SIDDHARTH UNIVERSITY, KAPILVASTU
SIDDHARTH NAGAR

DEPARTMENT OF PHYSICS

SYLLABUS

Bachelor of Science (B.Sc.) & Master of Science (M.Sc.)

in

Physics

(I – X Semester)

With effect from the Academic Year 2025-26 onwards

Approved in BOS dated on 28/05/2025

DEPARTMENT OF PHYSICS

Programme: Bachelor of Science (B.Sc.) & Master of Science (M.Sc.)

Duration: 5 Years (10 Semesters)

Programme Overview:

The Bachelor of Science (B.Sc.) and Master of Science (M.Sc.) programme is designed as per Utter Pradesh NEP 2020 UG-PG course structure with FYUGP of University Grant Commission (UGC), New Delhi. The various aims of this programme are as follows-

1. The main aim of this programme is to help cultivate the love for Nature and its manifestations, to transmit the methods of science (the contents are only the means) to observe things around, to generalize, to do intelligent guessing, to formulate a theory & model, and at the same time, to hold an element of doubt and thereby to hope to modify it in terms of future experience and thus to practice a pragmatic outlook.
2. The programme intends to nurture the proficiency in functional areas of Physics, which is in line with the international standards, aimed at realizing the goals towards skilled India.
3. Keeping the application oriented training in mind; this programme aims to give students the competence in the methods and techniques of theoretical, experimental and computational aspects of Physics so as to achieve an overall understanding of the subject for holistic development. This will cultivate in specific application oriented training leading to their goals of employment.
4. The Bachelor's Project (Industrial Training / Survey / Dissertation) is intended to give an essence of research work for excellence in explicit areas. It integrates with specific job requirements / opportunities and provides a foundation for Bachelor (Research) Programmes.

Programme outcomes (POs)

- After conpletion of the Bachelor of Science (B.Sc.) and Master of Science (M.Sc.) programme, the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance.
- Experimental physics has the most striking impact on the industry wherever the instruments are used.The industries of electronics, telecommunication and instrumentation will specially recognize this course.
- Electromagnetic Wave Propagation serves as a basis for all communication systems and deals with the physics and technology of semiconductor optoelectronic devices. These are becoming important components in consumer Optoelectronics, IT and Communication devices, and in industrialinstrumentation.
- The need of Optical instruments and Lasers is surely highlighted everywhere and at the end of the course the students are expected to get acquaint with applications of Lasers in technology.
- The Classical, Quantum and Statistical computational tools are required in the calculation of physical quantities of relevance in interacting many body problems in physics. Present programme introduces the branches of Solid State Physics and Nuclear Physics that are going to be of utmost importance to both undergraduate and graduate level. Proficiency in this area will attract demand in research and industrial establishments engaged in activities involving applications of these fields.
- Present course will attract immense recognition in R&D sectors and in the entire cutting edge technology based industry.

Syllabus for B.Sc. & M.Sc. Program
(Academic Year 2025-26)

Award/ Certificate/ Diploma/ Degree	Year	Sem.	Papers	Total Credit
Certificate in Science	1	I	Mathematical Physics and Newtonian Mechanics (4 Credit)	6
			Practical (2 Credit)	
		II	Thermal Physics & Semiconductor Devices (4 Credit)	6
			Practical (2 Credit)	
Diploma in Science	2	III	Electromagnetic Theory & Communication Systems (4 Credit)	6
			Practical (2 Credit)	
		IV	Perspectives of Modern Physics & Modern Optics (4 Credit)	6
			Practical (2 Credit)	
Degree in Science	3	V	Classical & Statistical Mechanics (4 Credit)	10
			Digital Electronics & Microprocessor (4 Credit)	
			Practical (2 Credit)	
		VI	Quantum Physics & Spectroscopy (4 Credit)	10
			Solid State & Nuclear Physics (4 Credit)	
			Practical (2 Credit)	
Fourth Year				
Apprenticeship/internship embedded UG degree program	4	VII VIII	12 months Apprenticeship/Internship through NATS or from equivalent organization/Industry/Institution	40
OR				
B.Sc. Honors in Physics	4	VII	Paper 1: Mathematical Physics (4 Credits)	20
			Paper 2: Classical Mechanics (4 Credits)	
			Paper 3: Quantum Mechanics- I (4 Credits)	
			Paper 4: Semiconductor Electronics (4 Credits)	
			Paper 5: Physics Practical (4 Credits)	
		VIII	Paper 1: Statistical Physics (4 Credits)	20
			Paper 2: Electromagnetic theory (4 Credits)	
			Paper 3: Quantum mechanics- II (4 Credits)	
			Paper 4: Solid state Physics (4 Credits)	
			Paper 5: Physics Practical (4 Credits)	
OR				
B.Sc. Honors with research in Physics (Student who secure 75 % marks in the first 6 semester)	4	VII	Paper 1: Mathematical Physics (4 Credits)	20
			Paper 2: Classical Mechanics (4 Credits)	
			Paper 3: Quantum Mechanics (4 Credits)	
			Paper 4: Physics Practical (4 Credits)	
			Paper 5: Research Project/Dissertation (4 Credits)	
		VIII	Paper 1: Electromagnetic theory (4 Credits)	20
			Paper 2: Molecular Spectroscopy and Computational	

			Techniques (4 Credits)	
			Paper 3: Material Science/VLSI Design & Thin Film Technology (4 Credits)	
			Paper 4: Physics Practical (4 Credits)	
			Paper 5: Research Project/Dissertation (4 Credits)	
M.Sc. in Physics	5	IX	Paper 1: Atomic and Molecular Physics (4 Credits)	20
			Paper 2: Electronics – I (4 Credits) /Condensed Matter Physics –I (4 Credits)	
			Paper 3: Bio Physics - I (4 Credits)/Molecular Modeling - I (4 Credits) / Nanoscience and Nanotechnology-I (4 Credits)	
			Paper 4: Physics Practical (4 Credits)	
			Paper 5: Research Project (4 Credits)	
		X	Paper 1: Nuclear Physics (4 Credits)	20
			Paper 2: Electronics – II (4 Credits) /Condensed Matter Physics –II (4 Credits)	
			Paper 3: Bio Physics - II (4 Credits)/Molecular Modeling - II (4 Credits) / Nanoscience and Nanotechnology-II (4 Credits)	
			Paper 4: Physics Practical (4 Credits)	
			Paper 5: Research Project (4 Credits)	

(SEMESTER-I) PAPER-I
MATHEMATICAL PHYSICS & NEWTONIAN MECHANICS

Programme: Certificate in Mechanics and Electronics	Year: First	Semester: First
Course Code: B010101T	Course Title: MATHEMATICAL PHYSICS & NEWTONIAN MECHANICS	

Course Outcomes (COs)

1. Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
2. Understand the physical interpretation of gradient, divergence and curl.
3. Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
4. Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
5. Study the origin of pseudo forces in rotating frame.
6. Study the response of the classical systems to external forces and their elastic deformation.
7. Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
8. Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

Credits: 4	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A BASIC MATHEMATICAL PHYSICS	
I	**Vector Algebra** Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo- scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction, dot product, wedge product, cross product and triple product of vectors. Position, separation and displacement vectors.	7
II	**Vector Calculus** Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function.	8
III	**Coordinate Systems** 2D & 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.	8
IV	**Introduction to Tensors** Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew- symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Examples of tensors in physics.	7

PART B NEWTONIAN MECHANICS & WAVE MOTION		
V	**Dynamics of a System of Particles** Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws & their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (Euler, Coriolis & centrifugal) in rotating frame, and effects of Coriolis force.	8
VI	**Dynamics of a Rigid Body** Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.	8
VII	**Motion of Planets & Satellites** Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous & geo-stationary satellites and basic idea of Global Positioning System (GPS).	7
VIII	**Wave Motion** Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.	7

Suggested Readings

PART A

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Analysis", S. Chand Publishing, 2010
3. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Calculus", S. Chand Publishing, 1987, 4e

PART B

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics",

Pearson Education Limited, 2017, 14e

4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e

Suggestive Digital Platforms / Web Links

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Equivalent Online Courses

1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

SEMESTER-I PAPER-II
PRACTICAL

Programme: Certificate in Mechanics and Electronics	Year: First	Semester: First
Course Code: B010102P	**Course Title: PRACTICAL**	

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics

Lab Experiment List

1. Moment of inertia of a flywheel
2. Moment of inertia of an irregular body by inertia table
3. Modulus of rigidity by statistical method (Barton's apparatus)
4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)
5. Young's modulus by bending of beam
6. Young's modulus and Poisson's ratio by Searle's method
7. Poisson's ratio of rubber by rubber tubing
8. Surface tension of water by capillary rise method
9. Surface tension of water by Jaeger's method
10. Coefficient of viscosity of water by Poiseuille's method
11. Acceleration due to gravity by bar pendulum
12. Frequency of AC mains by Sonometer
13. Height of a building by Sextant
14. Study the wave form of an electrically maintained tuning fork / alternating current sourcewith the help of cathode ray oscilloscope.

Online Virtual Lab Experiment List / Link

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=74

1. Torque and angular acceleration of a fly wheel
2. Torsional oscillations in different liquids
3. Moment of inertia of flywheel
4. Newton's second law of motion
5. Ballistic pendulum
6. Collision balls
7. Projectile motion
8. Elastic and inelastic collision

(SEMESTER-II) PAPER-I
THERMAL PHYSICS & SEMICONDUCTOR DEVICES

Programme: Certificate in Mechanics and Electronics	Year: First	Semester: Second
Course Code: B010201T	Course Title: THERMAL PHYSICS & SEMICONDUCTOR DEVICES	

Course Outcomes (COs)

1. Recognize the difference between reversible and irreversible processes.
2. Understand the physical significance of thermodynamical potentials.
3. Comprehend the kinetic model of gases w.r.t. various gas laws.
4. Study the implementations and limitations of fundamental radiation laws.
5. Utility of AC bridges.
6. Recognize the basic components of electronic devices.
7. Design simple electronic circuits.
8. Understand the applications of various electronic instruments.

Credit: 4	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A **THERMODYNAMICS & KINETIC THEORY OF GASES**	
I	**0^{th} & 1^{st} Law of Thermodynamics** State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between C_P and C_V. Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).	8
II	**2^{nd} & 3^{rd} Law of Thermodynamics** Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.	8
III	**Kinetic Theory of Gases** Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).	7
IV	**Theory of Radiation** Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law and Wien's displacement law from Planck's law.	7

PART B CIRCUIT FUNDAMENTALS & SEMICONDUCTOR DEVICES		
V	**DC & AC Circuits** Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).	6
VI	**Semiconductors & Diodes** P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.	9
VII	**Transistors** Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. characteristics; active, cutoff & saturation regions; current gains & relations between them. DC Load Line analysis and Q-point stabilisation. Voltage Divider bias circuit for CE amplifier. Qualitative discussion of RC coupled voltage amplifier.	9
VIII	**Electronic Instrumentation** Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.	6

Suggested Readings

PART A

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e

PART B

1. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
2. W.D. Stanley, "Electronic Devices: Circuits and Applications", Longman Higher Education, 1989
3. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
4. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

Suggestive Digital Platforms / Web Links
1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/   2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd   3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx   4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Equivalent Online Courses
1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy   2. edX, https://www.edx.org/course/subject/physics   3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/   4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics   5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. I (SEMESTER-II) PAPER-II
PRACTICAL

Programme: Certificate in Mechanics and Electronics	Year: First	Semester: Second
Course Code: B010202P	**Course Title: PRACTICAL**	

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the thermal and electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics

Lab Experiment List

1. Mechanical Equivalent of Heat by Callender and Barne's method
2. Coefficient of thermal conductivity of copper by Searle's apparatus
3. Coefficient of thermal conductivity of rubber
4. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
5. Value of Stefan's constant
6. Verification of Stefan's law
7. Variation of thermo-emf across two junctions of a thermocouple with temperature
8. Temperature coefficient of resistance by Platinum resistance thermometer
9. Charging and discharging in RC and RCL circuits
10. A.C. Bridges: Various experiments based on measurement of L and C
11. Resonance in series and parallel RCL circuit
12. PN Junction, Zener and LED diode characteristics
13. Half wave and full wave rectifiers
14. Characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations
15. Frequency response of RC coupled amplifier
16. Handling of Cathode Ray Oscilloscope (CRO)

Online Virtual Lab Experiment List / Link

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=194

1. Heat transfer by radiation
2. Heat transfer by conduction
3. Heat transfer by natural convection
4. The study of phase change
5. Black body radiation: Determination of Stefan's constant
6. Newton's law of cooling
7. Lee's disc apparatus
8. Thermo-couple: Seebeck effects

	Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ernet.in/be/index.html# 1. Familiarisation with resistor 2. Familiarisation with capacitor 3. Familiarisation with inductor 4. Ohm's Law 5. VI characteristics of a diode 6. Half & Full wave rectification 7. Capacitative rectification 8. Zener Diode voltage regulator 9. BJT common emitter characteristics 10. BJT common base characteristics 11. Studies on BJT CE amplifier 12. RC frequency response	

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

Suggestive Digital Platforms / Web Links

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ernet.in/be/index.html#
3. Digital platforms of other virtual labs

B.Sc. II (SEMESTER-III) PAPER-I

ELECTROMAGNETIC THEORY & COMMUNICATION SYSTEMS

<table>
<tr><td>Programme: Diploma in Applied Physics</td><td colspan="2">Year: Second</td><td>Semester: Third</td></tr>
<tr><td>Course Code: B010301T</td><td colspan="3">Course Title: ELECTROMAGNETIC THEORY & COMMUNICATION SYSTEMS</td></tr>
<tr><td colspan="4">Course Outcomes (COs)</td></tr>
<tr><td colspan="4">1. Better understanding of electrical and magnetic phenomenon in daily life.
2. To troubleshoot simple problems related to electrical devices.
3. Comprehend the powerful applications of ballistic galvanometer.
4. Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
5. Understand the various components and features of a general communication system.
6. Recognize the importance of amplitude modulation and demodulation.
7. Insight in basics and properties of frequency and phase modulation.
8. Comprehend the theory and working of optical fibers along with its applications.</td></tr>
<tr><td colspan="2">Credits: 4</td><td colspan="2">Core Compulsory / Elective</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
</table>

