems, NQR Instrumentation, Applications (brief details only): Nature of chemical bonds – Structural information about group III halides – Charge transfer compounds.

BOOKS FOR STUDY:

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell, Tata McGraw Hill, New Delhi.
2. Spectroscopy, B. P. Straughan and S. Walker, Vols. 1-3, Chapmann ad Hall, New York.

REFEENCE BOOKS

1. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice-Hall of India, New Delhi.
2. Spectroscopy, Chatwal and Anand, Himalya Publishing House, New Delhi.
3. Spectroscopy,H. Kaus,PragathiPrakasham,Meerut.
4. Spectroscopy, B. K. Sharma, Goel Publishing House, Meerut.
5. Modern Optical methods of Analysis, E. D. Olson, McGraw-Hill, New York.

GENERIC ELECTIVE

PHY22303 (A): ELECTRONICS-I (8051 MICROCONTROLLERS)

OBJECTIVES:

1. This subject deals about the basic 16-bit (8086) processor and an 8-bit (8051) controllers,
2. Architecture , internal organization and their functions of 8-bit (8051) controllers,
3. Basic idea of Assembly language programming Tools
4. Interfacing an external device with the processors/ controllers.

OUTCOMES:

1. Distinguish and analyze the properties of Microprocessors & Microcontrollers.
2. Identify a detailed s/w & h/w structure of the Microprocessor and apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
3. Analyze the data transfer information through serial & parallel ports.
4. Train their practical knowledge through laboratory experiments.

UNIT I: INTRODUCTION TO MICROCONTROLLERS

Introduction, Microcontrollers and Microprocessors, History of Microcontrollers and Microprocessors, Embedded versus External Memory Devices, 8 – bit and 16 – bit Microcontrollers, CISC and RISC Processors, Harvard and VonNeumann Architectures, Commercial Microcontroller Devices – Intel, Atmel and PIC families.

UNIT II: ARCHITECTURE OF 8051 MICROCONTROLLER

Introduction, 8051 architecture, Registers in 8051, Pin description and connections, Parallel I/O ports, Memory Organization. Interrupts, Timer/Counters and Serial Communication (Basic Concepts). Addressing Modes: Immediate addressing, Register addressing, Direct addressing, Register indirect addressing and Indexed addressing modes.

UNIT III: 8051 PROGRAMMING TOOLS

Instruction Set: Arithmetic and Logic Instructions, Jump, Loop and Call instructions, Simple programs. Assembly language programming Tools: Assembler, Data types and directives, Programming Template, Development Systems and Tools, Software simulators.

UNIT IV: INTERFACING TECHNIQUES OF 8051

Timer/ Counter Programming – Programming 8051 timers, Counter programming. Serial communications – Basics of Serial communications, 8051 connection to RS232, Programming. Interrupt Programming – 8051 Interrupts, Programming timer interrupts, external hardware interrupts.

UNIT-V: APPLICATIONS AND DESIGN OF MICROCONTROLLER BASED SYSTEMS

Interfacing of LEDs, 7 Segment display device, LCD display, Interfacing Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), Opto isolator, stepper motor and DC motor.

BOOKS FOR STUDY

1. The 8051 Microcontroller Architecture, Programming and Applications, K.J.Ayala, West publishing company, Newyork.
2. Microcontrollers - Theory and Applications, Ajay V Deshmukh, Tata McGraw-Hill Publishing Company Ltd, New Delhi.

REFERENCE BOOKS:

1. The Intel Microprocessors: Architecture, Programming and Interfacing, BarryB.Bray, Pearson Publications.
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, Pearson Education, New Delhi.
3. The 8051 Microcontroller & Embedded Systems using Assembly and C, Kenneth J Ayala, Dhananjay V GadreCengageLearing ,India pvt.Ltd,Delhi.
4. Microcomputer systems: The 8086/8088 Family Architecture Programming and Design by Yu Cheng Lin and Glenn A. Gibson, PHI.
5. Designing with PIC Microcontrollers by John B. Peatman, Pearson Education,Inc.

GENERIC ELECTIVE

PHY22303 (B):PHYSICS OF ADVANCED MATERIALS

OBJECTIVES - This course enables the students

1. To become familiar with crystal growth techniques and identify imperfection in crystals.
2. To become familiar with the electrical behaviour of dielectric materials and understand the field charge induced by dielectrics.
3. To learn the properties and applications of ferroelectrics
4. To become familiar with the theory behind the ferromagnetic and anti-ferromagnetic materials.
5. To understand the photoconductivity and luminescence properties of solids.

OUTCOMES - After the completion of this course, students will be

1. Able to learn various crystal growth techniques and understand the imperfection if any in the crystals.
2. Able to acquire knowledge about the properties of dielectrics and ferroelectrics.
3. Able to describe the ferromagnetic and anti-ferromagnetic materials and their applications.
4. Able to measure photoconductivity of the given material by using appropriate equipment.
5. Able to acquire knowledge on thermoluminescence, electroluminescence, photoluminescence, cathodoluminescence and chemiluminescence properties of solids.

UNIT - I: CRYSTAL GROWTH

Crystal growth: Nucleation and growth – Homogeneous and heterogeneous nucleation – Classification of crystal growth techniques – Melt growth: Bridgman,Czochralski techniques.

UNIT - II: IMPERFECTIONSIN CRYSTALS: Classification of imperfections – Point defects – Schottky and Frenkel defects -Expressions for equilibrium defect concentrations – Colourcentres –Production of colourcentres – Line defects – Dislocations – Edge and Screw dislocations – Burger vector – Estimation of dislocation densities – Ordered phases of matter- Translational and orientational order

UNIT- III: DIELECTRICS AND FERROELECTRICS

Dielectrics: Introduction – Dipole moment – various types of polarization – Electronic, ionic and orientational polarization – Langevin's theory – Lorentz field – Clausius-Mosotti equation –Measurement of dielectric constant – Applications of dielectrics.

