DEPARTMENT OF PHYSICS

Vision

Imbibing the spirit of the Holy Cross, the institution envisions a harmonious society by empowering women for global competency and ecological sustainability through holistic approach with innovative skills.

Mission

- To provide quality education and to promote scholarly activities catering to global competencies
- To nurture participatory leadership to enhance social consciousness and socialResponsibility
- To uphold ethical values of honesty, personal accountability and transparency throughprofessional commitment
- To create global professionals and entrepreneurs with innovative spirit and zeal
- To create empowered women of competence, commitment and compassion.
- To instill in students the awareness of interconnectedness between man and nature

Programme Educational Objectivities (PEOs)

PEO – 1	The graduates use scientific and computational technology to solve social issues and pursue research.
PEO– 2	The graduates will continue to learn and advance their careers in industry both in public and private sectors, government and academia.
PEO– 3	The graduates adapt to the evolving technical challenges and changing career opportunities and communicate effectively as an individual and as a team member in professional environment.

Programme Outcomes (POs)

PO	**Upon completion of M.Sc Degree Programme, the graduates will be able to :**
PO – 1	Recognize the scientific facts behind natural phenomena.
PO – 2	Relate the theory and practical knowledge to solve the problems of the society.
PO – 3	Prepare successful professionals in industry, government, academia, research, entrepreneurial pursuits and consulting firms.
PO – 4	Face and succeed in high level competitive examinations like NET, GATE and TOEFL.
PO – 5	Carry out internship programme and research projects to develop scientific skills and innovative ideas.
PO – 6	Utilize the obtained scientific knowledge to create eco– friendly environment.
PO – 7	Prepare expressive, ethical and responsible citizens with proven expertise.

Programme Specific Outcomes (PSOs)

PSO	**Upon completion of M.Sc. Degree Programme, the graduates of Physics will be able to :**
PSO – 1	Have well– defined knowledge on theoretical concepts and experimental methods of advanced physics. (Classical mechanics, Mathematical physics, Quantum Mechanics, Solid state Physics, Molecular Spectroscopy, Integrated electronics, Astrophysics, Nanophysics, Microprocessor etc.)
PSO – 2	Acquire skills in performing advanced physics experiments and projects using modern technology and numerical simulations.
PSO – 3	Develop and communicate analytical skills ranging from nuclear to cosmology to progress in the expanding frontiers of physics.
PSO – 4	Apply and interpret physics principles in various physical observations.
PSO – 5	Use the techniques, skills, and modern technology necessary to communicate effectively with professional and ethical responsibility.
PSO – 6	Demonstrate proficiency in analyzing, applying and solving scientific problems.
PSO – 7	Understand the impact of Physics in a global, economic, environmental, and societal context.

Eligibility Norms for Admission

A pass in the B.Sc Physics as major with the minimum of 50% in major and major related courses or equivalent examination as per the norms of Manonmaniam Sundaranar University,Tirunelveli. For SC / ST candidates a pass in B.Sc. Physics is sufficient.

Duration of the Programme : 2 years

Medium of Instruction : English

Passing minimum

A minimum of 50% in the external examination and an aggregate of 50% is required. There is no minimum pass mark for the continuous internal assessment.

Components of the M.Sc. Programme

Major	Core– Theory papers	11x100	1100
	Practical (Core Applied)	4x 100	400
Elective	Elective– Theory Papers/ Project	5x 100	500
	Total Marks	**20x100**	**2000**

Course Structure Distribution of Hours and Credits

Course	**Sem. I**	**Sem. II**	**Sem. III**	**Sem. IV**	**Total**	
					Hours	**Credits**
Major Core – Theory	6 (5) + 6 (5) + 6 (5)	6 (5) + 6 (5) + 6 (5)	6 (5) + 6 (5)	6 (5) + 6 (5) + 6 (5)	66	55
Major Core – Practical	6	6 (3+3)	6	6 (3+3)	24	12
Major Elective	6 (4)	6 (5)	6 (4)	6 (5)	24	18
Major Project	–	–	6 (5)		6	5
Total	**30(19)**	**30 (26)**	**30 (19)**	**30 (26)**	**120**	**90**
Non Academic Courses						
Life Skill Training – I	–	(1)	–	–	–	1
Life Skill Training – II	–	–	–	(1)	–	1
Service– Learning Programme (SLP) – Community Engagement Course		–	(2)	–	–	2
Summer Training Programme	–	–	–	(1)	–	1
TOTAL		**(1)**	**(2)**	**(2)**	–	**5**