Unit	Topics	No. of Lectures
	PART A **ELECTROMAGNETIC THEORY**	
I	**Electrostatics** Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.	8
II	**Magnetostatics** Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetisation, auxiliary field **H**, magnetic susceptibility and permeability.	8
III	**Time Varying Electromagnetic Fields** Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).	7

IV	**Electromagnetic Waves** Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.	7
PART B **COMMUNICATION SYSTEMS & INTRODUCTION TO FIBER OPTICS**		
V	**Communication System** Introduction and Block diagram. Components of Communication System - amplifier, transmitter, channel receiver and band spectrum modulation. Types of modulation, modulation factor & its importance. Forms of modulation.	7
VI	**Basics of Amplitude Modulation** Modulation-index, frequency spectrum, generation of AM (balanced modulator, collector modulator). Amplitude Demodulation (diode detector), Double Side Band Suppressed Carrier (DSBSC) generation, Single Side Band Suppressed Carrier (SSBSC) generation.	8
VII	**Introduction to Angle Modulation** General Frequency & Phase modulation, frequency spectrum, bandwidth requirement, Frequency & Phase Deviation, Modulation index, equivalence between FM & PM, Generation of FM and FM detector.	7
VIII	**Introduction to Fiber Optics** Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, intermodal dispersion losses and applications of optical fibers.	8

Suggested Readings

PART A

1. D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017,2e
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012
4. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e

PART B

1. M.S. Roden, "Analog and Digital Communication Systems", Discovery Press, 2003, 5e
2. D. Roddy, J. Coolen, "Electronic Communications", Pearson Education Limited, 2008, 4e
3. Jeffrey S. Beasley, Gary M. Miller, "Modern Electronic Communication", Pearson Education Limited, 2007, 9e
4. W. Schweber, "Electronic Communication Systems: A Complete Course", Pearson Education Limited, 2001, 4e
5. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e

Suggestive Digital Platforms / Web Links

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous

Suggested Equivalent Online Courses

1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. II (SEMESTER-III) PAPER-II
PRACTICAL

Programme: Diploma in Applied Physics	**Year: Second**	**Semester: Third**
Course Code: B010302P	**Course Title: PRACTICAL**	

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the electric and magnetic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	**Core Compulsory / Elective**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics

Lab Experiment List

1. Variation of magnetic field along the axis of single coil
2. Variation of magnetic field along the axis of Helmholtz coil
3. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity
4. Ballistic Galvanometer: High resistance by Leakage method
5. Ballistic Galvanometer: Low resistance by Kelvin's double bridge method
6. Ballistic Galvanometer: Self-inductance of a coil by Rayleigh's method
7. Ballistic Galvanometer: Comparison of capacitances
8. Carey Foster Bridge: Resistance per unit length and low resistance
9. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth's magnetic field
10. Earth Inductor: Horizontal component of earth's magnetic field

Online Virtual Lab Experiment List / Link

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=192

1. Tangent galvanometer
2. Magnetic field along the axis of a circular coil carrying current
3. Deflection magnetometer
4. Van de Graaff generator
5. Barkhausen effect
6. Temperature coefficient of resistance
7. Anderson's bridge
8. Quincke's method

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

B.Sc. II (SEMESTER-IV) PAPER-I

PERSPECTIVES OF MODERN PHYSICS & MODERN OPTICS

Programme: Diploma in Applied Physics	**Year: Second**	**Semester: Fourth**
Course Code: B010401T	**Course Title: PERSPECTIVES OF MODERN PHYSICS & MODERN OPTICS**	

Course Outcomes (COs)

1. Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
2. Understand the physical significance of consequences of Lorentz transformation equations.
3. Comprehend the wave-particle duality.
4. Develop an understanding of the foundational aspects of Quantum Mechanics.
5. Study the working and applications of Michelson and Fabry-Perot interferometers.
6. Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
7. Comprehend the use of polarimeters.
8. Study the characteristics and uses of lasers.

Credits: 4	**Core Compulsory / Elective**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A PERSPECTIVES OF MODERN PHYSICS	
I	**Relativity-Experimental Background** Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity.	7
II	**Relativity-Relativistic Kinematics** Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum.	9
III	**Inadequacies of Classical Mechanics** Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.	7
IV	**Introduction to Quantum Mechanics** Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule.	7
	PART B PHYSICAL OPTICS & LASERS	

V	**Interference** Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film andNewton's Ring experiment. Interferometer - Michelson and Fabry-Perot.	8
VI	**Diffraction** Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating.	8
VII	**Polarisation** Polarisation by dichronic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.	7
VIII	**Lasers** Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems (qualitative discussion).	7
Suggested Readings		
	PART A 1. A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e 2. John R. Taylor, Chris D. Zafiratos, Michael A.Dubson, "Modern Physics for Scientists and Engineers",Prentice-Hall of India Private Limited, 2003, 2e 3. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e 4. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007 5. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e **PART B** 1. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e 2. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e 3. A. Ghatak, "Optics", McGraw Hill, 2017, 6e	
Suggestive Digital Platforms / Web Links		
	1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx 4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
Suggested Equivalent Online Courses		
	1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX, https://www.edx.org/course/subject/physics 3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/ 4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html	

B.Sc. II (SEMESTER-IV) PAPER-II
PRACTICAL

Programme: Diploma in Applied Physics	**Year: Second**	**Semester: Fourth**
Course Code: B010402P	**Course Title: PRACTICAL**	

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the optical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	**Core Compulsory / Elective**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics

Lab Experiment List

1. Fresnel Biprism: Wavelength of sodium light
2. Fresnel Biprism: Thickness of mica sheet)
3. Newton’s Rings: Wavelength of sodium light
4. Newton’s Rings: Refractive index of liquid
5. Plane Diffraction Grating: Resolving power
6. Plane Diffraction Grating: Spectrum of mercury light
7. Spectrometer: Refractive index of the material of a prism using sodium light
8. Spectrometer: Dispersive power of the material of a prism using mercury light
9. Polarimeter: Specific rotation of sugar solution
10. Wavelength of Laser light using diffraction by single slit

Online Virtual Lab Experiment List / Link

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=189

1. Michelson's Interferometer
2. Michelson's Interferometer: Wavelength of laser beam
3. Newton's Rings: Wavelength of light
4. Newton's Rings: Refractive index of liquid
5. Brewster’s angle determination
6. Laser beam divergence and spot size

Suggested Readings

1. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015, 1e
3. S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014, 2e

B.Sc. III (SEMESTER-V) PAPER-I

CLASSICAL & STATISTICAL MECHANICS

Programme: Degree in Bachlor of Science	**Year: Third**	**Semester: Fifth**
Course Code: B010501T	**Course Title: CLASSICAL & STATISTICAL MECHANICS**	

Course Outcomes (COs)

1. Understand the concepts of generalized coordinates and D'Alembert's principle.
2. Understand the Lagrangian dynamics and the importance of cyclic coordinates.
3. Comprehend the difference between Lagrangian and Hamiltonian dynamics.
4. Study the important features of central force and its application in Kepler's problem.
5. Recognize the difference between macrostate and microstate.
6. Comprehend the concept of ensembles.
7. Understand the classical and quantum statistical distribution laws.
8. Study the applications of statistical distribution laws.

Credits: 4	**Core Compulsory / Elective**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0

Unit	Topics	No. of Lectures
	PART A **INTRODUCTION TO CLASSICAL MECHANICS**	
I	**Constrained Motion** Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle.	6
II	**Lagrangian Formalism** Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.	8
III	**Hamiltonian Formalism** Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.	7
IV	**Central Force** Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge-Lenz vector (Runge-Lenz vector) and its applications.	8
V	**Canonical Transformation** Canonical transformation, generating functions, properties, group properties, examples, infinitesimal generators, Poisson brackets, Poisson theorems, angular momentum, PBs small oscillation.	7

	PART B INTRODUCTION TO STATISTICAL MECHANICS	
VI	**Macrostate & Microstate** Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.	7
VII	**Concept of Ensemble** Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.	7
VIII	**Statistical Distribution Laws** Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in ith state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi- Dirac statistics. Comparison of statistical distribution laws and their physical significance	7
IX	**Canonical Distribution Law** Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.	6
X	**Applications of Statistical Distribution Laws** Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law. Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).	9

Suggested Readings

PART A

1. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e
2. N.C. Rana, P.S. Joag, "Classical Mechanics", McGraw Hill, 2017
3. R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017

PART B

1. F. Reif, "Statistical Physics (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e
2. B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
3. B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e

Suggestive Digital Platforms / Web Links

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Equivalent Online Courses

1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. III (SEMESTER-V) PAPER-II
DIGITAL ELECTRONICS & MICROPROCESSOR

Programme: Degree in Bachlor of Science	**Year: Third**	**Semester: Fifth**
Course Code: B010502T	**Course Title: DIGITAL ELECTRONICS & MICROPROCESSOR**	

Course Outcomes (COs)

1. nderstand various number systems and binary codes.
2. Familiarize with binary arithmetic.
3. Study the working and properties of various logic gates.
4. Comprehend the design of combinational and sequential circuits.
5. Learn the basics of microprocessor architecture.
6. Study the 8085 BUS organization.
7. Comprehend the Memory and I/O Interfacing.
8. Develop the technique of programming in 8085.

Credits: 4	**Core Compulsory / Elective**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A **DIGITAL ELECTRONICS**	
I	**Number System** Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.	7
II	**Binary Arithmetic** Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.	6
III	**Logic Gates** Truth Table, Symbolic Representation and Properties of NOT, AND, OR, NOR, NAND, EX-OR & EX- NOR Gates. NOR and NAND Gates as Universal Gates. Boolean Algebra. Karnough Map.	8
IV	**Combinational & Sequential Circuits** Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor, Multiplexer, Demultiplexer. Sequential Circuits: Flip-Flop, Counters and Sequential Circuits.	9
	PART B **MICROPROCESSOR**	

V	**Microprocessor Architecture** Evolution of microprocessors and microprocessor architecture. Features and PIN diagram of 8085 Microprocessor. Address Bus & Multiplexed Address / Data Bus, Control and Status Signals, Power-supply and Clock frequency, externally initiated signals including Interrupts Serial I/O Ports and Block diagram of 8085 microprocessor.	6

VI	**8085 BUS Organization** 8085 BUS organization and 8085 registers. Microprocessor operations - Microprocessor initiated operations, Internal data operations and Externally initiated operations. Microprocessor Communication & Bus Timings, De-multiplexing the Bus AD7 to AD0, Generating Control Signals, 8085 Machine Cycles & Bus Timings, Opcode Fetch Machine Cycle and Memory Read Machine Cycle.	7
VII	**Memory & I/O Interfacing** Memory and I/O Interfacing. Memory classifications, Flip-Flop or Latch as a storage element, Memory Map and Addresses Memory Instruction. Fetch Memory Interfacing - Memory structure & its requirements, basic concepts in Memory Interfacing circuits, Address Decoding and Memory Addresses. Input & Output Devices - I/Os with 8-Bit Addresses, I/Os with 16-Bit Addresses, Logic devices for Interfacing and Tri-State devices.	8
VIII	**Programming in 8085** Instruction set and Programming techniques. Instruction Formats - Single Byte, Two Bytes & Three Bytes instructions and Opcode format. Instruction Timings & Operation Status, DATA Transfer operations, Arithmetic operations, Logic operations, Branch operations, Stack, I/O & Machine Control instructions, Looping, Counting & Indexing Counter, Timing delays, Stack & Subroutines, Code conversion, BCD Arithmetic operations and 16 Bit data operations. How to write an assemble language program and execute a simple program.	9

Suggested Readings

PART A

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

PART B

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing, 2013, 6e
2. B. Ram, "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, NewDelhi, 2012
3. Dr. D.K. Kaushik, "An Introduction to 8085", Dhanpat Rai Publications, NewDelhi, 2012

Suggestive Digital Platforms / Web Links

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Equivalent Online Courses

1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. III (SEMESTER-V) PAPER-III
PRACTICAL

Programme: Degree in Bachlor of Science	Year: Third	Semester: Fifth
Course Code: B010503P		Course Title: PRACTICAL

Course Outcomes (COs)

Electronic instrumentation has the most striking impact on the industry wherever the digital instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

	Topics	No. of Lectures
	Lab Experiment List	
	1. Study and Verification of AND gate using TTL IC 7408 2. Study and Verification of OR gate using TTL IC 7432 3. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400 4. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402 5. Study and Verification of NOT gate using TTL IC 7404 6. Study and Verification of Ex-OR gate using TTL IC 7486 7. Basic Programming (Addition, Subtraction, Multiplication and Division) using 8085 microprocessor	
	Online Virtual Lab Experiment List / Link	
	Virtual Labs an initiative of MHRD Govt. of India https://de-iitr.vlabs.ac.in/List%20of%20experiments.html 1. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates 2. Construction of half and full adder using XOR and NAND gates and verification of its operation 3. To study and verify half and full subtractor 4. Realization of logic functions with the help of Universal Gates (NAND, NOR) 5. Construction of a NOR gate latch and verification of its operation 6. Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates 7. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers 8. Implementation and verification of decoder or demultiplexer and encoder using logic gates 9. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates 10. Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop 11. Verify Binary to Gray and Gray to Binary conversion using NAND gates only 12. Verify the truth table of 1-Bit and 2-Bit comparator using logic gates	

Suggested Readings

1. D. Leach, A. Malvino, Goutam Saha, “Digital Principles and Applications”, McGraw Hill, 2010, 7e
2. William H. Gothmann, “Digital Electronics: An Introduction to Theory and Practice”, Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, “Modern Digital Electronics”, McGraw Hill, 2009, 4e
4. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085”, Penram International Publishing, 2013, 6e
5. B. Ram, “Fundamentals of Microprocessors and Microcontrollers”, Dhanpat Rai Publications, NewDelhi, 2012
6. Dr. D.K. Kaushik, “An Introduction to 8085”, Dhanpat Rai Publications, NewDelhi, 2012

Suggestive Digital Platforms / Web Links

1. Virtual Labs an initiative of MHRD Govt. of India, https://de-iitr.vlabs.ac.in/List%20of%20experiments.html
2. Virtual Labs an initiative of MHRD Govt. of India, http://209.211.220.205/vlabiitece/mi/labsMI.php
3. Digital platforms of other virtual labs

B.Sc. III (SEMESTER-VI) PAPER-I
QUANTUM PHYSICS & SPECTROSCOPY

Programme: Degree in Bachlor of Science	Year: Third	Semester: Sixth
Course Code: B010601T	**Course Title: QUANTUM PHYSICS & SPECTROSCOPY**	

Course Outcomes (COs)

1. Understand the significance of operator formalism in Quantum mechanics.
2. Study the eigen and expectation value methods.
3. Understand the basis and interpretation of Uncertainty principle.
4. Develop the technique of solving Schrodinger equation for 1D and 3D problems.
5. Comprehend the success of Vector atomic model in the theory of Atomic spectra.
6. Study the different aspects of spectra of Group I & II elements.
7. Study the production and applications of X-rays.
8. Develop an understanding of the fundamental aspects of Molecular spectra.