Ferroelectrics: Piezo-, Pyro- and ferroelectric crystals– Spontaneous polarization – Classification and properties of ferroelectrics - Ferroelectric domains – Oxygen ion displacement theory – Applications of ferroelectrics.

UNIT- IV: FERROMAGNETISM AND ANTI-FERROMAGNETISM

Ferromagnetism: Introduction – Weiss molecular field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Exchange interaction – Ferromagnetic domains – Magnetic bubbles – Bloch wall – Thickness and energy – Ferromagnetic spin waves – Magnons – Dispersion relations.

Anti-ferromagnetism: Introduction – Two sub lattice model of anti-ferromagnetism – Ferri magnetism - Ferrites – Structure – Applications – Multiferroics

UNIT - V: FUNCTIONAL MATERIALS

Amorphous semiconductors: Band structure – Electronic conduction – Optical absorption – Applications.

Liquid crystals: Classification – Orientational order and intermolecular forces – Magnetic effect – Optical properties – Applications.

Polymers: Classification –Structural property correlation – Molecular weight – Crystalline in polymers Applications.

Books for Study

1. Solid State Physics, C. Kittel, Edition: 8th 2012, John Wiley & Sons.
2. Solid State Physics, A.J. Dekkar, Edition: 1st, 2000. Macmillan India Ltd.
3. Solid State Physics, M.A. Wahab, Edition:3rd, 2020, Narosa Publishing House.
4. Fundamentals of Solid State Physics, Saxena, Gupta, Saxena, Edition: 31st, 2019, Pragathi
5. Solid State Physics, R.L. Singhal,2018, KedarNath, Ram Nath& Co. Publications, Meerut.
6. Science of Engineering Materials and carbon nano tubes, C.M. Srivastsava and C. Srinivasan, Edition:3rd, 2010 New Age Inter. Pub.
7. Crystal Growth, B.R. Pamplin, 1977, Pergmon Press.
8. Crystal Growth from High Temperature Solutions, D. Elwell and H.J. Scheel,1975, Academic Press.

GENERIC ELECTIVE

PHY22303(C):APPLIED SPECTROSCOPY

OBJECTIVES -This course enables the students

1. To become familiar with Beer's law and working of Spectrophotometer.
2. To learn about the IR spectrophotometry and Fourier Transform Infrared Spectrometer used for the study of molecular structure.
3. Tofamiliar with the principles of Fluorescence and Phosphorescence spectroscopy and their applications.
4. To learn the theory of Raman scattering and application of Raman Spectroscopy.
5. To learn the technique of structure determination using IR and Raman spectroscopy.
6. To learn non-linear Raman phenomenon and photo-acoustic Raman scattering and multi photon spectroscopy.

OUTCOMES - After the completion of this course, students will be

1. Able to learn absortion principle and spectrophotometers working in different spectral regions.
2. Able to undertake molecular structure elucidation.
3. Able to use effectively the Fluorescence and Phosphorescence spectroscopic techniques for various analytical purposes.
4. Able to determine the structure of molecules using IR and Raman spectroscopy.
5. Able to acquire knowledge about the non-linear Raman phenomenon and photo-acoustic Raman scattering and multi photon spectroscopy.

UNIT I – SPECTROPHOTOMETRY

Introduction- Beer's law – Absorptivity – UV and visible absorption- Instrumentation- Essential parts of spectrophotometer- Gratings and prisms – Radiant energy sources – filters – Photosensitive detectors- Barrier layer cells – Photo emissive cells – Photomultiplier tubes –Relationship between absorption in the visible and UV region and molecular structure.

UNIT II - IR SPECTROPHOTOMETRY AND FLUORESCENCE

IR spectrophotometry - Fourier Transform Infrared (FTIR) Spectrometer – Molecular structure.Instrumentation and applications.

Fluorescence**:**Introduction – Flourescence- Resonance Flouorescence- Normal Fluorescence-Intensities of Transitions – Non-radioactive decay of fluorescent molecules.

UNIT III: PHOSPHORESCENCE SPECTROSCOPY

Phosphorescence and the nature of the triplet state- Population of the triplet state – Delayed fluorescence- Excitation spectra - Experimental methods – Emission lifetime measurements – Time resolved emission spectroscopy – Applications of Fluorescence and Phosphorescence.

UNIT IV - RAMAN SPECTROSCOPY

Introduction- Theory of Raman Scattering – Rotational Raman Spectra- Vibrational Raman Spectra – Mutual Exclusion principle – Raman Spectroscopy/ Sample Handling Techniques- polarization of Raman Scattered Light – Single Crystal Raman Spectra – Raman Investigation of Phase Transitions – Resonance Raman Scattering – Structure Determination using IR and Raman Spectroscopy.Difference between Raman spectra and Infrared spectra.

UNIT V - NON-LINEAR SPECTROSCOPIC PHENOMENA

Non-linear Raman phenomenon - Hyper Raman spectroscopy – Stimulated Raman spectroscopy – Inverse Raman effect – Coherent Anti-stokes Raman scattering – Photo-acoustic Raman scattering – Multi Photon Spectroscopy.