- Non Academic Courses are mandatory and conducted outside the regular workinghours
- **SLP (Service Learning Programme) – Community Engagement Course is** conducted outside the regular working hours on Saturdays and holidays, during the II and III Semesters for all the PG students. No. of hours allotted for eachof this

programme is 30 and is supervised by the faculty in charge

- **STP (Summer Training Programme)** (Mandatory Course – 30 hours) will be offered in the second year for all the students.

Courses offered

Semester	Course code	Title of the Course	Hours/ Week	Credits
I	PP2011	Core I – Classical Mechanics	6	5
	PP2012	Core II – Mathematical Physics	6	5
	PP2013	Core III – Quantum Mechanics– I	6	5
	PP2014 PP2015 PP2016	Elective I – (a) Advanced Nuclear Physics (b) Molecular Physics (c) Numerical methods	6	4
	PP20P1	Practical I – Advanced Physics Lab – I (General Physics)	3	–
	PP20P2	Practical II – Advanced Physics Lab – II(Programming with C++)	3	–
	LST201	Life Skill Training (LST) – I	–	–
II	PP2021	Core IV – Electromagnetic Theory	6	5
	PP2022	Core V – Quantum Mechanics– II	6	5
	PP2023	Core VI – Condensed MatterPhysics– I	6	5
	PP2024 PP2025 PP2026	Elective II – (a) Experimental design (b)Introductory Astronomy, Astrophysics & Cosmology (c) Laser Physics	6	5
	PP20P1	Practical I – Advanced Physics Lab – I (General Physics)	3	3
	PP20P2	Practical II – Advanced Physics Lab – II (Programming with C++)	3	3
	LST201	Life Skill Training (LST) – I	–	1
	SLP201	SLP (Service Learning Programme) – Community Engagement Course	–	–
III	PP2031	Core VII – Electronics	6	5
	PP2032	Core VIII – Condensed MatterPhysics– II	6	5
	PP20PR	Project	6	5
	PP2033 PP2034 PP2035	Elective III – (a) Biophysics (b) Microprocessor and Microcontroller (c) Solar Energy Utilization	6	4
	PP20P3	Practical III– Advanced Physics Lab – III (Electronics)	3	–

	PP20P4	Practical IV – Advanced Physics Lab – IV (Microprocessor and Micro Controller)	3	–
	LST202	Life Skill Training (LST) – II	–	–
	SLP201	SLP (Service Learning Programme) – Community Engagement Course	–	2
IV	PP2041	Core IX – Nuclear and Elementary Particle Physics	6	5
	PP2042	Core X – Spectroscopy	6	5
	PP2043	Core XI – Thermodynamics and Statistical Mechanics	6	5
	PP2044 PP2045 PP2046	Elective IV – (a)MaterialsPhysics and Processing Techniques (b) Advanced Nanophysics (c) X– ray Crystallography	6	5
	PP20P3	Practical III– Advanced Physics Lab – III(Electronics)	3	3
	PP20P4	Practical IV – Advanced Physics Lab – IV (Microprocessor and Micro Controller)	3	3
	LST202	Life Skill Training (LST) – II	–	1
	STP201	Summer Training Programme	–	1
		TOTAL	**120**	**90+5**

Self– Learning Courses– Extra Credit Courses

Semester	Cours eCode	Title of the Course	Credits
III	PP20S1	Physics for Lectureship Examination – I	2
IV	PP20S2	Physics for Lectureship Examination – II	2
II– IV	–	Online courses (Swayam/NPTL)	2

Question Pattern (Self– Learning Courses)