Credits: 4	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A INTRODUCTION TO QUANTUM MECHANICS	
I	**Operator Formalism** Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables. Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations.	7
II	**Eigen & Expectation Values** Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Hermitian Operators: Definition, properties and applications. Prove of the hermitian nature of various physical-dynamical operators.	7
III	**Uncertainty Principle** Uncertainty Principle: Commutativity &simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical-dynamical parameters and its applications.	7
IV	**Schrodinger Equation and its application** Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation and Equation of motion of an operator in Schrodinger representation. linear operators, product of two operators, commuting and non-commuting operator. Application to 1D Problems: Infinite Square well potential (Particlein1Dbox), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator.	9

	Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom.	
PART B INTRODUCTION TO SPECTROSCOPY		
V	**Vector Atomic Model** Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.	8
VI	**Spectra of Alkali & Alkaline Elements** Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra.	7
VII	**X-Rays & X-Ray Spectra** Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.	7
VIII	**Rotational, Vibrational and Electronic Spectra** Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter-nuclear distance. Rotational-Vibrational spectra, transition rules, P,Q,R branches, Electronic Spectroscopy of diatomic molecule, Frank Condon Principle, Fluorescence and Phosphorescence	8

Suggested Readings

PART A

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
4. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

PART B

1. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
2. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
3. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
4. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

Suggestive Digital Platforms / Web Links

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Equivalent Online Courses

1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. III (SEMESTER-VI) PAPER-II
SOLID STATE & NUCLEAR PHYSICS

Programme: Degree in Bachlor of Science	Year: Third	Semester: Sixth
Course Code: B010602T	Course Title: SOLID STATE & NUCLEAR PHYSICS	

Course Outcomes (COs)

1. Understand the crystal geometry w.r.t. symmetry operations.
2. Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
3. Study various properties based on crystal bindings.
4. Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
5. Study the salient features of nuclear forces & radioactive decays.
6. Understand the importance of nuclear models & nuclear reactions.
7. Comprehend the working and applications of nuclear accelerators and detectors.
8. Understand the classification and properties of basic building blocks of nature.

Credits: 4	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART A INTRODUCTION TO SOLID STATE PHYSICS	
I	**Crystal Structure** Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.	7
II	**Crystal Diffraction** X-ray diffraction and Bragg’s law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald’s method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.	7
III	**Crystal Bindings** Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals-London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.	7

IV	**Lattice Vibrations** Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity. Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals. Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes and Classification of solids on the basis of band theory.	9
	PART B **INTRODUCTION TO NUCLEAR PHYSICS**	
V	**Nuclear Forces & Radioactive Decays** General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.	9
VI	**Nuclear Models & Nuclear Reactions** Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included). Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.	9
VII	**Accelerators & Detectors** Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.	6
VIII	**Elementary Particles** Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.	6

Suggested Readings

PART A

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2004, 8e
2. J.P. Srivastava, "Elementa of Solid State Physics", Prentice-Hall of India Private Limited, 2014, 4e
3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015

PART B

1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House Pvt. Ltd., 2011, 5e

Suggestive Digital Platforms / Web Links
1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Equivalent Online Courses
1. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX, https://www.edx.org/course/subject/physics
3. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
4. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html

B.Sc. III (SEMESTER-VI) PAPER-III
PRACTICAL

Programme: Degree in Bachlor of Science	Year: Third	Semester: Sixth
Course Code: B010603P	Course Title: PRACTICAL	

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the components / instruments are used for electronic / optical communication systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 2	Core Compulsory / Elective

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics

Lab Experiment List

1. Amplitude Modulation and Demodulation
2. DSB-SC Modulation and Demodulation
3. SSB-SC Modulation and Demodulation
4. Frequency Modulation and Demodulation
5. To measure Numerical aperture of Single Mode Optical Fiber

Online Virtual Lab Experiment List / Link

Virtual Labs at Amrita Vishwa Vidyapeetham
http://vlab.amrita.edu/index.php?sub=59&brch=163

1. Amplitude Modulation and Demodulation
2. BPSK Modulation and Demodulation
3. Frequency Modulation
4. QPSK Modulation
5. Realization of different modulation schemes using I/Q modulators

labAlive Virtual Communications Lab
https://www.etti.unibw.de/labalive/#experiments

6. Analog Modulation
7. Digital Modulation
8. To study and verify half and full subtractor
9. Signal Parameters
10. Fourier Transform
11. Wireless Communications

Virtual Labs at Amrita Vishwa Vidyapeetham
http://vlab.amrita.edu/index.php?sub=59&brch=269

12. Fiber Optic Analog and Digital Link
13. Fiber Optic Bi-directional Communication
14. Wavelength Division Multiplexing
15. Measurement of Bending Losses in Optical Fiber
16. Measurement of Numerical Aperture
17. Study of LED and Detector Characteristics

Suggested Readings

1. M.S. Roden, "Analog and Digital Communication Systems", Discovery Press, 2003, 5e
2. D. Roddy, J. Coolen, "Electronic Communications", Pearson Education Limited, 2008, 4e
3. Jeffrey S. Beasley, Gary M. Miller, "Modern Electronic Communication", Pearson Education Limited, 2007, 9e
4. W. Schweber, "Electronic Communication Systems: A Complete Course", Pearson Education Limited, 2001, 4e
5. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms / Web Links

1. Virtual Labs at Amrita Vishwa Vidyapeetham, http://vlab.amrita.edu/index.php?sub=59&brch=163
2. labAlive Virtual Communications Lab, https://www.etti.unibw.de/labalive/#experiments
3. Virtual Labs at Amrita Vishwa Vidyapeetham, http://vlab.amrita.edu/index.php?sub=59&brch=269
4. Digital platforms of other virtual labs

B.Sc. IV (SEMESTER-VII) PAPER I
MATHEMATICAL PHYSICS

<table>
<tr><td colspan="2">Programme: B.Sc. Honors in Physics</td><td>Year: Fourth</td><td>Semester : Seventh</td></tr>
<tr><td colspan="2">Course Code: PYUC 401</td><td colspan="2">Course Title : Mathematical Physics</td></tr>
<tr><td colspan="4">Course Objectives: The subject is so designed that student will learn:
1. Introduction to Vector analysis in curved coordinates and Tensors
2. Some Special Functions related to physics
3. Matrices and Calculus of Residues
4. Integral Transforms
Student Learning Outcomes:
1. Introduction to Vector analysis in curved coordinates and Tensors
2. Some Special Functions related to physics
3. Matrices and Calculus of Residues
4. Application to integral Transforms and Fourier transforms in physical problems.</td></tr>
<tr><td colspan="2">Credits: 4</td><td colspan="2">Core Paper</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="2">Topics</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Vector analysis in curved coordinates and Tensors: Review of vector algebra and calculus, Gauss and Stokes theorems, Orthogonal coordinates differential vector operators, special coordinate systems, circular cylindrical coordinates, spherical polar coordinates, tensor analysis, contraction, direct product, quotient rule, pseudo tensors, dual tensors, non-Cartesian tensors, covariant differentiation, and tensors differentiation operators. Elements of Group theory.</td><td>15</td></tr>
<tr><td>II</td><td colspan="2">Special Functions: Second order ordinary differential equations, Frobinus method for solving second order linear ODEs, Beta and Gamma functions, Legendre's equation, Legendre polynomials and their properties, Bessel's equation, Bessel function and their properties, Laguerre's equation, its solutions and properties, Hermite equation, Hermite Polynomials and their properties.</td><td>15</td></tr>
<tr><td>III</td><td colspan="2">Matrices and Calculus of Residues: Different types of matrices, orthogonal, Hermitian, unitary and normal, Eigen values and Eigen functions of matrices, diagonalisation of matrices, properties of analytic functions, Complex variable, Cauchy's integral theorem, Cauchy integral formula, Laurent expansion, singularities, Cauchy's residue theorem, evaluation of definite integrals, dispersion relations.</td><td>15</td></tr>
<tr><td>IV</td><td colspan="2">Integral Transforms: Laplace Transform (LT), first and second shifting theorems, LT of derivative and integral of a function, Inverse LT by partial fractions, Solution of initial value problems by using LT Fourier Series and Fourier Transform: Fourier series, Half range expansion, Arbitrary period, Fourier integral and transforms, FT of delta and Gaussian function.</td><td>15</td></tr>
<tr><td colspan="4">Book Recommended
1. Mathematical method for Physicists, Arfken & Weber, Elsevier Academic Press
2. Mathematical Method for Physics and Engineers, K.F.Reily, M.P.Hobson and S.J.Bence, Cambridge University Press
3. Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons</td></tr>
</table>

4. *Special Functions,* E.D. Rainville, Chelsea Publication Co. 5. *Special Functions for Scientists and Engineers,* W.W. Bell, Dover Publications **6.** *Functions of complex variable,* R.V. Churchill, McGraw Hill

B.Sc. IV (SEMESTER-VII) PAPER II
CLASSICAL MECHANICS

Programme: B.Sc. Honors in Physics	**Year: Fourth**	**Semester : Seventh**
Course Code: PYUC 402	**Course Title : Classical Mechanics**	

Course Objectives:
1. To demonstrate knowledge and understanding of the fundamental concepts in the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation of mechanics.
2. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
3. To reduce two body problem into one-body problem
4. Small oscillations and Lagrange's eqn of motions

Student Learning Outcomes:
1. Basic concept in the formulation of kinetic and potential energies of dynamics of system of particles, motion of rigid body.
2. Lagrangian and Hamiltonian formulation.
3. Conservation theorems and Kepler's problem.
4. Application to small oscillations in terms of normal modes and normal frequencies and their applications in (a)longitudinal vibrations of two coupled harmonic oscillators (b) linear, symmetric, triatomic molecule, (c) oscillations of two linearly coupled plane pendulum

Credits: 4	**Core Paper**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	**Topic**	**No of Lectures**
I	**Lagrangian Formulations:** System of particles and equation of motion ofa system of particles, conservation of linear momentum, energy and angular momentum. Constraints, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion and its application, Single free particle, a bead sliding on a uniformly rotating wire in a force-free space, Simple Pendulum, Compound Pendulum.	15
II	**Hamilton Formulations:** Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equation of motion, Examples of (a) The Hamiltonian of a particle in a central force field, (b) the simple harmonic oscillator. Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle. Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of poison brackets (antisymmetry, linearity, and Jacobi identity), Poisson bracket of angular momentum, The Hamilton-Jacobi equation and application to Linear harmonic oscillator.	15
III	**Central force problem:** Reduction of two body problem into one-body	15

	problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem (inverse-square law of force).	
IV	**Small oscillations**: Types of equilibrium, Quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, Normal modes and normal frequencies, examples of (a)longitudinal vibrations of two coupled harmonic oscillators (b) linear, symmetric, triatomic molecule, (c) oscillations of two linearly coupled plane pendulum.	15

Book Recommended

1. *Classical Mechanics,* H. Goldstein, Narosa Publishing House
2. *Classical Mechanics,* N.C. Rana and P.S. Joag, Tata McGraw Hill
3. *Introdution to Dynamics,* I.C. Percival and D. Richards, Cambridge University Press
4. *Classical Mechanics*,Gupta and Kumar, Pragati Prakashan, Meerut.

B.Sc. IV (SEMESTER-VII) PAPER III
QUANTUM MECHANICS - I

Programme: B.Sc. Honors in Physics	Year: Fourth	Semester : Seventh

Course Code: PYUC 403	Course Title : Quantum Mechanics - I

Course Objectives:
The student will lean about:
1. Wave Mechanical Formulation and Energy Eigen value Problem
2. Matrix Formulation
3. Theory of Angular Momentum
4. Identity of Particles and Scattering

Student Learning Outcomes:
The students will learn about the physical and mathematical basis of quantum mechanics for non-relativistic systems.

Credits: 4	Core Paper

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No of Lectures
I	**Wave Mechanical Formulation and Energy Eigenvalue Problem**: Time-dependent Schrödinger equation, Conservation of probability, Time-independent Schrödinger equation, The potential step: reflection coefficient, The potential barrier: transmission and reflection coefficient, Eigenvalues and eigenfunctions of linear harmonic oscillator, The periodic potential, spherically symmetric potential, The hydrogen atom.	15
II	**Matrix Formulation:** Dynamical variables and operators, Expectation value, Expansion of eigen functions, Completeness property, Commutator algebra – Physical significance in Quantum Mechanics, Commuting observables, Unitary transformations, Matrix representations of wave functions and operators, Equations of motion in Schrödinger, Heisenberg and Interaction pictures.	15
III	**Theory of Angular Momentum**: Spatial rotations, Orbital angular momentum, Commutation relations – L_x, L_y, L_z and L^2, Eigenfunctions and eigenvalues of L^2 and L_z, Spin angular momentum, Pauli spin matrices, Total angular momentum, the spectrum of J^2 and J_z, Ladder operators, Addition of two angular momenta, Clebsch-Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1/2$, $j_2=1$.	15
IV	**Identity of Particles and Scattering**: Symmetric and antisymmetric wave functions, Slater's determinantal wave functions, Stern-Gerlach experiments; Scattering, Introduction to classical and quantum scattering theory, Scattering cross section, The Born approximation method, Scattering from screened coulomb potential, Validity of Born approximation, Partial wave analysis, Phase shift, Scattering from square well potential.	15

Book Recommended

1. *Introduction To Quantum Mechanics* by David J. Griffiths, Pearson (2005).
2. *Quantum Mechanics* by G. Aruldas, PHI Learning Private Ltd. (2009)
3. *Quantum Mechanics* by L.I. Schiff, Tata Mcgraw Hill Education Private Limited Tata Mcgraw Hill Education Private Limited (2010).
4. *Modern Quantum Mechanics*by J. J Sakurai, Pearson (1994).
5. *Quantum Mechanics: Theory And Applications* by A. Ghatak, Macmillan India Limited (2004).