Prescribed Books:

1. Molecular spectra and Molecular structure Volume I, **G. Herzberg** (2nd Edition, Van. Nostrand London)
2. Fundamentals of Molecular Spectroscopy,**C.N. Banwell**(Tata Mcgraw- Hill Publishing Company Ltd, 1983)
3. Spectroscopy,**Straughan and Walker** (volume 2 and volume3, John wiley and Sons, 1976)
4. Molecular Structure and Spectroscopy,**G. Aruldhas**(Printice- Hall of India, Pvt. Ltd. 2001)
5. Instrumental Methods of Analysis,**Willard, Merritt, Dean and Settle** (CBS Publishers and Distributor, New Delhi, 200)

OPEN ELECTIVE

PHY22304 (A): NUMERICAL TECHNIQUES & COMPUTER PROGRAMMING

OBJECTIVES:

1. To obtain the solution of algebraic and transcendental equations
2. To understand the numerical differentiation & integration
3. To understand the basic ideas of 'C' Language
4. To discuss the simple programs using 'C' Language

OUTCOMES:

1. To solve physics problems through different numerical techniques
2. Explain the Numerical solutions of differential equations
3. Identify different Operators and expressions in 'C' Language
4. To explain user defined functions and tools in C-programs

UNIT- I: NUMERICAL TECHNIQUES

Solution of algebraic and transcendental equations: Bisection method, Method of false position and Newton-Raphson method. Principle of least squares – fitting of polynomials. Interpolation: Finite differences(forward, backward and central difference), Newton's formula for Interpolation, Central difference Interpolation formula (Gauss's &Sterling formula), Lagrange's Interpolation formula, Inverse Interpolation.

UNIT-II: NUMERICAL INTEGRATION

Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule and 3/8 Rule. Solutions of linear systems-Direct methods: Matrix Inversion method, Gaussian Elimination method, Modification of Gaussian Elimination method (Gauss-Jordan Method). Iterative methods: Jacobi method, Gauss Seidel method.

UNIT-III: NUMERICAL DIFFERENTIATION

Numerical differentiation: Numerical solutions of ordinary differential equations: Solution by Taylor's series, Picard's method of successive approximations, Euler's method (Error estimates for the Euler's method, Modified Euler's method) and Runge-Kutta method.

UNIT- IV: INTRODUCTION TO 'C' LANGUAGE

Character Set, C tokens, Key words and Identifiers, Constants and Variables, Data types, Declaration of variables. Operators and expressions: Arithmetic, Relational, Logical, Assignment, Increment and Decrement operators, Conditional, Bitwise and special operators. Precedence in evaluating arithmetic operators.Reading and Writing a character. IF, IF-ELSE, Nesting IF-ELSE, ELSE IF ladder and GOTO statements, WHILE, DO, FOR loop statements. Simple programs

UNIT- V: PROGRAMMING IN C -LANGUAGE

Arrays: One and Two dimensional arrays, Declaring and initializing string variables. Reading strings from terminal and writing strings to screen. User defined functions: definition of functions, Return values and their types. Function calls and function declaration. Pointers: Declaring and initializing pointers, Accessing a variable through its pointer. C-Programming: Linear regression, Sorting of numbers, Calculation of standard deviation and matrix multiplication

BOOKS FOR STUDY:

1. Mathematical Physics. H. K. Dass, S. Chand& Co.
2. Programming in ANSI C, E Balaguruswamy, TMH New Delhi.

REFERENCE BOOKS:

1. Numerical Methods. S. Sastry
2. Numerical Methods. B. S. Gopal&S. N. Mittal
3. Let us C, YashavantKanetker, BPB Publications, New Delhi.
4. Computer oriented numerical methods, Rajaraman
5. Computer-Oriented Numerical Methods, P. Thangaraj, PHI Learning Pvt. Ltd.

OPEN ELECTIVE

PHY22304 (B): RENEWABLE ENERGY SOURCES

OBJECTIVES:

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy like Wind, Solar energy.
4. Analyse the environmental aspects of renewable energy resources and industrial application

OUTCOMES:

1. Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
2. Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
3. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
4. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations and acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

UNIT-I: BIO DIVERSITY CONCEPTION INDIVIDUALS

Introduction to Renewable energy, biogas cogeneration, wood as source of energy, energy crops, Bio-diesel, fuel from plantation, ethanol, synthesis fuels.
Renewable energy (78-96),chapter-5

UNIT-II: SOLAR ENERGY

Solar Thermal: solar collectors, hot water from sun, cooling with the sun. Solar drying, air collectors, Solar thermal power plants.
Solar Electric: Photo voltaic effect, the heart of a PV array, The solar cell, Grid connected, PV arrays, Off grid PV arrays, Solar energy as part of sustainable development, The outlook for PV lower cost from New technologies and production.
Renewable energy (40-60), chapter-2

UNIT-III: WIND ENERGY

Power in the wind: Aerodynamics principles of wind turbines, Power available in the wind, Rotor efficiency, Factors effecting wind power, Impact of tower height, Wind turbine sitting, Idealized wind turbine, Power curve, Cpeed control for maximum power.Wind Turbine design considerations: Basic design, choice between two and three blade rotors, weight and size considerations.

UNIT-IV: WIND CHARACTERISTICS OF SITE

Wind Characteristics of site: Annual average wind speed, annual diurnal wind speed, monthly, diurnal wind speed, monthly variations in wind speed, frequency distribution of wind speed.
Renewable energy (98-112), chapter-6

UNIT-V: OCEAN AND SMALL HYDRO- ENERGY

Water power, Ocean wave and tidal energies, Hydro power nature conservation, underground heat, Micro Hydro plants
Renewable energy (114-128), chapter-7

BOOKS FOR STUDY

1. Hand book of Renewable energy technology. Editors A F Zobba and R Bansal World scientific publications
2. Renewable energy: The facts, Dieter Scirfried and Walter Witzel Earth Scan Publications for Sustainable Future. London