Internal Test	Marks	External Exam	Marks
Part– A(10x1) (No Choice– simple objective type)	10	Part– A(20x1) (No Choice– simple objective type)	20
Part B (5x2) (No Choice objective type)	10	Part B (10x2) (No Choice objective type)	20
Part C(5x4) (No Choice objective type) Higher order thinking skills	20	Part C(5x4) (No Choice objective type) Higher order thinking skills	20
Total	**40**	**Total**	**60**

Summer Training Program

Semester	Name of the Course	Total hours	Credit
III/IV	Computer Hardware –H20STP	30	1

Internal Component

Component	Marks
Assignment	20
Summer Training Program Attendance	30
Total	**50**

External Component

Course	Summative Examinations	Marks
Summer Training Program	Project report (15– 20 pages print)	**50**
	Total	**50**

Instruction for Course Transaction Theory (Major Core / Elective)

Component	**Sem. I**	**Sem. II**	**Sem. III**	**Sem. IV**
Lecture hours	70/55	70/55	70/55	70/55
Continuous Internal Assessment (2)	5	5	5	5
Quiz (2)	1	1	1	1
Class Test (2)	2	2	2	2
Seminar	10	10	10	10
Problem solving/Open book test/ Group Discussion	2	2	2	2
Total hours / semester	**90/75**	**90/75**	**90/75**	**90/75**

Practical Hours

Major	**Semester**	**Hours per week**	**Total Hours / Semester**
	I / II / III /IV	6	90

Examination Pattern :

Allotment of Marks for PG Programme Ratio of Internal and External (Core/Elective): 40:60

(a). Major / Elective

Internal: External – 40:60

Components	Allotment of Marks	
	Internal	**External**
Core & Elective Courses Theory Papers	40	60
Practicals	40	60
Project	40	60
Life Skill Training (I & II)	50	50

- Each paper carries an internal component.
- There is a passing minimum for external component.

Internal Component and Distribution of marks

Continuous Internal Assessment

Formative Assessment (FA)	Marks
Internal Test (2)	20
Quiz (2)	4
Class Test (2)	4
GD/Open Book test/ Article Review/ Book Review	4
Seminar	4
Online Home Assignment	4
Total	**40**

Question Pattern (Major / Elective)

Internal Test	Marks	External Exam	Marks
Part A(4x1) (No Choice)	4	Part A(10x1) (No Choice)	10
Part B (5x3) (Internal Choice)	15	Part B (5x3) (Internal Choice)	15
Part C(3x7) (Internal Choice)	21	Part C (5x7) (Internal Choice)	35
Total	**40**	**Total**	**60**

(b) Practical Papers:

Internal – 40 marks (Model exam 15, performance– 10, regularity– 5, submission of record– 10)

External – 60 marks (Marks will be allotted as per the practical syllabus)

c) Project

Ratio of Internal and External 40 : 60

Internal (Supervisor)	Marks
I Review	10
II Review	10
Report	20
External (External Examiner)	
Report	40
Viva-voce (individual, open viva-voce)	20
Total	**100**

d) Foundation Course

Life Skill Training– I (I Year)

Internal Component

Component	Marks
Album (20 pages)	40
Group Song, Mime, Skit(Groupof 5 students)	20
Total	**60**

External Component

Course	Summative Examinations	Marks
Life Skill Training– I	Questions are of open choice. Students must answer 5 out of 7 questions. Each question carries 8 marks (5x8=40 marks)	**40**
	Total	**40**

Life Skill Training– II (II Year)

Internal Component

Component	**Marks**
Case Study (30 page)	60
Total	**60**

External Component

Course	**Summative Examinations**	**Marks**
Life Skill Training– II	Questions are of open choice. Students must answer out of 7 questions. Each question carries 8 marks (5x8=40 marks)	**40**
	Total	**40**

Community Engagement Programme– SLP Extension Activity (II & III sem)

Courses / Programmes conducted outside the regular working hours on Saturdays and holidays.