6. *Quantum Mechanics: An Introduction* by Walter Greiner, Springer (India) Pvt. Ltd. (2008)
7. *Quantum Physics: Of Atoms Molecules Solids Nuclei And Practicles* by Robert Resnick and Robert Eisberg, Wiley India Pvt Ltd (2006).

B.Sc. IV (SEMESTER-VII) PAPER IV
SEMICONDUCTOR ELECTRONICS

Programme: B.Sc. Honors in Physics	**Year: Fourth**	**Semester : Seventh**
Course Code: PYUC 404	**Course Title: Semiconductor Electronics**	

Course Objectives:
The subject is so designed that student will learn about transistors, Oscillators, Operational Amplifiers, Digitals circuits.

Student Learning Outcomes:
The students will learn about
1. Design, working and IV characteristics of Bipolar junction transistors and Field effect transistor.
2. Design, working and Frequency curve of oscillators, multivibrators and wave generators.
3. Introduction to operational amplifier and their applications.
4. Introduction to logic gater, K-map, flip flops, counters, shift registers.

Credits: 4	**Core Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	**Topics**	**No of Lectures**
I	**Transistors**- Bipolar junction transistor BJT, Junction field effect transistor JFET, Metal oxide semiconductor field effect transistor MOSFET: Structure, working, derivation of the equation for I-V characteristics under different conditions, high frequency limits.	15
II	**Operational Amplifiers:** Introduction, block diagram, ideal characteristics, comparison with 741 Operational amplifier as a open loop amplifier, Limitations of open loop configuration, Operational amplifier as a feedback amplifier, Closed loop again, input impedance, output impedance of inverting and non-inverting amplifiers, Voltage follower, Differential amplifier, voltage gain. Linear & Nonlinear Applications of op-amp.	15
III	**Digital Circuits:** Review of gates (AND, OR, NAND, NOR, NOT, EX-OR), Boolean laws and theorems simplification of SOP equations, Simplification of POS equations, Simplification using Karnaugh Map technique (4 variables).	15
IV	**Flip flops, Registers & Counters**: Latch using NAND and NOR gates, RS flip flop, clocked RS flip flop, JK flip flop, JK master slave Flip Flop—racing- Shift Registers, Counters: Ripple counters- truth table, timing diagram, Synchronous counters-truth table, timing diagram, Decade counter.	15

Book Recommended

1.*Electronic devices and circuit theory* by Robert Boylested and Louis Nashdsky, PHI, New Delhi
2.*OP amps & linear integrated circuits* by Ramakanth A Gayakwad, PHI second addition, 1991
3. *Microelectronics* by Jacob Millman, Mc-Hill international book co, New Delhi, 1990
4.*Optoelectronics- theory and practice* by Alien Chappal, Mc-Hill international book co, New York.
5. *Schaum's Outline of Electronic Devices and Circuits* by J.J. Cathey.
6.*Digital Electronics: A Practical Approach* by W. Kleitz**.**
7. *Principles of Electronics*byV.K. Mehta**.**

8. *Handbook of Electronics* by Gupta and Kumar. 9.*Basic Electronics* by B.L. Theraja**.**

B.Sc. IV (SEMESTER-VII) PAPER V
BPYL 105: PRACTICAL

<table>
<tr><td>Programme: B.Sc. Honors in Physics</td><td colspan="2">Year: Fourth</td><td>Semester : Seventh</td></tr>
<tr><td colspan="2">Course Code: PYUP 405</td><td colspan="2">Course Title : Practical</td></tr>
<tr><td colspan="4">Course outcomes
Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.</td></tr>
<tr><td colspan="2">Credits: 4</td><td colspan="2">Practical</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4</td></tr>
<tr><td colspan="4">List of Experiments</td></tr>
<tr><td colspan="4">1. Study of characteristics of Solar cell
2. Compton Effect
3. Plank’s constant
4. Study of RC coupled amplifier
5. Study of characteristics of SCR
6. Photoelectric effect
7. Study of feedback amplifier</td></tr>
</table>

B.Sc. IV (SEMESTER-VIII) PAPER I
STATISTICAL PHYSICS

<table>
<tr><td colspan="2">Programme: B.Sc. Honors in Physics</td><td>Year: Fourth</td><td colspan="2">Semester : Eighth</td></tr>
<tr><td colspan="3">Course Code: PYUC 406</td><td colspan="2">Course Title: Statistical Physics</td></tr>
<tr><td colspan="5">Course Objectives:
The course is so designed that student will learn introduction to statistical physics, Ensemble Theory, quantum statistics and fluctuations.
Student Learning Outcomes: The student will be able to learn
1. Basic concept of phase space and phase cell.
2. Concept of ensembles
3. MB, BE, and FD statistics.
4. Fluctuations in ensemble, correlation of space-time dependent fluctuations, fluctuations and transport phenomenon</td></tr>
<tr><td colspan="3">Credits: 4</td><td colspan="2">Core Paper</td></tr>
<tr><td colspan="5">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="3">Topics</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="3">Introduction to statistical physics: phase space and phase space trajectory, concept of a statistical ensemble, distribution function, mean value of a physical quantity, statistical equilibrium, statistical independence and quasi-closed systems. Liouville’s theorem (no derivation) and its significance, thermodynamic potential: Helmholtz and Gibb’s potentials, first and second order phase transitions</td><td>15</td></tr>
<tr><td>II</td><td colspan="3">Ensemble Theory:Concept of ensembles: microcanonical, canonical and grand canonical ensembles. Microcanonical distribution in classical statistics. Gibb’s canonical distribution. Partition function, grand canonical distribution, free energy and equation of state of an ideal gas, chemical potential of a monoatomic ideal gas. Statistical distribution in quantum statistics.</td><td>15</td></tr>
<tr><td>III</td><td colspan="3">Quantum statistics: Fermi-Dirac and Bose-Einstein distribution, F-D and B.E gases of elementary particles.
The electron gas in metals, Degenerate electron gas-equation of state, degeneracy temperature, specific heat. Degenerate Bose Gas, Specific heat and pressure, B-E condensation, Ising model, Diffusion equation</td><td>15</td></tr>
<tr><td>IV</td><td colspan="3">Fluctuations: Fluctuations in ensemble, correlation of space-time dependent fluctuations, fluctuations and transport phenomenon, Brownian motion, Langevin theory, fluctuation dissipation theorem, Fokker-Plank equation.</td><td>15</td></tr>
<tr><td colspan="5">Book Recommended:
1. Fundamentals of Statistical and Thermal Physics by F. Rief. McGraw Hill.
2. Statistical Mechanics by K. Huang, Wiley Publication.
3. Statistical Mechanics by R.K. Pathria, Academic Press Inc.
4. Statistical Mechanics by D.A. McQuarrie, University Science Books Publication, 2000.
5. Fundamentals of Statistical Mechanics by B.B. Laud, New Age International Private Limited, 2020.</td></tr>
</table>

B.Sc. IV (SEMESTER-VIII) PAPER II
ELECTROMAGNETIC THEORY

<table>
<tr><td colspan="2">Programme: B.Sc. Honors in Physics</td><td colspan="2">Year: Fourth</td><td>Semester : Eighth</td></tr>
<tr><td colspan="3">Course Code: PYUC 407</td><td colspan="2">Course Title: Electromagnetic Theory</td></tr>
<tr><td colspan="5">Course Objectives:
The course is so designed that student will learn electrostatics. Magnetostatics, Maxwell Equations, Electromagnetic Waves, Radiation and plasma Physics.
Student Learning Outcomes: The student will learn
1. Basic concept of electrostatics and magnetostatics.
2. Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges.
3. Radiation by moving charges, Lienard-Wiechert potentials.
4. Formation of plasma, Debye theory of screening.</td></tr>
<tr><td colspan="3">Credits: 4</td><td colspan="2">Core Paper</td></tr>
<tr><td colspan="5">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="3">Topic</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="3">Electrostatics: Differential equation for electric field, Poisson and Laplace equations, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics.

Magnetostatics: Biot-Savart law, differential equation for static magnetic field, vector potential, examples of magnetostatic problems, Faraday's law of induction.</td><td>15</td></tr>
<tr><td>II</td><td colspan="3">Maxwell's Equations: Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges.

Electromagnetic Waves: Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity.</td><td>15</td></tr>
<tr><td>III</td><td colspan="3">Radiation: Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lormour formula.</td><td>15</td></tr>
<tr><td>IV</td><td colspan="3">Introductory Concepts of Plasma Physics: Formation of plasma, Debye theory of screening, plasma oscillations, motion of charges in electromagnetic fields, magneto-plasma, plasma confinement, hydromagnetic waves.</td><td>15</td></tr>
<tr><td colspan="5">Book Recommended

1. Classical Electrodynamics by J.D. Jackson.
2. Introduction to Electrodynamics by D.J. Griffiths.
3. Foundations of Electromagnetic Theory by J.R. Reitz, F.J. Milford and R.W. Christy.
4. Introduction to Plasma Physics and Controlled Fusion by F.F. Chen.</td></tr>
</table>

B.Sc. IV (SEMESTER-VIII) PAPER III
QUANTUM MECHANICS-II

<table>
<tr><td colspan="2">Programme: B.Sc. Honors in Physics</td><td colspan="2">Year: Fourth</td><td colspan="2">Semester : Eighth</td></tr>
<tr><td colspan="3">Course Code: PYUC 408</td><td colspan="3">Course Title: Quantum Mechanics - II</td></tr>
<tr><td colspan="6">Course Objectives: The course is so designed that student will learn about:
1. Approximation Methods in Quantum mechanics.
2. Covariance of Dirac Equations.
3. Relativistic quantum mechanics.
4. Second quantization.
Student Learning Outcomes:
From this course, students will learn about the basic approximation methods applied to the solution of perturbation problems in quantum mechanics, Klien Gordan Equation, Quantum mechanics in relativistic manner, Second quantization method.</td></tr>
<tr><td colspan="3">Credits: 4</td><td colspan="3">Core Paper</td></tr>
<tr><td colspan="6">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="4">Topics</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="4">Approximate Methods:
WKB approximation method, Time independent perturbation theory for non-degenerate and degenerate cases up to second order energy and eigen function, Application to: Perturbed oscillator, First order Stark effect, Time dependent perturbation theory, Transition Probability.</td><td>15</td></tr>
<tr><td>II</td><td colspan="4">Application of Approximation Methods:
Born-Oppenheimer approximation and its application, H_2 molecule, Heitler-London theory, Valence bond theory of diatomic molecules, Simple valence bond treatment of H_2O and C_6H_6 molecules; LCAO approximation, Huckel approximation and its application to benzene molecules.</td><td>15</td></tr>
<tr><td>III</td><td colspan="4">Relativistic Quantum Mechanics:
Free particle Klein-Gordon equation, Plane wave solution and Physical interpretation, Inadequacy of Klein-Gordon equation, Dirac equation, α and β matrices and related algebra, Klein-Gordan equation in electromagnetic field.</td><td>15</td></tr>
<tr><td>IV</td><td colspan="4">Covariance of Dirac's Equation:
Covariant form of Dirac equation, Dirac and Feynman interpretation of negative energy states, Dirac Continuity equation, Plane wave solution and negative energy states; Non relativistic correspondence, (γ) matrices: Representation and algebra.</td><td>15</td></tr>
<tr><td colspan="6">Book Recommended
1. Advanced Quantum Mechanics by J. J Sakurai, Pearson (2005).
2. Relativistic Quantum Fields by James D. Bjorken, Sidney D. Drell, Dover publications
3. A First Book of Quantum Field Theory by A Lahiri, Narosa Book Distributors Pvt Ltd
4. Quantum Field Theory by F. Mandl and G. Shaw, John Wiley & Sons (20100525).</td></tr>
</table>

B.Sc. IV (SEMESTER-VIII) PAPER IV
SOLID STATE PHYSICS

<table>
<tr><td colspan="2">Programme: B.Sc. Honors in Physics</td><td colspan="2">Year: Fourth</td><td>Semester : Eighth</td></tr>
<tr><td colspan="3">Course Code: PYUC 409</td><td colspan="2">Course Title: Solid State Physics</td></tr>
<tr><td colspan="5">Course Objectives: The course is so designed that student will learn about:
1. The crystal structure and reciprocal lattices, symmetry elements,
2. Phonon- Lattice Vibration and Thermal Properties
3. Free electron theory of Metals
4. Superconductivity and Magnetism.
Student Learning Outcomes: The student will learn about
1. Basics of crystal structure and its classification, symmetry elements also a general idea of reciprocal lattice.
2. Optical properties of solids and lattice vibrations, phonon interaction.
3. Classical free electron theory and its failure, Free electron theory of metals, KP model. Some basic introduction about the formation of energy band, classification of metal, semiconductor and insulators.
4. Idea of superconductivity, magnetic properties of superconductors, cooper pair, BCS model.</td></tr>
<tr><td colspan="3">Credits: 4</td><td colspan="2">Core Paper</td></tr>
<tr><td colspan="5">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="3">Topics</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="3">Crystal structure and Reciprocal Lattices: Periodic array of atoms, fundamental types of lattices and Bravais lattice; Miller Indices of a family of planes and interplanar spacing for an orthorhombic crystal, Cubic Zinc Sulphide and closed packed structures. Bragg's law, Scattered wave amplitude, Reciprocal lattice, Construction of reciprocal lattices, Reciprocal lattice of SC, BCC, FCC, Concept of Brillouin zone, Fourier Analysis of the base; Basic of Crystal binding and elastic constants of crystals.