SEMESTER-IV

Semester	Components of Study	Course Code	Title of the Course	No. of credits	(Theory) No. of hours per week	Practical/Project No. of hours per week	Internal Assessment	Semester End Exams	Total
SEMESTER-IV	Mandatory Core	PHY22401	**Advanced Quantum Mechanics**	04	04		20	80	100
		PHY22402	**Atomic and Molecular Physics**	04	04		20	80	100
	Generic Elective	PHY22403	**(A) Electronics-II (Communication Electronics and Digital Signal Processing)**	04	04	--	20	80	100
			(B) Properties & Characterization of Materials						
			(C) Communication Systems						
	Elective Foundation	PHY22404	**(A) Nuclear And Particle Physics**	04	04		20	80	100
			(B) Vacuum and Thin Film Physics						
			(C) Frontiers Of Physics						
	Multi-Disciplinary Course / Project/Lab	PHY22405	**Practicals**	04	--	08	30	70	100
		PHY22406	**Project work**	04	--	08	--	100	100
		PHY22407	**Comprehensive Viva-Voce**	01	00	--	--	50	50
	Sub-total			25	16	16	110	540	650

MANDATORY CORE

PHY22401: ADVANCED QUANTUM MECHANICS

OBJECTIVES:

1. To apply and distinguish ability of particles to Pauli's exclusion principle
2. To discuss approximation methods like perturbation method, variational method and WKB approximation methods.
3. To introduce the quantum mechanical theory of scattering and scattering cross-section.
4. To apply relativistic mechanics to the Klein-Gordan equation.

OUTCOMES:

1. To explain Hydrogen molecule and to differentiate ortho and para hydrogen.
2. The approximation methods were applied to find the energy values of perturbed harmonic oscillator, to find the ground state energy of the helium atom and to the problem of alpha particle decay.
3. To explain the scattering method and find the scattering cross - sectionof square-well potential.
4. The limitations of Klein-Gordan equation and its rectification by Dirac, and solution of Dirac equation.

UNIT-I: IDENTICAL PARTICLES AND MOLECULES

Identical Particles: Symmetric and anti-symmetric wave functions, Indistinguishability of identical particles, Pauli's exclusion principle. Hydrogen molecule ion, Hydrogen molecule: Hitler London treatment. Oscillations and Rotations of H_2.Concept of Ortho and Para Hydrogen.

UNIT-II: APPROXIMATION METHODS- PERTURBATION THEORY

Time-independent perturbation method.Effect of anharmonicity on the solution of harmonic oscillator problem. Time-dependent perturbation theory, transition probabilities-Fermi'sgolden rule.

UNIT-III: VARIATION TECHNIQUE AND WKB APPROXIMATION METHOD

Variation technique: application to solve the ground state energy of He atom. WKB approximation method: α-particle decay. Sudden and Adiabatic perturbations.

UNIT-IV: THEORYOF SCATTERING

The scattering experiment.The method of partial waves.Scattering by a central potential. Zero energy scattering. Scattering by square-well potential, effective range.Resonance scattering.Born Approximation, Validity of Born Approximation.

UNIT-V: RELATIVISTIC QUANTUM MECHANICS

Klein-Gordan equation, Probability and current density, Inadequacies of Klein-Gordan equation.Dirac matrices, Dirac relativistic equation for free particles and solution.Concept of negative energy states.Theory of holes**.**

BOOKS FOR STUDY

1. Quantum Mecanics, G. Aruldhas, Prentice Hall of India Pvt. Ltd, New Delhi.
2. Introduction to Quantam Mechanics with applications to chemistry. Linus Pauling and E. BrightWilson,Jr. McGraw Hill,BookCompany, New York and London.

REFERENCE BOOKS

1. Quantum Mechanics. B. K. Agarwal and Hariprakash, Prentice-Hall of India Ltd. , New Delhi.
2. Quantum Mechanics. L. I. Schiff, McGraw Hill Book Co. ,Tokyo.
3. A Text Book of Quantum Mechanics. P. M. Mathews and K. Venkateswaran, Tata McGraw Hill, New Delhi.
4. Introduction to Quantum Mechanics, R. H. Dicke and J. P. Witke, Addison-Wisley Pub. Co. Inc.,London.
5. Quantum Mechanics, V. K. Tankappan, Wiley-Eastern Ltd. ,New Delhi.

MANDATORY CORE

PHY22402: ATMOIC AND MOLECULAR PHYSICS

OBJECTIVES:

1. To understand the principles of Atomic Absorption Spectroscopy (AAS),
2. To understand the types of molecular spectra and Instrumentation.
3. Understand the basic idea of UV & Visible Spectrophotometry
4. To understand the Infrared and Raman Spectroscopy

OUTCOMES:

1. Distinguish between the Absorption and Emission Spectroscopy
2. Able to explain different types of molecular spectra.
3. Explain the applications of Visible spectroscopy
4. Explain the advantages of Raman spectroscopy over IR.

UNIT- I: ATOMIC ABSORPTION AND EMISSION SPECTROSCOPY

Principle of Atomic Absorption Spectroscopy (AAS), Instrumentation, Atomic absorption spectrometers, Differences between atomic absorption and flame emission spectroscopy, Determination of lead in petrol. **Emission Spectroscopy:** Line spectra of atoms and ions – Excitation and Ionization potentials – Emission spectrographs –Constant deviation spectrometer – Qualitative analysis – Quantitative methods (Internal standard).

UNIT- II: MOLECULAR SPECTRA

Born-Oppenheimer approximation, Types of molecular spectra, Diatomic molecule as a rigid rotator and its spectra (Microwave), Vibrations of a molecule and its spectra (IR), Vibration-rotational spectra, Electronic Spectra: vibrational coarse structure –rotational fine structure, Effect of isotopic substitution on rotation and vibration spectra of CO, Franck-Condon principle, Dissociation energies and Pre-dissociation.

UNIT- III: UV & VISIBLE SPECTROPHOTOMETRY

Beer-Lambert's law, Deviations from Beer's law, Instrumentation: radiation sources – Monochromators – Detectors – Non recording single and double spectrophotometers – Recording double spectrophotometers, Differences between single and double beam spectrophotometers – Applications of Visible spectroscopy: Structures of simple organic and inorganic compounds – Evaluation of molar absorptivity (ε) and molecular weight of isoprene**.**

UNIT- IV: INFRARED SPECTROSCOPY

Theory of IR, Vibrating diatomic molecule as anharminic oscillator.IR single and double beam spectrometer, Vibrations of polyatomic molecules, Instrumentation of nfrared spectroscopy: Source, Monochromator, Sampling of substances and Detector.