No. of hours allotted for each of these programmes is 30 and is supervised by the faculty in charge. Field work : 15 hours; Class hours: 15 hours

Internal Component

Component	**Marks**
Assignment	10
Group Discussion	10
Field work Attendance	30
Total	**50**

External Component

Course	Summative Examinations	Marks
Community Engagement Programme	Project report/ Case study (10– 15 pages print)	**50**
	Total	**50**

Semester I

Classical Mechanics (Core – I)

Course Code: PP2011

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. To have in depth knowledge in classical mechanics.
2. To enable students to develop skills in formulating and solving physics problems.
3. To study the kinematics of the rigid body through Euler equation.
4. To get knowledge in central force field and relativity.

CO	Upon completion of this course, students will be able to:	CL
CO – 1	understand the basic mechanical concepts related to single and system of particles.	U
CO – 2	apply various mechanical principles to find solution for physical problems.	Ap
CO – 3	solve the equations of motion using Lagrangian, Hamiltonian and Hamilton– Jacobi equations.	C
CO – 4	explain the origin of coriolis and centrifugal terms in the equation of motion in a rotating frame.	R
CO – 5	understand and develop a scientific knowledge in central force problems and relativity	U

Unit I: Lagrangian Formulation 15 hours

Lagrangian formulation: System of particles – Constraints and degrees of freedom– Generalized coordinates, Force and Energy – Conservation laws – Conservations of linear and angular momenta – Symmetric properties – Homogeneity and isotropy – D'Alemberts principle of virtual work- Lagrange's equation of motion – non holonomic systems – velocity

dependent potential – Dissipative force – Newtonian and Lagrangian Formalism

Unit II: Hamilton's Equation and Canonical Transformation 15 hours

Calculus of variation – Principle of least action – Hamilton's principle – Hamilton`s function- Lagrange's equation from Hamilton's principle – Hamilton's principle for non holonomic system – Variational principle – Hamilton's equations from variational principle – Legendre transformation and Hamilton's equation of motion – Canonical transformations– Hamilton's canonical equations – Generating functions– Examples – Poisson brackets and its properties.

Unit III: Hamilton– Jacobi Theory and Small Oscillations 15 hours

Hamilton– Jacobi equation for Hamilton's principle function – Example: Harmonic oscillator problem – Hamilton's characteristic function – Action – Angle variable – Application to Kepler problem in action angle variables. Eigen value equation – Normal coordinates – Normal frequencies of vibration – Free Vibrations of linear tri atomic molecule.

Unit IV: Kinematics of Rigid Body 15 hours

Independent coordinates of rigid body – Orthogonal transformation – Properties of transformation matrix – Euler angle and Euler's theorem – Infinitesimal rotation – Coriolis force – Angular momentum and kinetic energy of motion about a point – Moment of inertia tensor – Euler's equations of motion – Force free motion of a symmetrical top – Heavy symmetrical top with one point fixed

Unit V: Central Force Problem and Theory of Relativity 15 hours

Reduction to the equivalent one body problem– Centre of mass– Equation of motion and first integral– classification of orbits – Kepler problem: Inverse– Square law of force – Scattering in a central force field – Transformation of scattering to laboratory coordinates. Virial theorem – Lorentz transformation – Relativistic Mechanics – Relativistic Lagrangian and Hamiltonian for a particle – Mass in Relativity – Mass and energy – Space– time diagram – Momentum vectors

Skill Development

1. Making the students to go for industrial visit on Priyadharshini Planetarium, TVM and also the scientific centre, Bangalore, so that they are able to create skills in Mechanics.
2. By applying the Lagrangian, Hamilton and Hamilton– Jacobi equations, the students are able to solve the equations of motion.

Books for Study

1. Classical Mechanics – H. Goldstein, C. Poole and J. Safko, Pearson Education in SouthAsia, New Delhi, Third Edition, 2007.
2. Classical Mechanics – G. Aruldhas, PHI Learning Private Limited, New Delhi, 2009.

Books for Reference

1. Classical Mechanics – S. L. Gutpa, V. Kumar and H.V. Sharma, Pragati Prakashan, Meerut, 2016.
2. Classical Mechanics of Particles and Rigid Bodies – K.C. Gupta, New Age International Publishers, New Delhi, Third Edition, 2018.
3. Classical Mechanics – N. C. Rana and P. J. Joag, Tata Mc– Graw Hill Publishing Company Limited, New Delhi, 2004.
4. Classical Mechanics – J. C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore, Second Edition, 2017.
5. Classical Mechanics, B. D. Gupta and Satya Prakash, Keder Nath Publishers, Meerut, Revised Edition, 2015.
6. Introduction to Classical Mechanics, R. G. Takwale and P. S. Puranik, Tata Mc Graw Hill, New Delhi, 1989.