Symmetry element: Proper rotation axis, improper rotation axis, rotoreflection, rotoinversion, glide planes, screw axes, space groups and point groups.</td><td>15</td></tr>
<tr><td>II</td><td colspan="3">Phonon- Lattice Vibration and Thermal Properties: Wave motion of one dimensional atomic lattice, Group velocity and phase velocity, Force constants, Brillouin zones, Normal modes of vibration in one dimensional atomic lattice of finite length, Lattice with two atoms per primitive cell, Optical properties in the infrared, Phonons, Momentum of phonons, Inelastic scattering of photons by long wavelength phonons, Local phonon model; Specific heat, Classical Theory, Einstein's Theory, Debye's Theory, thermal conductivity.</td><td>15</td></tr>
<tr><td>III</td><td colspan="3">Free electron theory of Metals: Drude model of electrical and thermal conductivity, Sommerfeld model of free election gas; Motion of electrons in a one-dimensional periodic potential, Band Theory of Solids: Metals, insulators and intrinsic semiconductors; Kroning-Penney Model. Basic of Hall Effect, band gap of semiconductor, Hall Effect in semiconductors.

Fermi surface and Metals: Construction of Fermi Surfaces, Fermi surface</td><td>15</td></tr>
</table>

	and Brillouin zones, Experimental Methods in Fermi Surface Studies, de Hass van Alphen effect, quantum Hall effect, Magnetoresistance.	
IV	**Superconductivity and Magnetism:** Occurrence of superconductivity, Meissner effect, London equation, effect of magnetic field, type I and type II superconductors, High temperature Superconductor, Cooper pairs and elementary discussion of BCS model, Josephson junction, super fluidity; Langevin Theory of diamagnetism and Quantum Theory of diamagnetism and paramagnetism; Ferromagnetism, Anti ferro magnetism, Ferri magnetic Domain.	15

Book Recommended

1. *Introduction to Solid State Physics* by C. Kittel.
2. *Solid State Physic s*by A.J. Dekker.
3. *Condensed Matter Physics* by M.P. Marder.
4. *Principles of the Theory of Solids* by J.M. Ziman.
5. *Solid State Physics* by N.W. Achcroft and N.D. Mermin.
6. *Solid State Physics (Part-I): Transport Properties of Solid* by M.S. Dresselhaus.
7. *Solid State Physics-Structure and Properties of Materials*by M.A. Wahab.
8. *Principles of Condensed Matter Physics* by P.M. Chaikin and T.C. Lubensky.
9. *Solid State Physics* by S.O. Pillai.
10. *Solid State Physics* by G. Burns.

B.Sc. IV (SEMESTER-VIII) PAPER V
PRACTICAL

Programme: B.Sc. Honors in Physics	**Year: Fourth**	**Semester : Eighth**
Course Code: PYUP 410	**Course Title : Practical**	
Course outcomes Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.		
Credits: 4	**Practical**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
List of Experiments		

1. Measurement of Adiabatic compressibility of:
   a. Distilled water
   b. Piezoelectric crystal
2. Study of Solid-liquid phase diagram for a mixture.
3. Study of Magneto-resistance and its field dependence
4. Hall effect: Determination of
   a. Hall coefficient,
   b. Mobility
5. Determination of Band Gap energy of given thermistor
6. Magnetic susceptibility
7. Band Gap of Semiconductor
8. Frank-Hertz experiment

B.Sc. IV (SEMESTER-VII) PAPER I
MATHEMATICAL PHYSICS

Programme: B.Sc. Honors with Research in Physics	**Year: Fourth**	**Semester : Seventh**
Course Code: PYUC 401	**Course Title : Mathematical Physics**	

Course Objectives: The subject is so designed that student will learn:

1. Introduction to Vector analysis in curved coordinates and Tensors
2. Some Special Functions related to physics
3. Matrices and Calculus of Residues
4. Integral Transforms

Student Learning Outcomes:

5. Introduction to Vector analysis in curved coordinates and Tensors
6. Some Special Functions related to physics
7. Matrices and Calculus of Residues
8. Application to integral Transforms and Fourier transforms in physical problems.

Credits: 4	**Core Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No of Lectures
I	**Vector analysis in curved coordinates and Tensors:** Review of vector algebra and calculus, Gauss and Stokes theorems, Orthogonal coordinates differential vector operators, special coordinate systems, circular cylindrical coordinates, spherical polar coordinates, tensor analysis, contraction, direct product, quotient rule, pseudo tensors, dual tensors, non-Cartesian tensors, covariant differentiation, and tensors differentiation operators. Elements of Group theory.	15
II	**Special Functions:** Second order ordinary differential equations, Frobinus method for solving second order linear ODEs, Beta and Gamma functions, Legendre's equation, Legendre polynomials and their properties, Bessel's equation, Bessel function and their properties, Laguerre's equation, its solutions and properties, Hermite equation, Hermite Polynomials and their properties.	15
III	**Matrices and Calculus of Residues:** Different types of matrices, orthogonal, Hermitian, unitary and normal, Eigen values and Eigen functions of matrices, diagonalisation of matrices, properties of analytic functions, Complex variable, Cauchy's integral theorem, Cauchy integral formula, Laurent expansion, singularities, Cauchy's residue theorem, evaluation of definite integrals, dispersion relations.	15
IV	**Integral Transforms:** Laplace Transform (LT), first and second shifting theorems, LT of derivative and integral of a function, Inverse LT by partial fractions, Solution of initial value problems by using LT **Fourier Series and Fourier Transform:** Fourier series, Half range expansion, Arbitrary period, Fourier integral and transforms, FT of delta and Gaussian function.	15

Book Recommended

1. *Mathematical method for Physicists,* Arfken & Weber, Elsevier Academic Press
2. *Mathematical Method for Physics and Engineers,* K.F.Reily, M.P.Hobson and S.J.Bence, Cambridge University Press
3. *Advanced Engineering Mathematics,* E. Kreyszig, John Wiley & Sons

4. *Special Functions,* E.D. Rainville, Chelsea Publication Co.
5. *Special Functions for Scientists and Engineers,* W.W. Bell, Dover Publications
6. *Functions of complex variable,* R.V. Churchill, McGraw Hill

B.Sc. IV (SEMESTER-VII) PAPER II
CLASSICAL MECHANICS

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Seventh
Course Code: PYUC 402	**Course Title : Classical Mechanics**	

Course Objectives:

1. To demonstrate knowledge and understanding of the fundamental concepts in the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation of mechanics.
2. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
3. To reduce two body problem into one-body problem
4. Small oscillations and Lagrange's eqn of motions

Student Learning Outcomes:

5. Basic concept in the formulation of kinetic and potential energies of dynamics of system of particles, motion of rigid body.
6. Lagrangian and Hamiltonian formulation.
7. Conservation theorems and Kepler's problem.
8. Application to small oscillations in terms of normal modes and normal frequencies and their applications in (a)longitudinal vibrations of two coupled harmonic oscillators (b) linear, symmetric, triatomic molecule, (c) oscillations of two linearly coupled plane pendulum

Credits: 4	**Core Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No of Lectures
I	**Lagrangian Formulations:** System of particles and equation of motion ofa system of particles, conservation of linear momentum, energy and angular momentum. Constraints, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion and its application, Single free particle, a bead sliding on a uniformly rotating wire in a force-free space, Simple Pendulum, Compound Pendulum.	15
II	**Hamilton Formulations:** Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equation of motion, Examples of (a) The Hamiltonian of a particle in a central force field, (b) the simple harmonic oscillator. Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle. Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of poison brackets (antisymmetry, linearity, and Jacobi identity), Poisson bracket of angular momentum, The Hamilton-Jacobi equation and application to Linear harmonic oscillator.	15

III	**Central force problem:** Reduction of two body problem into one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem (inverse-square law of force).	15
IV	**Small oscillations**: Types of equilibrium, Quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, Normal modes and normal frequencies, examples of (a)longitudinal vibrations of two coupled harmonic oscillators (b) linear, symmetric, triatomic molecule, (c) oscillations of two linearly coupled plane pendulum.	15

Book Recommended

1. *Classical Mechanics,* H. Goldstein, Narosa Publishing House
2. *Classical Mechanics,* N.C. Rana and P.S. Joag, Tata McGraw Hill
3. *Introdution to Dynamics,* I.C. Percival and D. Richards, Cambridge University Press
4. *Classical Mechanics,*Gupta and Kumar, Pragati Prakashan, Meerut.

B.Sc. IV (SEMESTER-VII) PAPER III
QUANTUM MECHANICS

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Seventh
Course Code: PYUC 411	**Course Title : Quantum Mechanics**	

Course Objectives:
The course is so designed that students will get acquainted with wave mechanical formulation and energy eigen value problem, theory of angular momentum, approximation methods and relativistic quantum mechanics.

Student Learning Outcomes:
From this course, the students will learn about the physical and mathematical basis of quantum mechanics for non-relativistic systems, about basic approximation methods applied to the solution of perturbation problems in quantum mechanics, Klien Gordan Equation and Quantum mechanics application in relativistic approach.

Credits: 4	Core Paper

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No of Lectures
I	**Wave Mechanical Formulation and Energy Eigenvalue Problem**: Time-dependent Schrödinger equation, Conservation of probability, Time-independent Schrödinger equation, The potential step: reflection coefficient, The potential barrier: transmission and reflection coefficient, Eigenvalues and eigenfunctions of linear harmonic oscillator, The periodic potential, spherically symmetric potential, The hydrogen atom.	15
II	**Theory of Angular Momentum**: Spatial rotations, Orbital angular momentum, Commutation relations – L_x, L_y, L_z and L^2, Eigenfunctions and eigenvalues of L^2 and L_z, Spin angular momentum, Pauli spin matrices, Total angular momentum, the spectrum of J^2 and J_z, Ladder operators, Addition of two angular momenta, Clebsch-Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1/2$, $j_2=1$.	15
III	**Approximate Methods:** WKB approximation method, Time independent perturbation theory for non-degenerate and degenerate cases up to second order energy and eigen function, Application to: Perturbed oscillator, First order Stark effect, Time dependent perturbation theory, Transition Probability.	15
IV	**Relativistic Quantum Mechanics:** Free particle Klein-Gordon equation, Plane wave solution and Physical interpretation, Inadequacy of Klein-Gordon equation, Dirac equation, α and β matrices and related algebra, Klein-Gordan equation in electromagnetic field.	15

Book Recommended

1. *Introduction To Quantum Mechanics* by David J. Griffiths, Pearson (2005).
2. *Quantum Mechanics* by G. Aruldas, PHI Learning Private Ltd. (2009)
3. *Quantum Mechanics* by L.I. Schiff, Tata Mcgraw Hill Education Private Limited Tata Mcgraw Hill Education Private Limited (2010).
4. *Modern Quantum Mechanics*by J. J Sakurai, Pearson (1994).
5. *Quantum Mechanics: Theory And Applications* by A. Ghatak, Macmillan India Limited (2004).

6. *Quantum Mechanics: An Introduction* by Walter Greiner, Springer (India) Pvt. Ltd. (2008)
7. *Quantum Physics: Of Atoms Molecules Solids Nuclei And Practicles* by Robert Resnick and Robert Eisberg, Wiley India Pvt Ltd (2006).

B.Sc. IV (SEMESTER-VII) PAPER IV
PRACTICAL

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Seventh
Course Code: PYUP 412		**Course Title : Practical**

Course outcomes

Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 4	Practical

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

List of Experiments

1. Study of characteristics of Solar cell
2. Compton Effect
3. Plank's constant
4. Study of characteristics of SCR
5. Photoelectric effect
6. Study of feedback amplifier
7. Hall effect: Determination of
    a. Hall coefficient,
    b. Mobility
8. Determination of Band Gap energy of given thermistor

B.Sc. IV (SEMESTER-VII) PAPER V
RESEARCH PROJECT

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Seventh
Course Code: PYUP 413		**Course Title : Research Project**

This course will provide you with guidance and support throughout the writing of your dissertation. From discussing your initial ideas of your dissertation through the process of actually writing the document, this course will provide you with the information and support required from both the teaching staff and your allocated dissertation supervisor.

B.Sc. IV (SEMESTER-VIII) PAPER I
ELECTROMAGNETIC THEORY

Programme: B.Sc. Honors with Research in Physics	**Year: Fourth**	**Semester : Eighth**
Course Code: PYUC 407	**Course Title : Electromagnetic Theory**	

Course Objectives:
The course is so designed that student will learn electrostatics. Magnetostatics, Maxwell Equations, Electromagnetic Waves, Radiation and plasma Physics.

Student Learning Outcomes: The student will learn
1. Basic concept of electrostatics and magnetostatics.
2. Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges.
3. Radiation by moving charges, Lienard-Wiechert potentials.
4. Formation of plasma, Debye theory of screening.

Credits: 4	**Core Paper**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	**Topic**	**No of Lectures**
I	**Electrostatics:** Differential equation for electric field, Poisson and Laplace equations, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics. **Magnetostatics:** Biot-Savart law, differential equation for static magnetic field, vector potential, examples of magnetostatic problems, Faraday's law of induction.	15
II	**Maxwell's Equations:** Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges. **Electromagnetic Waves:** Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity.	15
III	**Radiation:** Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lormour formula.	15
IV	**Introductory Concepts of Plasma Physics:** Formation of plasma, Debye theory of screening, plasma oscillations, motion of charges in electromagnetic fields, magneto-plasma, plasma confinement, hydromagnetic waves.	15

Book Recommended

1. *Classical Electrodynamics* by J.D. Jackson.
2. *Introduction to Electrodynamics* by D.J. Griffiths**.**
3. *Foundations of Electromagnetic Theory* by J.R. Reitz, F.J. Milford and R.W. Christy**.**
4. *Introduction to Plasma Physics and Controlled Fusion* by F.F. Chen.

B.Sc. IV (SEMESTER-VIII) PAPER II
MOLECULAR SPECTROSCOPY AND COMPUTATIONAL TECHNIQUES

Programme: B.Sc. Honors with Research in Physics	**Year: Fourth**	**Semester : Eighth**
Course Code: PYUC 414		**Course Title : Molecular Spectroscopy and Computational Techniques**

Course Objectives:
The course is so designed that student will learn about vibrational, rotational and electronic spectra, insight of laser systems and computational techniques in physics for modelling.

Student Learning Outcomes: The student will learn
1. Basic concept of vibrational and rotational spectra
2. Rotational structure of electronic bands, Frank-Condon principle.
3. Basic principles of laser and its applications.
4. Molecular Orbital Theory, Density Functional Theory and Monte Carlo Simulations.