UNIT- V: RAMAN SPECTROSCOPY

Principle, Differences between Raman and IR spectra,. Classical and quantum theories of Raman Effect, Laser Raman spectrometer, Inorganic applications of Raman spectra: CO_2, N_2O, SO_2, H_2O, and H_2SO_4. Organic applications of Raman spectra, Advantages of Raman spectroscopy over IR.Disadvantages of Raman spectra.

BOOKS FOR STUDY

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell, Tata McGraw Hill, New Delhi.
2. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice-Hall of India, New Delhi.

REFERENCE BOOKS

1. Spectroscopy,Chatwal and Anand, Himalya Publishing House,New Delhi.
2. Spectroscopy, B. K. Sharma, Goel Publishing House, Meerut.
3. Spectroscopy, H. Kaur, PragatiPrakashan, Meerut.
4. Spectroscopy, B. P. Straughan&S. Walker,Vols. 1-3,Chapmann ad Hall, NY.
5. Molecular Spectroscopy, J. D. Graybeal, Tata McGraw Hill, New York.

GENERIC ELECTIVE

ELECTRONICS-II

PHY22403 (A): COMMUNICATION ELECTRONICS AND DIGITAL SIGNAL PROCESSING

OBJECTIVES:

1. To describe model communication system of AM & FM.
2. To understand the power spectra of digital modulated signals.
3. To discuss word length issues, multi rate signal processing and application
4. Describe various Digital filter specifications

OUTCOMES:

1. Understanding Amplitude and Angle Modulations for communications systems.
2. Understanding Pulse Modulation with different methods
3. Compare the architectures of DSP and General Purpose Processors.
4. Design FIR and IIR type digital filters.

UNIT-I: ANALOG COMMUNICATIONS

Amplitude Modulation: Principles of AM, AM modulator circuits, AM transmitter, Trapezoidal Patterns, Super Heterodyne receiver, AM detector-Peak detector, Single Side Band (SSB) communication systems - SSB systems, Comparison of SSB to conventional AM, SSB generation-Balanced Ring Modulator, Amplitude Compandoring SSB.

Angle Modulation: Principles of frequency modulation, FM Modulator- Varactor diode modulator, FM transmitter, FM receiver, FM Demodulator-Balanced slope detector.

UNIT-II: DIGITAL COMMUNICATIONS

Shannon limit for Information capacity, Digital Amplitude Modulation, Frequency Shift Keying(FSK), Phase Shift Keying (PSK), M-ary encoding, Quadrature Amplitude Modulation(QAM), Bandwidth Efficiency, Carrier recovery, Differential Phase Shift Keying (DPSK).

UNIT-III: PULSE MODULATION IN DIGITAL COMMUNICATIONS

Pulse Modulation: Different methods, Pulse Code Modulation (PCM): PCM transmission system, Sampling circuit, Sample rate, Folded Binary Code, Dynamic range, Delta Modulation PCM, Adaptive Delta Modulation PCM.

UNIT-IV: INTRODUCTION TO DIGITAL SIGNAL PROCESSING (DSP)

Simple examples of DSP, The common DSP equation and explanation, Periodic sampling of cosine signal, Periodicity of DSP system, frequency response, Aliasing and Nyquist criterion, Antialiasing, Nyquist criterion in terms of frequency of a sampled signal. Digital filter specification – Low pass, High pass, Band pass and Band stop, Graphical Specifications.

UNIT-V: INTRODUCTION TO DIGITAL FILTER DESIGN

Frequency response of Digital Filters and DSP Systems – The Euler equation, Frequency scaling, Computing the frequency response. IIR Filter design: Basic analog filter approximations, impulse invariant IIR filter, Step invariant IIR filter, the Bilinear Transformation (BLT) filter. Digital filter stability - Z-Plane unit circle, Properties using Z-Plane. FIR Filter design: Introduction, General FIR filter coefficients equation and its solution, the causal and non-causal filter coefficients. Windows for FIR Filters: Gibbs effect, Hamming window, Von Hann window, Bartlett window.

BOOKS FOR STUDY

1. Electronic Communication Systems, Fundamentals through advanced, Wayne Tomasi, Pearson Education.
2. Digital Signal Processing, Steve White, Vikas publishing house.

REFERENCE BOOKS

1. Spectroscopy, Chatwal and Anand, Himalya Publishing House,New Delhi.
2. Digital Signal Processing 6/e, P.RameshBabu, SCITECH Publications India PVT Ltd.
3. Understanding Digital Signal Processing, 3rd Ed, Richard G Lyons, PHI.
4. Digital Signal Processing, Principle, Algorithms and applications, Dimitris and John, Pearson Publication.
5. Electronic Communaication Systems 6th Ed, Bernard Davis & SRM Prasanna, Mc-Graw Hill, George Kennedy

GENERIC ELECTIVE

PHY22403 (B):PROPERTIES AND CHARACTERIZATION OF MATERIALS

OBJECTIVES:

1. This course presents the properties and characterization of materials, emphasizing onsurface, interface and microanalysis, using the underlying analytical techniques as a unifying framework, carrying through to illustrative applications.
2. To provide with the knowledge to: define a characterization strategy appropriate to the problem/situation - select the most appropriate/promising techniques -analyze and interpret the results – utilizing interpretation/simulation tools - develop state of the art expertise – hardware, software, systems integration - understand new techniques as theyemerge.

OUTCOMES:

1. The course provides some knowledge that is state-of-the-art techniques in the study ofproperties and characterization of materials.
2. A further benefit of the course is to provide students a fundamental and practicalunderstanding of the interaction of particle radiation with condensed matter.
3. This knowledge finds applications in optoelectronics, microelectronics and, in general, all aspects of materials processing and characterization.