Semester I

Mathematical Physics (Core – II)

Course Code: PP2012

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. To emphasize the use of mathematical tools like evaluation of definite integrals in the field of classical and quantum mechanics.
2. To demonstrate competence with a wide variety of mathematical techniques to enhance problem solving skills.

CO	Upon completion of this course, students will be able to:	CL
CO – 1	apply the various theorems in complex analysis to evaluate definite integrals.	E
CO – 2	determine the series solutions and the recurrence relations (Bessel, Legendre and Hermite differential equations) and solve problems associated with them.	E
CO – 3	discuss the basic principles and methods used for the analysis of partial differential equations and apply the techniques to related problems.	C
CO – 4	discuss the concepts of Fourier, Laplace and inverse Laplace transform, tensors, group theory and their properties.	C
CO – 5	develop expertise in mathematical techniques required in physics and to enhance problem solving skills.	An

Books for Study

1. Satya Prakash, Mathematical Physics, New Delhi: S. Chand & Sons Company Pvt. Ltd, (4^{th} ed.) (2005).
2. Joshi A.W. Matrices and Tensors for Physicists, New Age International Publishers Limited, (1995).
3. H.K. Dass, Mathematical Physics, (1997), S. Chand & Company Pvt. Ltd, I edition.
4. Pipes Harwell, Mathematics for Physicists and Engineers. Mc Graw Hill International Book Company, (1976).

Books for Reference

1. Eugene Butkov, Mathematical Physics. New York, NY: Addison Wesley Publishing, (1978).
2. Courant, D. Hilbert. Methods of Mathematical Physics. New Delhi: Wiley Eastern Limited, (1978).
3. Arfken, Weber. Mathematical Methods for Physicists. (5^{th} ed.) San Diego. Elsevier Academic press, (2001).
4. B. S. Rajput, Mathematical Physics, 20^{th} Edition, Pragati Prakashan, 2008.
5. Group Theory – Chemical applications of Group Theory, F. Albert cotton, (1990), John Wiley & sons Ltd, 3^{rd} edition

Semester I

Quantum Mechanics– I (Core – III)

Course code: PP2013

No. of hours per week	No. of credits	Total No. of hours	Marks
6	5	90	100

Objective

To help the students to acquire understanding of the fundamental concepts and mathematical tools necessary to solve the wave equations.

CO	Upon completion of this course, students will be able to:	CL
CO – 1	summarize the concept of wave function and the postulates of quantum mechanics.	U
CO – 2	formulate time dependent and time independent equation and solve them for simple potentials.	C
CO – 3	evaluate the eigen values and eigen function spin and total angular momenta and determine the matrices.	E
CO – 4	analyze the principles of quantum theory, equation of motion, scattering theory and angular momentum.	An

Unit– I: Foundations of Wave Mechanics 15 hours

Wave packet – Time dependent Schrödinger equation – Interpretation of the wave function – – Admissibility conditions on the wave function – Hermitian operator – Postulates of quantum mechanics – Simultaneous measurability of observables – General uncertainty relation – Ehrenfest's theorem.

Unit– II: Eigen States and Many Electron Atoms 15 hours

Square– well Potential with Rigid Walls– Square Potential Barrier –Alpha Emision– Time independent Schrodinger equation – Time dependent Schrödinger equation – Stationary states – Eigen functions and eigen values– Kronig Penny square well periodic potential – Indistinguishable Particles– Particle Exchange Operator– Symmetric and Antisymmetric Wave Functions– Pauli Principle – Inclusion of spin

Unit– III: Exactly Soluble Eigenvalue Problems 15 hours

One dimensional linear harmonic oscillator – operator method – Particle moving in a spherically symmetric potential – Spherical harmonics– Radial equation– Rigid rotator– Hydrogen atom– solution of the radial equation – Energy eigen values– Radial wave functions– Wave functions of hydrogen– like atom– Radial Probability density– ThreeDimensional square– well potential.