Credits: 4	**Core Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No of Lectures
I	**Electronic Spectra:** Electronic energy and total energy, vibration structure of electronic transitions, progressions and sequences, rotational structure of electronic bands, band head formation and band origin. Intensity distribution in vibrational structure, Frank-Condon principle and its quantum mechanical formulation.	15
II	**Vibrational and Raman Spectra:** Normal modes, symmetry characterization of electronic states and vibrational modes of polyatomic molecules, Raman spectroscopy, Classical and quantum theory of Raman effect, Mössbauer spectroscopy, Nuclear Magnetic Resonance and Electron Spin Resonance.	15
III	**Laser**: Basic principles of laser, Einstein coefficients, Population inversion, light amplification, threshold condition, Optical resonator, Semiconductor laser operating principle, application of laser.	15
IV	**Computational methods:** Molecular Orbital Theory, The Hartree-Fock method, ab-initio calculation, Semi-empirical methods, Huckel theory, Valence bond theories, Geometrical Parameters, Density Functional Theory, Molecular dynamics, Minimization, Monte Carlo Simulations.	15

Book Recommended

1. Molecular Spectra and Molecular Structure by G. Herzberg (Dover Publication).
2. Fundamentals of Spectroscopy by C.N. Banwell and E.M. McCash (Tata-McGraw-Hill)
3. Introduction to Molecular Spectroscopy by G.M. Barrow (McGraw-Hill) 4. Modern Spectroscopy by M.J. Hollas (Wiley Inter Science)
4. Lasers: Fundamentals and Applications by K. Thyagarajan · Ajoy Ghatak (Springer)
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill
6. Molecular Structure & Spectroscopy, G. Aruldhas, Prentice Hall of India
7. Introduction to Atomic Spectra, H.E. White, McGraw Hill
8. Density function theory: A practical introduction, D.S. Sholl, J. A. Steckel, Wiley

B.Sc. IV (SEMESTER-VIII) PAPER IIIa
MATERIAL SCIENCE

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Eighth
Course Code: PYUE 415	**Course Title : Material Science**	

Course Objectives:
The course is so designed that student will learn about crystal structure, different types of solar cells, liquid crystal materials and superconductivity.
Student Learning Outcomes: The student will learn
1. Crystal structures, imperfections and nucleation.
2. Types of Solar cells, their working and used materials.
3. Superconductors and applications of superconductivity.
4. LCD devices and applications.

Credits: 4	Core Paper

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No of Lectures
I	**Crystallography**: Crystal structures: BCC, FCC and HCP – directions and planes – linear and planar densities – crystal imperfections- edge and screw dislocations – grain and twin boundaries – Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials – Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.	15
II	**Solar Cells**: Photovoltaic effect, Solar cell characterization & Simulation, Types of Solar cells, Solid state solar cells, Silicon solar cell, Solar cells based on thin film heterojunctions, Nanostructured solar cells, Dye sensitized solar cells: basic concepts, working and materials. Organic Solar cells: basic concepts, working and materials. Hybrid solar cell: basic concepts, working and materials.	15
III	**Superconductivity**: Nature and properties of superconducting materials - Type I and II superconductors, BCS theory, AC and DC Josephson effect. Applications - superconducting magnets, super density switches, SQUID High temperature (High Tc) superconductors	15
IV	**Liquid Crystalline Materials**: Introduction - classification of thermotropic liquid crystals, Elementary ideas on material, Properties of liquid crystals, electro-optic, thermo-optic effects and LCD devices and applications.	15

Book Recommended

1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley & Sons, 2007.
2. C. Kittel, Introduction to Solid State Physics, Wiley Eastern Ltd, 2005.
3. V. Raghavan, Materials Science and Engineering: A First Course, Prentice Hall, 2006.
4. K.L. Chopra, Thin Film Phenomena, Mc Graw Hill,1979.
5. M.H. Francombe, S.M. Rossnagel, A. Ulman, Frontiers of Thin Film Technology, Vol. 28,

Academic press, 2001.

6. R.F. Bunshah, Deposition Technologies for Films and Coatings, Noyes Publications, New Jersey, 1982.
7. F.A. Lowenheim, Electroplating, McGraw Hill, NewYork,1978.
8. Introduction to Nano technology by C.P. Poole Jr. and F.J. Oweus, Wiley Inter science.
9. Nano-Technology by Gregory Timp (Editior), AIP Press, Springer
10. Pradeep T., A Text book of Nano science and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd.
11. Hari Singh Nalwa, Nano structured Materials and nanotechnology, Academic Press
12. Graphene: Synthesis and applications, edited by Wonbong Choi and Jo- won Lee.

B.Sc. IV (SEMESTER-VIII) PAPER IIIb
VLSI DESIGN &THIN FILM TECHNOLOGY

Programme: B.Sc. Honors with Research in Physics	**Year: Fourth**	**Semester : Eighth**
Course Code: PYUE 416	**Course Title : VLSI Design & Thin Film Technology**	

Course Objectives:
The course is so designed that student will learn about silicon wafers and their properties, deposition techniques, MOS technology and VLSI devices, thin film diodes and amplifiers.

Student Learning Outcomes: The student will learn

1. VPE, LPE and MBE mechanisms, ion implantation and diffusion mechanisms.
2. Various deposition techniques, Lithography, chemical and plasma etching.
3. MOS Transistors, Analysis and design of inverters and inverter based circuits.
4. Properties of thin Film active and passive circuit elements.

Credits: 4	**Core Paper**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No of Lectures
I	**Properties of silicon wafers**: Mechanical, Electrical, structural Epitaxial growth, VPE, LPE and MBE mechanism, apparatus and methods of evaluation of EPI-layers. Oxidation, Ion implantation system and principles, Annealing and sintering, Fick's law, diffusion mechanism, measurement techniques, diffusion in SiO_2 .	15
II	**Metallization**: Deposition techniques, CVD and PVD, Laser ablation, Laser annealing and mixing. Lithography, photolithography, EBMF and X-ray lithography, Wet chemical etching, lift off process and plasma etching. Bonding.	15
III	**MOS Technology and VLSI**: Electrical properties of MOS circuits and Device modelling, Sealing of MOS circuits, MOS Transistors – fabrication and characteristics. MOSFET scaling and short-channel effects, Analysis and design of inverters and inverter based circuit. Packaging of VLSI devices, Fault finding in VLSI chips.	15

IV	Properties of thin Film Passive circuit elements, Properties of thin film active elements; Thin film diodes, transistors, Hot electron amplifier, Thin film micro-circuitry: Basic processing steps, preparation of drawings, photographic Techniques, Mask fabrication, Thin film Image sensors.	15

Book Recommended

1. VLSI Fabrication Principles, S.K. Gandhi, John Willey & Sons.
2. VLSI Technology, S.M. Sze, McGraw Hill,Int. Book Company.
3. Integrated Circuit Engineering, A.B. Glasser, S. Sharpe
4. Semiconductor & Integrated, P.E. Gise, R. Blanchard Fabrication Techniques Restonn Pub. Co. Inc. PHC.
5. Large Scale Integration, M.J. Hower, D.V. Morgan, John Wiley & Sons Ltd.
6. VLSI Technology, C. Y. Chang, S.M. Sze, McGraw Hill.

B.Sc. IV (SEMESTER-VIII) PAPER IV
PRACTICAL

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Eighth
Course Code: PYUP 417		**Course Title : Practical**

Course outcomes

Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 4	Practical

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

List of Experiments

1. Hysteresis loop
2. Band Gap of Semiconductor
3. Frank-Hertz experiment

B.Sc. IV (SEMESTER-VIII) PAPER V
RESEARCH PROJECT

Programme: B.Sc. Honors with Research in Physics	Year: Fourth	Semester : Eighth
Course Code: PYUP 418		**Course Title : Research Project**

This course will provide you with guidance and support throughout the writing of your dissertation. From discussing your initial ideas of your dissertation through the process of actually writing the document, this course will provide you with the information and support required from both the teaching staff and your allocated dissertation supervisor.

M.Sc. in Physics

(SEMESTER-IX) PAPER I

ATOMIC & MOLECULAR PHYSICS

<table>
<tr><td>Programme: M.Sc. in Physics</td><td>Year: Fifth</td><td>Semester : Ninth</td></tr>
<tr><td colspan="2">Course Code: PYMC 501</td><td>Course Title : Atomic and Molecular Physics</td></tr>
<tr><td colspan="3">Course Objectives:
The student is so designed that student will learn about the hydrogen atom problem, atomic spectra, rotational and vibrational spectra, spectroscopy techniques.
Student Learning Outcomes:
The students will learn about hydrogen atom problem and its solution by using hydrogen atom and its physical interpretation. Rotational and vibrational spectroscopy of diatomic and polyatomic molecules.</td></tr>
<tr><td colspan="2">Credits: 4</td><td>Core Paper</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
</table>

Unit	Topic	No of Lectures
I	**Hydrogen Atom Problem**: Application of Schrödinger equation for hydrogen atom, interpretation of the results of Schrodinger equation, atomic energy levels, dependence of wave function on the angle θ and ϕ and radial dependence of wave function, Pauli exclusion principle, maximum number of electrons in a given group or subgroup.	15
II	**Atomic Spectra:** Different series in alkali spectra, term values in alkali spectra and quantum defect, spin-orbit interaction, doublet structure in alkali spectra coupling schemes. LS coupling, JJ coupling interaction energy in L-S coupling & JJ coupling, fine structure & hyperfine structure (qualitative) Line-broadening mechanisms (general ideas), normal and anomalous Zeeman effect, Paschen-Back effect and Stark effect.	15
III	**Rotational and Vibrational Spectra:** Rotation of molecules, classification of molecules, and interaction of radiation with rotating molecule, rotational spectra of rigid diatomic molecules. Isotope effect in rotational spectra, intensity of rotation lines, non-rigid rotator, linear polyatomic molecules, symmetric top molecules, asymmetric top molecules. Vibrational energy of a diatomic molecule, infrared spectra (preliminaries) Morse curve and the energy levels of a diatomic molecules. Vibrating diatomic molecule, diatomic vibrating rotator, normal modes of vibration in crystal, interpretation of vibrational spectra.	15
IV	**Spectroscopy Techniques:** Raman spectroscopy, Frank Condon principle and selection rules, Photoelectron Spectroscopy, Mössbauer spectroscopy, Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).	15

Book Recommended

1. *Introduction to Atomic Spectra* by H.E. White, McGraw Hill
2. *Molecular Structure & Spectroscopy* by G. Aruldhas, Prentice Hall of India
3. *Elements of Spectroscopy* byGupta, Kumar & Sharma, Pragati Prakashan
4. *Fundamentals of molecular spectroscopy* by C. Banwell &E. McCash, Tata McGraw Hill

5. *Introduction to Molecular Spectroscopy* by G.M. Barrow, McGraw Hill
6. *An Introduction to Molecular Spectroscopy* by Gerhard Herzberg, Nostrand Co.
7. *Atomic & Molecular Physics* by Raj Kumar, Kedar Nath & Sons

(SEMESTER-IX) PAPER IIa
ELECTRONICS - I

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Ninth**
Course Code: PYME 502	**Course Title : Electronics - I**	

Course Objectives: The course is so designed the student will learn about photonic Devices, Microwave devices, Memory and other electronic devices, Photodetectors.

Student Learning Outcomes: The student will learn about the
1. Working and output characteristics of Photonic devices like LDR, LED and Solar cell.
2. Working and output characteristics of tunnel diode, gunn diode, IMPATT diodes and other parametric devices.
3. Construction and function of memory devices like SRAM, CMOS, NMOS, SRAM and other electro-optic, magneto-optic effects, Photo detectors, and LEDs

Credits: 4	**Elective Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No of Lectures
I	**Photonic Devices** - Radiative and non-radiative transitions, Photoconductive devices LDR, diode photo detector, Solar cell, light emitting diode LED, high frequency limit, effect of surface and indirect recombination light confirmation factor, optical gain and threshold current for lasing.	15
II	**Microwave Devices**- Tunnel Diode, Transfer electron devices, Gunn Diode, Avalanche transit time devices, IMPATT diode and parametric devices.	15
III	**Memory and other electronic Devices** - Static and Dynamic random-access memories, SRAM and DRAM, CMOS and NMOS, non-volatile NMOS, magnetic, optical and ferro-electric memories, charge coupled devices CCD, Electro-optic, Magneto-Optic and Acousto-Optic effects, Piezo-electric, Electro-strictive and Magneto-strictive effects, sensors and Actuators devices.	15
IV	**Photodetectors**: Photo detectors with external photo effect, Photo detectors with internal photo effect, photo conductor and photo resistor, junction photo detector, circuits with LED, diode tester, polarity and voltage tester, LED, numeric and alphanumeric display units, semiconductor switches and potential isolation, the phototransistor as a switch in the optocouplers, steady state performance, dynamic performance.	15

Book Recommended

1. Semiconductor Devices- Physics and Technology by S M Sze, Willey, (1985).

2. *Introduction to Semiconductor Devices* by M S Tyagi, John Willey & Sons.

3. *Measurement, Instrumentation and Experimental Design in Physics and Engineering* by M Sayer and A. Mansingh, PHI

4. *Opticl Enginnering* by Ajoy Ghatak and K Tyagrajan, Cambridge Univ Press.