UNIT-I: STRUCTURAL CHARACTERIZATION:

Properties: Lattice parameter, crystallite size.Characterization: X-ray powder diffraction, Neutron diffraction, instrumentation, specimenpreparation, ASTM catalogue of Materials identification, Phase identification, intensity ofdiffracted peaks, indexing of x-ray diffraction peaks, data analysis and interpretation, Rietveldrefinement technique, Williamson-Hall plots, determination of crystal structure, latticeparameter.

UNIT-II: MICROSTRUCTURAL CHARACTERIZATION:

Properties: Particle size, grain size, transmissivity, absorptivity, photoconductivity,polarization.Characterization: Transmission electron microscopy (TEM), basic principle, brief idea of setup, specimen preparation, image formation, particle size determination. Scanning electronmicroscopy (SEM), Instrumentation basics, specimen preparation, imaging modes, grain sizeestimation.Optical microscopy, instrumentation, specimen preparation, imaging modes,applications, limitations.

UNIT-III: ELECTRICAL CHARACTERIZATION:

Properties: DC and AC conductivity, dielectric properties-dielectric constant, dielectric loss,dielectric strength and breakdown.Characterization: Two-probe, four probe methods for resistivity measurement, P-E loops, HallEffect experiment, dielectric characterization using impedance analyzer.

UNIT-IV: MAGNETIC CHARACTERIZATION:

Properties: Hysteresis loop, initial permeability, saturation magnetization, coercivity, remnantmagnetization, magnetic domains, magnetic anisotropy, Curie temperature.Characterization: Vibration sample magnetometer, SQUID magnetometer, M-H hysteresisloops, AC magnetic susceptibility.

UNIT-V: THERMAL CHARACTERIZATION:

Properties: Heat capacity, thermal expansion, thermal conductivity, and thermoelectricityCharacterization: Differential thermal analysis (DTA), Differential Scanning Calorimeter(DSC), Thermo gravimetric analysis (TGA), principle, instrumentation, experimentalparameters, data analysis and interpretation.

Text & Reference Books:

1. B. D. Cullity and S. R. Stock, “Elements of X-ray Diffraction”, Third Edition, Prentice HallInc., New Jersey, 2001.
2. Characterization of Materials, (Volumes 1 & 2) Elton N. Kaufmann, John Wiley and Sons.
3. Materials Characterization, Introduction to Microscopic and Spectroscopic Methods byYangLeng, JohnWiley& Sons (Asia) Pvt Ltd.
4. Materials Characterization - S. Sankaran and ViajayaAgarwal
5. Advanced Characterization Techniques - K.Biswas and Gurao
6. S. Zhang, L. Li and A. Kumar, “Materials Characterization Techniques”, CRC Press, BocaRaton, 2008.

GENERIC ELECTIVE

PHY22403 (C):COMMUNICATION SYSTEMS

OBJECTIVES - This course enables the students:
1. To learn details of Computer Communications systems like ISDN, LAN, TDMA, FDMA, ALOHA and CSMA.
2. To know the concept of CDMA.
3. To acquaint with optical Fiber systems and Coherent optical fiber systems used for the communication.
4. To learn wireless communication systems like GSM, cellular, 1G, 2G, 3G etc.
5. To get basic knowledge on Satellite and optical communications.

OUTCOMES - After the completion of this course, students will be:
1. Able to learn technology behind computer communication systems.
2. Able to acquire knowledge on optical Fiber systems and Coherent optical fiber systems used for the communication.
3. Able to understand and work on wireless communication systems like GSM, cellular, 1G, 2G, 3G etc.
4. Able to understand Satellite and optical communications and technology involved.

UNIT I: COMPUTER COMMUNICATIONS SYSTEMS

Types of networks, Design features of computer communication networks – ISDN, LAN Time Division Multiple Access (TDMA), Frequency division multiple Access (FDMA), ALOHA, slotted ALOHA and carrier sense multiple Access (CSMA), Introduction to CDMA.

UNIT II: FIBER OPTICS COMMUNICATION

Optical Fiber System **:** Intensity modulation/direct detection, optical transmitter circuit, Optical receiver circuit, system design considerations, Digital Systems & planning considerations, Analog systems, distribution systems, Advanced multiplexing strategies.

UNIT III: COHERENT OPTICAL FIBER COMMUNICATIONS

Basic Systems of coherent communications, Detection principles, Practical Constraints, Modulation formats, Demodulation schemes, Receiver sensitive, Signal and Multi carrier systems.

Introduction to Optical communications systems: Optical fibers, sources and detectors, analog and digital systems.

UNIT IV: SATELLITE COMMUNICATIONS

Introduction Satellite systems: Orbiting satellites, satellite frequency bands, communication satellite system-modulation and multiple access format-satellite systems in India, Satellite receiving systems, G/T ratio, satellite uplink and down link analysis. Applications to communications and remote sensing.

UNIT V: INTRODUCTION TO WIRELESS COMMUNICATION SYSTEMS

Global system for mobile (GSM): cellular concept, system design. Transmission system, Receiving system; frequency re-use; Spread spectrum modulation; Multiple access techniques as applied to wireless communications; 1G, 2G, 3G wireless networks.

Text Book

1. Modern Digital and Analog communication system, B.P. Lathi: Oxford 3rdEdition.
2. Digital Communications Fundamentals and Applications, Bernard Sklar, Sklar Pearson Education.
3. Taub and Schilling, "Principles of Communication Systems", Second edition, Tata McGraw Hill edition, 1991.
4. Simon Haykin, "Communication Systems, Third Edition", John Willey & Sons, Inc.1994.
5. Wayne Tomasi, "Advanced Electronics Communications Systems",IV Edi, P. Hall,Inc,1998
6. John M. Senior, "Optical Fiber Communications", Second Edition, PHI, 1999
7. GerdKesier "Optical Fiber Communications" Second Edition, McGrw- Hill International Editions,1991.
8. Principles of Communication, R.E. Ziemer, WH Tranter 5thEdition, John Wiley (Fifth module).