Unit– IV: Matrix Formulation of Quantum Theory, Equation of Motion & Angular Momentum 15 hours

Linear vector space– Dirac's notation– Equation of motions– Schrodinger, Heisenberg and Interaction representation. Angular momentum operators – Angular momentum commutation relations – Eigen values and eigen functions of L_2 and Lz– General angular momentum – Eigen values of J_2 and Jz– Angular momentum matrices – Spin angular momentum – Spin vectors for spin– (1/2) System –Addition of angular momentum : ClebschGordon coefficients – Stern Gerlach Experiment.

Unit– V: Scattering Theory 15 hours

Scattering cross– section – Scattering amplitude – Partial waves – Scattering by a central potential: Asymptotic solution– Optical theorem– Ramsauer– Townsend effect– Partial wave analysis – Scattering by an attractive square– well potential – Breit– Wigner Formula– Scattering length – Expression for phase shifts – Integral equation – The Born approximation – Scattering by screened coulomb potential – Validity of Born approximation.

Skill Development

1. Solve the time– independent Schrodinger equation for a three dimensional harmonic oscillator.
2. For the ground state of the hydrogen atom, evaluate the expectation value of the radius vector r of the electron.
3. Estimate the Einstein B coefficient for the n=2, l=1, m=0 to n=l, l=0, m=0 transition in the hydrogen atom.

Books for Study

1. A Text book of Quantum Mechanics – G. Aruldhas, Prentice Hall of India Pvt., Ltd., 2019.
2. A Text book of Quantum Mechanics – P. M. Mathews and K. Venkatesan, Tata McGraw – Hill Publications, Second Edition, 2010.

Books for Reference

1. Quantum Mechanics – Theory and applications – A. K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
2. Quantum Mechanics – Satya Prakash, Kedar Nath Ram Nath and Co. Publications, 2018.
3. Quantum Mechanics – V. K. Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
4. Quantum Mechanics – E. Merzbacher, John Wiley Interscience Publications, Third Edition, 2011.
5. Quantum Mechanics – Quantum Mechanics: Concept and applications, Nouredine Zettili, John Wiley & sons Ltd, 2nd edition, 2009.

Semester-I

Advanced Nuclear Physics (Elective – I)

Course code: PP2014

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. To impart fundamental aspects of nuclear physics to the students.
2. To elaborate the idea on theory, production and nuclear reactions
3. To obtain vast knowledge in nuclear energy impacts

CO	Upon completion of the course, students will be able to:	CL
CO– 1	Understand the basic knowledge on nuclei and neutron to know other factors like properties and scattering	U
CO– 2	Examine the neutron interactions to formulate probability, Diffusion, Fermi– age equations	E
CO– 3	Analyse the working of nuclear reactors and its reaction to produce nuclear energy	An
CO– 4	Study the nuclear fusion reaction and apply its principle for stellar energy	Ap

UNIT– I: Methods Of Investigating Nuclear Size 15 Hours

Classification of nuclei, nuclear size – methods to investigate nuclear size – Mesonic X–rays, Electron scattering, Coulomb energies of mirror nuclei, neutron scattering methods

UNIT– II: Discovery And Properties Of Neutron 15 Hours

Discovery of neutron, fundamental properties of neutron, neutron sources, – radioactive

sources, Photo– neutron sources, accelerated particle sources – Detection of neutrons – General principles, slow neutron detectors by foil activation method, detection of fast neutrons by scintillation counter.

UNIT– III: Classification And Interaction Of Neutron 15 Hours

Classification of neutrons according to energy, Neutron –electron interactions, slowing down of fast neutrons, slowing down time, slowing down density, resonance escape probability, neutron diffusion– solution to diffusion equation, diffusion of fast neutrons– Fermi– age equation

UNIT– IV: Reactor Physics 15 Hours

Condition of criticality of nuclear reactor, the critical equation and buckling, critical reactor dimensions, criticality of large thermal reactors– migration length, the reflector reactor, continuum theory of nuclear reactions, optical model theory of nuclear reactions, photonuclear reactions.