(SEMESTER-IX) PAPER IIb
CONDENSED MATTER PHYSICS - I

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Ninth**
Course Code: PYME 503	**Course Title : Condensed Matter Physics –I**	
Course Objectives: The course is so designed the student will learn about the 1. Symmetry Properties of Crystal Lattice 2. Crystal Physics and Binding 3. Free electron theory of Metals 4. Disordered Materials **Student Learning Outcomes:** The student will learn about the group representation, rotoinversion, rotoreflection, Crystal Physics, periodic lattices, miller indices and Binding, Free electron theory of Metals, Disordered Materials, Free electron theory, classification of metal semiconductors and insulators, KP model and also about disordered materials.		
Credits: 4	**Elective Paper**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topic	No of Lectures
I	**Symmetry Properties of Crystal Lattice:** Mathematical group representation, Proper rotation axis, Improper rotation axis, Roto-reflection, Roto inversion, Glide planes, Screw axes, Space groups and point groups, Classes, The crystalline structure, Transformation of crystal lattice, Symmetries in Bravis lattice, Transformation and construction.	15
II	**Crystal Physics and Binding:** Periodic array of atoms, fundamental types of lattices and Bravis lattice; Miller Indices of a family of planes and interplanar spacing for an orthorhombic crystal, Cubic Zinc Sulphide and closed packed structure, Bragg's law, scattered wave amplitude, Diffraction of electromagnetic waves by crystals, Powder and rotating crystal methods, Neutron and electron diffraction.	15
III	**Free electron theory of Metals**: Drude model of electrical and thermal conductivity, Sommerfield model of free election gas; Motion of electrons in a one-dimensional periodic potential, Band Theory of Solids: Metals, insulators and intrinsic semiconductors; Kroning-Penney Model, Basic of Hall Effect, band gap of semiconductor, Hall Effect in semiconductors **Fermi surface and Metals:** Construction of Fermi Surfaces, Fermi surface and Brillouin zones, Experimental Methods in Fermi Surface Studies, de Hass van Alphen effect, quantum Hall effect, Magnetoresistance.	15
IV	**Disordered Materials:** Structure, Short range order and dangling bond; Random network model; Amorphous semiconductor; Density of states and mobility gap; Electrical transport, Optical and switching properties.	15

Book Recommended

1. *Introduction to Solid State Physics by C. Kittel.*
2. *Solid State Physics by S.O. Pillai*.
3. *Solid State Physics by A.J. Dekker.*
4. *Condensed Matter Physics by M.P. Marder.*

5. *Principles of the Theory of Solids by J.M. Ziman.* 6. *Solid State Physics by N.W. Ashcroft and N.D. Mermin.* 7. *Solid State Physics (Part-I): Transport Properties of Solid by M.S. Dresselhaus.* 8. *Solid State Physics-Structure and Properties of Materials by M.A. Wahab.* **9.** *Principles of Condensed Matter Physics by P.M. Chaikin and T.C. Lubensky.*

(SEMESTER IX) PAPER IIIa

BIO PHYSICS - I

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Ninth**
Course Code: PYME 504	**Course Title : Bio Physics - I**	
Course Objectives: The course is so designed that the student will learn about nucleic Acids, proteins, membranes and nerve impulse. **Student Learning Outcomes:** The course is so designed that the students will learn about biophysics.		
Credits: 4	**Elective Paper**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topic	No of Lectures
I	**Nucleic Acids:** Nucleosides and nucleotides, primary, secondary and tertiary structure of DNA, Watson - Crick model, backbone conformation, sugar puckering, different forms of DNA, Z-DNA, structure of RNA, different forms of RNA and their biological functions. The central dogma, DNA replication, RNA transcription and protein biosynthesis, reverse transcription, mutation and regulation of genes.	15
II	**Proteins:** Aminoacids, peptide bond, disulphide bridge, Primary, secondary,(αhelix and β- sheet),tertiary and quaternary structure of proteins. Protein conformation, torsion and dihedral angles, Ramachandran map, structure of heamoglobin and myoglobin.	15
III	**Membranes:** Cell membrane, Micelle. Bilayer and liposome; structure of membrane, conformational properties of membranes, passive membrane transport; Donnan equilibrium, Hodgkin-Katz formula, Active membrane transport and transport of charged particles through membranes. Simple idea of molecular reception - smell reception and taste reception	15
IV	**Nerve Impulse:** The neuron and Axon and Action potential, recording of action potential, Chronaxie and rheobase; depolarization and reporalization of axon membrane, mechanism of propagation of nerve impulse; Ionic channels, Elementary idea of synaptic transmission.	15

Book Recommended

1. *Molecular Biology of the Genes* by J. D. Watson (Benjamin Inc, California).
2. *Principles of Nucleic Acid Structure* by W. Saenger (Springer Verlag, New York).
3. *Biophysics;* Ed. W. Hoppe et. al., (Springer Verlag, New York).
4. *Introduction to Biophysics* by P.S. Narayanan.
5. *Biophysics* by M. V. Volkenstein (MIR publishers).
6. *Biophysics* by V. Pattabhi & N. Gauttam.
7. *Intermolecular Interactions: From Diatomics to Biopolymers*, Ed. B. Pullman (John Wiley, N. Y.).
8. *Physical Biochemistry* by K. E. van Holde, (Prentice Hall, N, J.).

(SEMESTER IX) PAPER IIIb
MOLECULAR MODELING – I

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Ninth**
Course Code: PYME 505	**Course Title : Molecular Modeling – I**	

Course Objectives:
The course is so designed that students will learn about the Introduction about the computational chemistry and molecular modeling, Molecular energetic profile, Brief introduction about Quantum Mechanics & Molecular Mechanics, Computer simulation methods.

Student Learning Outcomes:
The students will learn about the molecular modeling. They will learn about the concept of 2D and 3D structure, basic concept of chemo-informatics, and application to quantum mechanics into molecular modeling and some computer simulation methods.

Credits: 4	**Elective Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No of Lectures
I	**Introduction about the computational chemistry and molecular modeling:** Coordinate systems, Concept of 2D and 3D structure, molecules, Surfaces,	15
II	**Molecular energetic profile:** Brief idea about the computational software's for drawing, visualization and simulation of small and large molecules. Basic concept of Chemoinformatics, 3D-Structure file system and Databases.	15
III	**Brief introduction about Quantum Mechanics & Molecular Mechanics:** Molecular Orbital Theory, The Hartree-Fock method, ab-initio calculation, Semi-empirical methods, Huckel theory, Valence bond theories, Force Field, Geometrical Parameters, Density Functional Theory. **Non-covalent Parameters:** understanding of electrostatic interactions, van der Waals interaction, Hydrogen bonding, hydrophobic interactions .	15
IV	**Computer simulation methods:** Minimization, Molecular dynamics, Monte Carlo Simulations, Simulated Annealing, Conformational Search and Conformational Analysis, Understanding of iterations, convergence, protocols and algorithm such as steepest descents, conjugate gradient etc.	15

Book Recommended

1.*Computational Chemistry, Introduction to Theory and Application of Molecular and Quantum Mechanics* By Errol Lewars, Springer

2. *Molecular Modelling: Principle and Application, 2nd Ed.* By Andrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106.

(SEMESTER IX) PAPER IIIc
NANOSCIENCE AND NANOTECHNOLOGY - I

Programme: M.Sc. in Physics	Year: Fifth	Semester : Ninth
Course Code: PYME 506	Course Title : Nanoscience and Nanotechnology - I	

Course Objectives:
The course is so designed that student will acquire basic understanding of advanced materials, their functions and properties for technological applications.

Student Learning Outcomes:
The students will learn about
1. Background to nanoscience and nanotechnology
2. Properties of nanomaterials:
3. Nanoporous materials

Structure, synthesis and electronic application to Graphene.

Credits: 4	Elective Paper

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topic	No of Lectures
I	**Background to nanoscience and nanotechnology:** nano sized effects, surface to volume ratio, atomic structure, energy at the nanoscale, molecular and atomic size -quantum effects- types of nanotechnology and nano machines	15
II	**Properties of nanomaterials:** classification of nanocrystals, dimensionality and size dependent phenomena, Quantum dots, Nanowires and Nanotubes, 2D films, importance of the nanoscale materials and their devices, size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity.	15
III	**Nanoporous materials:** Nature of carbon clusters, discovery of C60 structures, Fullerenes, chemical and physical properties, spices of fullerenes, term and nomenclature, geometry of fullerenes-general, 5/6 Fullerenes, introduction to carbon nanotubes, carbon nanotubes and related structures, single walled carbon nanotubes (SWNTs), chirality, multi walled carbon nanotubes (MWNTs).	15
IV	**Graphene:** structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide.	15

Book Recommended

1. *Nanostructures & Nanomaterials: Synthesis, Properties &Applications* by G. Cao, Imperial College Press, 2004.
2. *Nanomaterials, Nanotechnologies and Design*:*An introduction for engineers and Architects* by Micheal F. Ashby, P.J. Ferreria, D.L. Schodek,
3. *Intoduction to Nanotechnology* by Charles P Poole & Frank J. Ownes.
4. *Physical properties of Carbon Nanotube* by R Satio.
5. *Applied Physics Of Carbon Nanotubes: Fundamentals Of Theory, Optics And Transport Devices*by S. Subramony & S.V. Rotkins.
6. *Carbon Nanotubes: Properties and Applications* by Michael J. O'Connell.
7. *Nanotubes and Nanowires* by CNR Rao and A Govindaraj, RCS Publishing.
8. *Nanoscale materials* by Liz Marzan and Kamat.

(SEMESTER- IX) PAPER IV
PRACTICAL

Programme: M.Sc. in Physics	Year: Fifth	Semester : Ninth
Course Code: PYMP 507		**Course Title : Practical**

Course outcomes

Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Credits: 4	Practical

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

List of Experiments

List of Experiments

General

[1] Numerical Integration
[2] Solution of H-atom problem
[3] To determine the g-factor using ESR spectrometer

Electronics

[1] To determine the output characteristics of LDR
[2] To draw the V-I characteristics of LED
[3] To draw a V-I characteristics of solar cell and to determine its maximum output and fill factor.
[4] To determine the energy gap and resistivity of the semiconductor using four probe method.
[5] To construct theFlip flop circuits and verify their truth table
[6] To study the V-I characteristics of UJT.
[7] To design the A to D and D to A convertor and verify its truth table

Nano Science & Nano Technology

[1] Thin film fabrication using spin coating unit
[2] Determination of concentration of unknown solution through UV-Vis spectrophotometer: Verification of Beer-Lambert's law
[3] Determination of Bandgap using ORIGIN software
[4] Green Synthesis of Nanoparticles like ZnO, Ag, Fe etc.
[5] To determine the surface parameters of AFM images using offline SPM software.
[6] Geometry optimization and frequency calculation using Gaussian program
[7] Drawing and visualization of small molecules using Chem Draw software

(SEMESTER IX) PAPER V
RESEARCH PROJECT

Programme: M.Sc. in Physics	Year: Fifth	Semester : Ninth
Course Code: PYMP 508		**Course Title : Research Project**

This course will provide you with guidance and support throughout the writing of your dissertation. From discussing your initial ideas of your dissertation through the process of actually writing the document, this course will provide you with the information and support required from both the teaching staff and your allocated dissertation supervisor.

(SEMESTER X) PAPER I

NUCLEAR PHYSICS

<table>
<tr><td colspan="2">Programme: M.Sc. in Physics</td><td>Year: Fifth</td><td>Semester : Tenth</td></tr>
<tr><td colspan="2">Course Code: PYMC 509</td><td colspan="2">Course Title : Nuclear Physics</td></tr>
<tr><td colspan="4">Course Objectives: The course is so designed that student will acquire basic understanding of nuclear physics.
Student Learning Outcomes: The student will learn about:
1. Forces acting between the nucleons
2. Nuclear disintegrations and decays
3. Various Nuclear Models to understand nuclear interaction.
4. Idea of Elementary particles, the constituents of matter.</td></tr>
<tr><td colspan="2">Credits: 4</td><td colspan="2">Core Paper</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="2">Topic</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Nuclear Forces and Nuclear Reactions: Deuteron problem, Spin dependence and non-central feature of nuclear forces, Meson theory, scattering length, effective range theory.
Nuclear reaction and their types, Q-equation, reaction cross section, partial wave analysis, Compound reaction mechanism, Level width, Nuclear resonances and single level Breit Winger formula.</td><td>15</td></tr>
<tr><td>II</td><td colspan="2">Radioactive decays: Alpha decay and Gamow's theory, Beta decay-Concept of neutrino and its detection, Fermi theory, Selection Rules, Allowed and forbidden transitions, Non-conservation of parity and Wu's experiment, Gamma decay: Multiple transitions selection rules, Idea of internal conversion, nuclear isomerism.</td><td>15</td></tr>
<tr><td>III</td><td colspan="2">Nuclear Models: Shell model, Evidence of shell structure, Magic numbers, Spin-orbit coupling, Extreme single particle model, Predictions of spin, parity and magnetic moments, Collective model- Vibrational and rotational spectra.</td><td>15</td></tr>
<tr><td>IV</td><td colspan="2">Elementary particles: Classification of elementary particles, Types of interactions between elementary particles, Exact conservation laws, Approximate conservation laws-Isospin, parity, strangeness, charge conjugation, time reversal, CP violation, CPT theorem, SU(3) classification of particles and resonances, Quark flavor and color, Quark structure of hadrons.</td><td>15</td></tr>
<tr><td colspan="4">Book Recommended
1. Nuclear Physics by Irving Kaplan, Narosa (2002).
2. Nuclear Physics by S.N. Ghoshal, S. Chand Publisher (1994).
3. Concepts of Nuclear Physics by B.L. Cohen, Tata Mcgraw Hill Education Private Limited (2005).
4. Elementary Nuclear Theory by H.A. Bethe, John Wiley (1947)
5. Introductory Nuclear Physics by Samuel S. M. Wong, Wiley-VCH; 2ndedition (1999)
6. Theoretical Nuclear Physics by John M. Blatt and V. F.Weisskopf, Dover (10/2010).
7. Basic Ideas and Concepts in Nuclear Physics, An Introductory Approach by Kris L. G. Heyde, Taylor& Francis Group (2004).
8. Quarks and Leptons by F. Halzenand A.D. Martin, John Wiley (1983).
9. Introduction to Elementary Particles by David J. Griffiths, Wiley (2008).
10. Theory of Nuclear Structure by M. K. Pal, EWP (1982).</td></tr>
</table>

(SEMESTER X) PAPER IIa

ELECTRONICS – II

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Tenth**
Course Code: PYME 510	**Course Title : Electronics - II**	

Course Objectives:

The course is so designed that student will acquire more understanding of advanced electronics.