Reference Books

1. Morden Electronic Communication Systems, Wayne Tomoasi, Person Education/PHI.
2. Digital Communication, John G Proakis, MGH.
3. Digital Communication Techniques Simon, Hindey Lindsey PHI.
4. Communication Systems, Simon Haykin, John Wiley & Sons. Pvt. Ltd.
5. Principles of Communication Systems, Taub and Schilling, Tata McGraw-Hill.
6. Digital and Analog Communication System, K. Sam Shanmugam. John Wiley.
7. Communication Systems Engineering, Proakis, Pearson Education.
8. Digital and Analog Communication System, Leon W Couch, Pearson Education/PHI.
9. Introduction to Statistical Signal Processing with Applications, M.D. Srinath, P.K.
10. Rajasekaran, R.E. Viswnathan PHI.
11. Analog and Digital Communication, M.S. Roden PHI.
12. Digital Modulation and Coding. Wilson, Pearson Education.

ELECTIVE FOUNDATION

PHY22404 (A): NUCLEAR AND PARTICLE PHYSICS

OBJECTIVES:

1. Introduction to nuclear forces and models
2. Explain the types of nuclear reactions
3. Concept of interaction of gamma radiation with matter
4. Basic concept of low and high energy circular accelerators

OUTCOMES:

1. Discovery and classification of elementary particles
2. General aspects of reactor design and Classification of reactors
3. Classification of elementary particles
4. Find various particle detectors and accelerators

UNIT-I: GENERAL PROPERTIES OF THE NUCLEUS

Introduction to Nuclear Properties – Radius, Mass, Packing fraction and binding energy.Nuclear angular momentum, parity and symmetry.Magnetic dipole moment and electric quadrupole moment. Nuclear Two-Body Problem: The Deuteron- Introduction, Simple theory of Deuteron. Spin dependence of Nuclear forces, Tensor Forces. Meson theory of Nuclear forces.

UNIT-II: NUCLEAR MODELS AND NUCLEAR REACTIONS

Introduction, the nuclear Shell or independent particle model, The Liquid Drop Model and semi-empirical binding energy formula, the collective nuclear model for the nuclear reactions. Reaction Dynamics: Q-equation, The compound nucleus, Cross sections for nuclear reactions, Compound nucleus formation and break-up, Stripping and photo-nuclear reactions.

UNIT-III: ELEMENTARY PARTICLES

Stable particles against decay through nuclear forces – parameters: Mass, particles and anti-particles, strangeness, decay times. Conservation Laws: Conservation of Baryons, Conservation of strangeness, Conservation of parity and isotopic spin, Stable particles: Mass-less Bosons, Leptons, Mesons, Baryons. Resonance and short-lived Particles: Detection method for very short-lived particles, Discovery of unstable particles, significance of short-lived particles.

UNIT-IV: PARTICLE DETECTORS

Particle detectors:Introduction to particle detectors,Gas filled detectors, Solidstate detectors, Scintillation counter Nuclear Emulsions. High-energy particle detectors, Cerenkov detectors.Bubble chamber and Cloud chamber and applications.

UNIT-V: PARTICLE ACCELARATORS

Particle accelerators:Introduction to particle accelerators Ion sources, Direct current accelerators, The Cyclotron. The linear accelerators, Betatron.The electron synchrotron.The proton synchrotron and applications.

BOOKS FOR STUDY

1. Introduction to Nuclear Physics. Herald Enge, Addison-Wesley, New York.
2. Nuclear Physics. Irving Kaplan, Oxford& IBH Co. New Delhi.

REFERENCE BOOKS

1. Nuclear Physics, DC Tayal, Himalaya Publishing House, Mumbai
2. The Fundamental Particles. C. E. Swartz, Addison-Wesley, London.
3. Atomic and Nuclear Physics. V. W. Kulkarni, Himalaya Publishing House.
4. Modern Physics, G. Aruldhas, P. Rajagopal, Prentice-Hall of India, New Delhi.
5. Concepts of Modern Physics, Arthur Beiser, Tata McGraw-Hill, India.

ELECTIVE FOUNDATION

PHY22404 (B):VACUUM AND THIN FILM PHYSICS

OBJECTIVES- This course enables the students to:
1. Definevacuum and compare various vacuum pumps and gauges.
2. Outline the thermodynamics of thin films.
3. Illustrate the mechanism of thin film formation.
4. Explain various techniques of thin film formation.
5. Summarize various properties of thin films.

OUTCOMES-After the completion of this course, students will be able to:
1. Demonstrate various types of pumps and gauges inspect leak in vacuum and can design avacuum system.
2. Define the thermodynamical parameters of thin films and can outline interdiffusion in thin films.
3. Demonstrate the stages of thin film formation and can outline the conditions for the formation of amorphous, crystalline and epitaxial films.
4. Illustrate and compare physical vapour deposition (PVD) and chemical vapour deposition (CVD) techniques.
5. Define various thin film properties and outline the techniques of their determination.