UNIT– V: Nuclear Fusion: Thermonuclear Energy 15 Hours

Nuclear fusion, the fusion reaction, thermonuclear reactions, sources of stellar energy, controlled thermonuclear reactions, the possibility of fusion reactor, cold fusion and transuranic elements.

Skill Development

1. Solving all types of problems of Nuclear and Particle Physics.
2. Exhibit a model on nuclear reactions.
3. Summer Internship Program and Industrial visit.

Books for Study

1. M. L. Pandya (1995), R.P.S Yadhav, Kedharnath, Ramnath, Elements of nuclear Physics, Meerut.
2. Robley D. Evans, (1982) ,The atomic nucleus, TMH, New Delhi.
3. Irving Kaplan, (1989), Nuclear Physics, Narosha Publishers, New Delhi.

4. V. Devanathan, Nuclear Physics, Narosa Publishing House, New Delhi.
5. A.B Gupta, Modern Atomic and Nuclear Physics, Books and Allied Limited, Kolkata.

Books for Reference

1. Tayal.D.C, (1982), Nuclear physics, Fourth edition, Mumbai, Himalaya Publishing House
2. Roy. R.R and Nigam.B. P, (1983), Nuclear Physics I edition, USA, New Age International Ltd.
3. Sathyaprakash (2005) Nuclear physics and Particle Physics, Sultan Chand and Sons, New Delhi.

Semester - I

Molecular Physics (Elective – I(b)

Course Code: PP2015

Hours / Week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. Providing the fundamental knowledge on the structure and dynamics of the molecules through various theories
2. Studying the relation between molecular interactions and properties
3. Providing phenomenological theories on reaction dynamics and transport properties

Course Outcome

CO	Upon completion of the course, students will be able to:	CL
CO – 1	understand the chemical bonding of molecules and various theories of homo and hetero nuclear diatomic molecules	U
CO – 2	analyze the symmetry operations and molecular orbital theory	An
CO – 3	analyse the electronic properties of molecules, Newtonian and Hamiltonian dynamics and Phase space trajectories	An
CO – 4	understand the molecular collisions and different energies caused by reactive collisions	U
CO – 5	evaluate the transport of electron and the formation of electronic bands and spectra.	E

Unit I: Molecular Structure and Bonding 15 hours

Chemical bonding – The VSEPR model – Valence bond theory – The hydrogen molecule – Homonuclear diatomic molecules – Polyatomic molecules – Molecular orbital theory – Homonuclear diatomic molecules – Heteronuclear diatomic molecules – Bond properties – Polyatomic molecules – Molecular shape in terms of molecular orbitals – Molecular structure, properties and conformations

Unit II: Molecular Symmetry 15 hours

Symmetry elements and operations – The symmetry classification of molecules – Some immediate consequences of symmetry – Applications to molecular orbital theory – Character tables and symmetry labels – Vanishing integrals and orbital overlap – Vanishing integrals and selection rule

Unit III: Molecular Interactions and Mechanics 15 hours

Electric properties of molecules – Electric dipole moments – Polarizabilities – Relative permittivity's – Interactions between dipoles – Repulsive and total interactions – Molecular interactions in gases – Potential energy (force field) in molecular mechanics – Various energy terms in force field – Newtonian and Hamiltonian dynamics – Phase space trajectories

Unit IV: Molecular Reaction Dynamics 15 hours

Collision theory – Diffusion controlled reactions – Reactive collisions – Potential energy surfaces – Transition state theory – The Eyring equation – Thermodynamic aspects – Microscopic–macroscopic connection – Zero– point Vibrational energy – Molecular electronic, rotational, Vibrational and translational partition functions

Unit V: Electron Transfer, Electronic Structure and Spectra 15 hours

The rates of electron transfer processes – Theory of electron transfer processes – Crystal–field theory – Ligand– field theory – Electronic spectra of atoms – Electronic spectra of complexes – Charge– transfer bands – Selection rules and intensities – Luminescence

Skill Development

1. Making a model on chemical bonding of molecular structure
2. Prepare a chart for electron transfer processes

Books for Study

1. P. Atkins and J. Depaula, Physical chemistry, (2009), Oxford University Press.

2. P. Atkins, T. Overton, J. Rourke and M. Weller, Inorganic chemistry, (2009), Oxford University Press.
3. Christopher J. Cramer John, Essential of Computational Chemistry – Theories and Models, (2004), Wiley & Sons, 2nd Edition.