Student Learning Outcomes:

They will learn about:

1. Modulation techniques
2. Noise
3. Microwave Devices
4. Radar Systems & Satellite Communications

Credits: 4	**Elective Paper**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	**Topic**	**No of Lectures**
I	**Modulation techniques**: Amplitude modulation- generation of AM wave, demodulation of AM waves DSBSC modulation, generation of DSBSC waves, coherent detection of DSBSC waves, SSB modulation, generation and detection of SSB waves, Principle of super-hetrodyne receiver, frequency modulation & spectrum, FM using varactor diode, Armstrong method of FM, frequency stabilization, Pulse amplitude modulation, Sampling theorem-pass and band-pass signals, channel BW for a PAM signal, delta modulation.	15
II	**Noise:** Mathematical representation of noise, sources of noise, frequency domain representation of noise, effect of filtering on the probability, density of Gaussian noise, spectral component of noise, effect of a filter on the power spectral density of noise, superposition of noise, mixing involving noise, linear filtering, noise bandwidth.	15
III	**Microwave Devices**: Klystrons, magnetrons and traveling wave tubes, velocity modulation, basic principles two cavity klystrons and reflex klystrons, principles of operation of magnetrons, Helix traveling wave tubes, wave modes, transferred electron devices, gunn effect, principle of operations, read diode, IMPATT and TRAPATT diode, Advantage and disadvantage of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation.	15
IV	**Radar Systems & Satellite Communications**: Radar block diagram of an operation, radar frequencies, pulse considerations, radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, integration of radar pulses, radar cross section, pulse repetition frequency, antenna parameters, system losses and propagation losses, radar transmitters, receivers, antenna displays, Satellite communication, orbital satellites, geostationary satellites, orbital patterns, look angles, orbital spacing, satellite systems, link modules.	15

Book Recommended

1. *Communication System* by Symen Haykins.
2. *Digital principles and applications* by A P Malvino and Donald P Leach Tata McGraw Hill comp, New Delhi, (1993).

3. *Communication System* by B P Lathi. 4.*Principles of Electronics* by V.K. Mehta**.** 5. *Handbook of Electronics* by Gupta and Kumar. 6. *Basic Electronics* by B.L. Theraja

(SEMESTER-X) PAPER IIb
CONDENSED MATTER PHYSICS - II

<table>
<tr><td colspan="2">Programme: M.Sc. in Physics</td><td>Year: Fifth</td><td>Semester : Tenth</td></tr>
<tr><td colspan="2">Course Code: PYME 511</td><td colspan="2">Course Title : Condensed Matter Physics –II</td></tr>
<tr><td colspan="4">Course Objectives:
The course is so designed that student will acquire more understanding of advanced condensed matter physics.
Student Learning Outcomes:
The students will learn about the transport properties of solids, some more idea about superconductivity and material characterization techniques like SEM, TEM , XRD, AFM, LEED, AES.</td></tr>
<tr><td colspan="2">Credits: 4</td><td colspan="2">Elective Paper</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="2">Topic</td><td>No of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Transport Properties: Linearized Boltzmann transport equation, Electrical conductivity, Relaxation time, Impurity scattering, Ideal resistance, Carrier mobility, General transport coefficient; Thermal conductivity, Thermoelectric effects, Lattice conduction, Phonon drag, Hall effect and magnetoresistance.</td><td>15</td></tr>
<tr><td>II</td><td colspan="2">Superconductivity: Basic features (Zero resistance, Meissner effect, Penetration depth, Critical field, Heat capacity and isotopic shift) of superconductors, Soft and hard superconductors; Thermodynamics of superconducting transitions, Electron-electron interaction and screening, electron-phonon-electron interaction and Cooper pairs, Salient features of BCS theory, Superconducting ground state, Quasi particle and energy gap, High temperature superconductor.</td><td>15</td></tr>
<tr><td>III</td><td colspan="2">Mossbauer Effect: Difficulties in observing resonance fluorescence of nuclear system, Recoil energy, Natural and dipole broadenings, Classical and quantum theories of Mossbauer effect, experimental method and principal uses of Mossbauer effect.</td><td>15</td></tr>
<tr><td>IV</td><td colspan="2">Materials Characterization Techniques: Techniques: X-Ray Diffraction (XRD),Scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), scanning tunneling microscopy (STM), XPS, Fourier Transform Infrared Spectroscopy (FTIR), Ultraviolet-VISIBLE Infrared Spectroscopy (UV-IR), Raman Spectroscopy, Low Energy Electron Diffraction (LEED) and Auger Electron Spectroscopy (AES), Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential scanning calorimetry (DSC).</td><td>15</td></tr>
<tr><td colspan="4">Book Recommended
1. Introduction to Solid State Physics by C. Kittel.
2. Solid State Physics by S.O. Pillai.
3. Solid State Physics by A.J. Dekker.
4. Condensed Matter Physics by M.P. Marder.</td></tr>
</table>

5. *Principles of the Theory of Solids* by J.M. Ziman.
6. *Solid State Physics* by N.W. Ashcroft and N.D. Mermin.
7. *Solid State Physics (Part-I): Transport Properties of Solid* by M.S. Dresselhaus.
8. *Solid State Physics-Structure and Properties of Materials* by M.A. Wahab.
   Principles of Condensed Matter Physics by P.M. Chaikin and T.C. Lubensky.

(SEMESTER X) PAPER IIIa

BIO PHYSICS - II

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Tenth**
Course Code: PYME 512	**Course Title : Bio Physics - II**	
Course Objectives: The course is so designed that student will acquire more understanding of biophysics. **Student Learning Outcomes:** The students will learn about radiation biophysics, photo biophysics, intermolecular interaction, X-ray methods and some idea about sedimentation, chromatography, and electrophoresis.		
Credits: 4	**Elective Paper**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topic	No of Lectures
I	**Radiation Biophysics**: Types of ionic radiations, interaction between radiation and matter. Radiation dose and dose rate, radiation effect on living cell, protein, nucleic acid and membrane. Radiation hazards and radiation protection. Photo biophysics: chemical structure and properties of chlorophyll, mechanism of photosynthesis, photochemical systems: PS-I and PS-II, Importance of photosynthesis.	15
II	**Intermolecular Interactions**: Intermolecular potential functions, Rayleigh-Schrodinger perturbation theory of long-range intermolecular interactions, classification of intermolecular forces, concept of short –range forces and inadequacy of Rayleigh-Schrodinger treatment at short range. Representation of short-range forces by classical and semi-empirical methods. Equivalence of classical and quantum-mechanical forces, Multi centred-multipole representation of intermolecular interactions.	15
III	**X-ray methods**: Basic principle of X- ray diffraction, structure factor, Analysis of Laue, Rotation and Powder photographs. NMR: Basic theory of Nuclear Magnetic Resonance, Chemical shift and spin-spin coupling, relaxation effect, NMR spectrometers and FT spectroscopy, Applications.	15
IV	**ORD and CD**: Basic concept of circular dichroism and optical rotation, Drude equation, Molecular basis of rotator power, Rotatory behavior of macromolecules, Moffit plots for helical and random coil structure. Sedimentation: Sedimentation velocity, apparatus and procedures for sedimentation studies, sedimentation equilibrium, Archibald method; Density ingredient sedimentation. **Electrophoresis**: Transport in an electric field, isoelectric focusing, orientation of molecules in electric fields. **Chromatography**: Basic idea of Molecular-Sievechromatography, Gelfiltration, analysis of the shape of eluting bands; Determination of shape	15

	and size of macromolecules.	

Book Recommended

1. *Molecular Biology of the Genes* by J. D. Watson (Benjamin Inc, California).
2. *Principles of Nucleic Acid Structure* by W. Saenger (Springer Verlag, New York).
3. *Biophysics;* Ed. W. Hoppe et. al., (Springer Verlag, New York).
4. *Introduction to Biophysics* by P.S. Narayanan.
5. *Biophysics* by M. V. Volkenstein (MIR publishers).
6. *Biophysics* by V. Pattabhi & N. Gauttam.
7. *Intermolecular Interactions: From Diatomics to Biopolymers*, Ed. B. Pullman (John Wiley, N. Y.).
8. *Physical Biochemistry* by K. E. van Holde, (Prentice Hall, N, J.).

(SEMESTER X) PAPER IIIb
MOLECULAR MODELING - II

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Tenth**
Course Code: PYME 513	**Course Title : Molecular Modeling - II**	

Course Objectives:
The course is so designed that student will acquire more understanding of molecular modeling.

Student Learning Outcomes:
The students will learn about the perturbation theory, density functional theory, Coupled Cluster Calculations, extrapolation to Chemical Accuracy, and Quantum Monte Carlo Methods and the Representation of Electronically Excited States.

Credits: 4	**Elective Paper**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	**Topic**	**No of Lectures**
I	**Perturbation Theory:** First-Order Correction to a Nondegenerate Reference System, Second-Order Correction—Nondegenerate Case, The Morse Potential, The Degenerate Case, Perturbation Theory in Approximate MO Theory, MP2 as Perturbation Theory, Time-Dependent Perturbation Theory, Time-Dependent Perturbation Theory for Charged Particles in the Electromagnetic Field.	15
II	**Density Functional Theory:** The Size Consistency Issue in CC and CI, Beyond CCSD, Performance of CCSD(T), Thermochemical Standards by Quantum Chemistry, Aspiration to Exact Description: Quantum Monte Carlo Calculations.	15
III	**Highly Accurate Methods: Coupled Cluster Calculations, Extrapolation to Chemical Accuracy and Quantum Monte Carlo Methods:** John Perdew's Ladder, Early Forms of Density Functional Theory: Gill's History, Thomas–Fermi–Dirac Theory, The Hohenberg–Kohn Existence Theorem, Kohn–Sham Procedure for Finding the Density.	15
IV	**The Representation of Electronically Excited States:** CI-Singles, Practical Use of the CIS Equations, Singlet and Triplet State Energies for the 1G Model, Structural Relaxation in the Excited State, Correlation Corrections, Time-Dependent Hartree–Fock Treatments of Excitations.	15

Book Recommended

1. Computational Chemistry, Introduction to Theory and Application of Molecular and Quantum

Mechanics. By Errol Lewars, Springer 2. Molecular Modelling: Principle and Application, 2nd Ed. By Andrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106. 3. Electronic Structure, Modeling: Connections Between Theory and Software by Carl Trindle and Donald Shillady.

(SEMESTER X) PAPER IIIc
NANOSCIENCE AND NANOTECHNOLOGY – II

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Tenth**
Course Code: PYME 514	**Course Title : Nanoscience and Nanotechnology – II**	
Course Objectives: The course is so designed that student will acquire more understanding of nano science and nanotechnology. **Student Learning Outcomes:** The students will learn about the synthesis, characterization and application of nanoparticles.		
Credits: 4	**Elective Paper**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topic	No of Lectures
I	**Methods of synthesis of nanoparticle:** Critical issues for nanostructure synthesis and assembly, nanomaterial synthesis strategies. Physical Methods: Ball milling, sonication, low temperature combustion synthesis (LCS) method: principle, typical process, process control Physical vapor deposition: introduction to deposition and growth, langmuire-knudsen relation, mass evaporation rate, thickness deposition rate, kundsen cell, directional distribution of evaporating species, evaporation of elements, compounds, alloys, Raoult's law, e beam, pulsed laser and ion beam evaporation, glow discharge and plasma, sputtering mechanism and yield, dc and rf sputtering, hybrid and modified PVD-ion plating, reactive evaporation.	15
II	**Chemical Methods** Sol-gel technique, solvo thermal methods, control of grain size, co-precipitation hydrolysis, sono chemical method combustion technique, colloidal precipitation template process, growth of nanorods, solid-state sintering, Electrodeposition, Arc method	15
III	**Characterization of nanomaterials:** Introduction to spectroscopy, Basic principles and applications of UV-Vis-NIR, FTIR, FT-Raman, Photoluminescence, NMR, X-ray powder diffraction, Ellipsometry-thickness measurements, transmission electron spectroscopy, scanning Electron Spectroscopy, X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, EDAX and WDA analysis	15
IV	**Applications of nanostructured materials:** Humidity sensors, gas sensor-LPG, Hydrogen, Nitrogen and CO2, Organic photovoltaic cell cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Organic- Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, biomedical applications in drug delivery system Ballistic electron transport and coherence, coulomb blockade and quantum transport, single electron transport (SET)	15
Book Recommended 1. *Introduction to Nanoscience and Nanotechnology* by Gabor.L et al. 2. *Elements of X-ray Diffraction* by B. D. Cullity, Addison Wesley, 1977.		

3. *Transmission Electron Microscopy: A Textbook for Materials Science* by David B Williams, C Barry Carter, (1996) Plenum Press, New York.
4. *Impedance Spectroscopy: Theory, Experiment, and Applications* by E. Barsoukov and J. Ross Macdonald (Editors) (2000) John Wiley & Sons (P)Ltd.
5. *Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers* by Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsevier, 2009.
6. *Nanostructures & Nanomaterials: Synthesis, Properties & Applications* by G. Cao, Imperial College Press, 2004.
7. *Nanomaterials: An introduction to synthesis, properties and application* by Dieter Vollath, WILE-VCH, 2008.

(SEMESTER- X) PAPER IV
PRACTICAL

Programme: M.Sc. in Physics	**Year: Fifth**	**Semester : Tenth**
Course Code: PYMP 515	**Course Title : Practical**	
Course outcomes Experimental physics has the most striking impact on the industry wherever the components / instruments are used for semiconductor/electronic systems. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.		
Credits: 4	**Practical**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
List of Experiments		

List of Practical
General:

1. To determine Planck's Constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colours.
2. To determine the value of energy levels using Frank-Hertz experiment
3. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
4. To determine the curie temperature of Ferrites.

Electronics:

1. To study the amplitude Modulation.
2. To demodulate an amplitude modulated wave and to study the output signal.
3. To study the frequency modulation of a carrier.
4. To study the Pulse modulation.

Nanoscience & Nanotechnology:

1. Determination of energy Band gap of semiconductor by Photoluminescence spectroscopy
2. Synthesis of ZnO by co precipitation method and determination of Bandgap and particle size through UV-Vis spectrophotometer
3. Synthesis of TiO_2 nanoparticles by Sol gel method and determination of Bandgap and particle size through UV-Vis spectrophotometer
4. Synthesis of metal nanoparticles by hydrothermal and determination of Bandgap and particle size through UV-Vis spectrophotometer
5. Synthesis of nanoparticles by solvothermal method and determination of Bandgap and particle size through UV-Vis spectrophotometer

6. Synthesis of nanomaterials by colloidal precipitation method and determination of Bandgap and particle size through UV-Vis spectrophotometer

(SEMESTER X) PAPER V

RESEARCH PROJECT

Programme: M.Sc. in Physics	Year: Fifth	Semester : Tenth
Course Code: PYMP 516		**Course Title : Research Project**
This course will provide you with guidance and support throughout the writing of your dissertation. From discussing your initial ideas of your dissertation through the process of actually writing the document, this course will provide you with the information and support required from both the teaching staff and your allocated dissertation supervisor.		