UNIT I – PRODUCTION AND MEASUREMENT OF VACUUM

Fundamentals of kinetic theory of gases – Vacuum fundamentals

Production of Vacuum: Mechanical oil sealed Rotary pumps - Roots pump – Turbo molecular pump - Vapor pumps – Diffusion pump - Sorption pump

McLeod gauge- Thermal conductivity gauges-Pirani gauge – Cold cathode Ionization gauges- Penning gauge – Hot cathode ionization gauge - Bayard- Alpert gauge- Quadruple mass spectrometer; Vacuum application – Tungsten filament and discharge lamps – Electron tubes- Vacuum metallurgy- Space simulators and freeze drying

UNIT II - METHODS OF THIN FILM PREPARATION

Physical methods: Vacuum evaporation, Types of evaporation sources - Resistive heating electron beam evaporation – Co-evaporation - Two source evaporation and three source evaporation - Flash evaporation- Laser ablation - Reactive evaporation - Epitaxial deposition- Hot wall epitaxy and Molecular beam epitaxy

UNIT III -THIN FILM PREPARATION-SPUTTERING

Sputtering: Glow discharge, DC sputtering, RF sputtering, Magnetron sputtering, Reactive sputtering; Chemical Methods: Electroplating – Spray Pyrolysis – Chemical vapor deposition (CVD)

UNIT IV - GROWTH AND THICKNESS MEASUREMENT OF THIN FILMS

Condensation – Nucleation – and growth of thin films – Langmuir Frenkel theory of condensation – Theories of thin film nucleation – Capillarity theory – Statistical or Atomistic theory – Comparison of nucleation theories – The four stages of film growth – Incorporation of defects during growth

Thickness Measurement: Multiple beam Interferometer (MBI) – Quartz Crystal Thickness Monitor

UNIT V – PROPERTIES OF THIN FILMS

Sources of electrical resistivity in metallic conductors – Sheet resistance – Temperature coefficient of resistance – Influence of thickness on the resistivity – Fuchs-Sondheimier theory – Hall Effect

Reflection and Transmission at an Interface - Reflection and Transmission by a single film – Reflection from an absorbing film – Multilayer films – Determination of optical constants by ellipsometry

Applications of thin films

Thin film resistors – Capacitors – Beam splitters – reflection and anti-reflection coatings – Optical filters

Reference Books:

1. "Vacuum Technology" A.Roth, North Holland, 1986.
2. "Vacuum Science and Technology" V.V. Rao, T.B. Ghosh and K.L. Chopra, Allied Publications, 1998.
3. "Fundamentals of Vacuum", Ward & Bann
4. "Hand book of Thin Film Technology" L.I. Maissel and R.L. Glang, McGraw Hill Bool Co., 1970.
5. "Thin Film Phenomenon" K.L. Chopra, McGraw Hill Bool Co., New York1969.
6. " Hand Book of Technologies for Films and Coatings" R.F. Bunshah, Noyes Publication, 1996.
7. "The Material Science of Thin Films", M. Ohring, Acddemic Press, New York, 1992.
8. "Preparation of Thin Films", JoyGeorge

ELECTIVE FOUNDATION

PHY 22404(C): FRONTIERS OF PHYSICS

OBJECTIVES - This course enables the students belong to other subjects:
1. To know the life sketchs of great Indian Physisists and their concributions.
2. To learn about the different conventional energy sources available on Earth and their characteristics.
3. To obtain knowledge on Non-Conventional Energy sourses.
4. To know the concepts of Nuclear Physics and advantages and disadvantages of Nuclear power.

OUTCOMES- After the completion of this course, students of non-physics stream will be:
1. Able to get knowledge on great Indian Physisists and their research contributions.
2. Exposed to the knowledge on various energy sourses available and their advantages and future treats.
3. Develop a good understanding about the Nuclear power and Nuclear power stations of India.

UNIT I: CONTRIBUTION OF INDIAN SCIENTISTS:
J.C.Bose, Dr.C.V.Raman, S.N.Bose, M.N.Saha, Prof. SatishDhawan, Dr.B.D.NagChaudhary, H.J.Bhabha, Dr.A.P.J.AbdulKalaam, Dr.Vikram Sarabhai, Prof.S.Bhagavantham, Prof. C.N.R.Rao

UNIT II: CONVENTIONAL ENERGY- SOLAR ENERGY
Role of new and renewable energy source; solar energy-solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT II: CONVENTIONAL ENERGY- WIND ENERGY
Wind energy-Sources and potentials, horizontal and vertical axis windmills, performance characteristics,Tidal and wave energy: Potential and conversion techniques.

UNIT-IV NON-CONVENTIONAL ENERGY
Non-renewable sources such as petroleum, natural gas, coal (Rayalaseema Thermal Power Project and Ramagundam Thermal Power Project)andHydel power plants – Srisailam Hydroelectric power plant and NagarjunaSagar Hydroelectric power plant

UNIT V: NUCLEAR ENERGY
Introduction Nuclear Physics concepts; Nuclear power plants – Advantages and disadvantages
1. Kalpakkam Atomic power station
2. Tarapur Atomic power station

Source: The relevant material of the above units must be down loaded from authenticated web location from https://www.google.com

M. Sc. DEGREE EXAMINATIONS, AUGUST, 2022
I/II/III/IV-SEMESTER QUESTION PAPER TEMPLATE
PHY 22XXX : TITLE OF THE PAPER

Time : 3 Hours **Max. Marks : 80**

SECTION – A

Answer **ALL** the Questions

Fill in the blanks, one question from each unit, each question carry 1 mark

1 X 5 = 05 Marks

1.
2.
3.
4.
5.

Multiple Choice Questions, one question from each unit, each question carry 1 mark

1 X 5 = 05 Marks

6.
7.
8.
9.
10.

Short answer Questions, one question from each unit, each question carry 2 marks

2 X 5 = 10 Marks

11.
12.
13.
14.
15.

SECTION – B

Answer **ALL** the Questions, **each question carry 12 marks**

12 X 5 = 60 Marks

16(a). Question from Unit I

OR

16(b). Question from Unit I

17(a). Question from Unit II

OR

17(b). Question from Unit II

18(a). Question from Unit III

OR

18(b). Question from Unit III

19(a). Question from Unit IV

OR

19(b). Question from Unit IV

20(a). Question from Unit V

OR

20(b). Question from Unit V