Books for Reference

1. Walter S. Struve, Fundamentals of Molecular Spectroscopy, (1989), A– Wile – Interscience Publication.
2. Jann Lanne, Frontiers of Molecular Spectroscopy, (2009), Elsevier.

Semester - I

Numerical Methods (Elective – I(c)

Course code: PP2016

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objective

To understand various numerical methods used to solve the physical problems.

CO	Upon completion of this course the students will be able to :	CL
CO– 1	apply various interpolation methods and finite difference concepts	Ap
CO– 2	analyze the numerical solutions of linear and non linear equations	An
CO– 3	utilize various numerical methods for differentiation and integration	Ap
CO – 4	solve ordinary differential equations whenever and wherever routine methods are not applicable	C

Unit– I : Interpolation 15 Hours

Introduction, Polynomial Forms, Linear interpolation, Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Divided difference table, Interpolation with equidistance points, Spline interpolation

Unit– II : Roots Of Nonlinear Equations 15 Hours

Introduction, Methods of Solution, Iterative Methods, Starting and Stopping and Iterative Process, evaluation of Polynomials, Bisection method, False Position Method, Newton–

Raphson Method, Secant Method, Fixed Point Method, Determining All Possible Roots.

Unit– III: Solutions of Linear Equations 15 Hours

Need and Scope, Existence of Solutions, Solution by Elimination, Basic Gauss Elimination Method, Gauss Elimination with Pivoting, Gauss– Jordan Method, Triangular Factorization Methods, Round– off Errors and Refinement, Ill– Conditioned Systems, Matrix Inversion Method, Jacobi Iteration Method, Gauss Seidel Method.

Unit– IV: Numerical Differentiation and Integration 15 Hours

Numerical Differentiation: Need and Scope, differentiating continuous functions, Differentiating tabulated functions, Difference tables, Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Higher Order Rules.

Unit– V : Numerical Solutions of Ordinary Differential Equations 15 Hours

Need and Scope, Tailor Series Method – Improving accuracy, Picard's method, Euler's Method – accuracy of Euler's method, Heun's Method – Error analysis, Polygon Method, Runge– Kutta Methods– Determination of weights, Fourth order Runge– Kutta methods.

Skill Development

1. Solve radioactive decay problem using Newton Raphson Method
2. Find the velocity and acceleration of a rocket using numerical differentiation method
3. Analyze the current in various branches of Wheatstone's bridge using Gauss elimination method

Books for Study

1. Sastry, S.S. (2009). Introductory Methods of Numerical Analysis. (3rd ed.) Prentice Hall of India Ltd.
2. Numerical Methods, R. K. Jain, S. R. K. Iyengar, (2012), New Age International (P) Ltd, 3rd edition
3. Numerical Methods, E. Balagurusamy (1999), Tata McGraw– Hill, India

Books for Reference

1. Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canale, (1990, McGraw Hill International editions, 2nd edtion)
2. Raja Raman, V. (2003). Computer Oriented Numerical Methods . Prentice Hall of India Ltd.
3. Xavier, C. (1996). Fortran 77 and Numerical Methods. New Age International Ltd.

Semester I

Life Skill Training – I

Course Code: LST201

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To understand the fundamental rules of success
- To practice integrity in day to day life

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO– 1	understand the human values to lead a successful life	PSO– 5	U
CO– 2	apply the ethics in real life situation	PSO– 5	A
CO– 3	analyse and improve one's attitude	PSO– 5	Y

Unit I

Success – Success formulae. Goals – The law of Karma, The law of clarity, and the law of flexibility. Positive Mental Attitude – the law of optimism and self– confidence.

Unit II

Purposeful– Burning desire – The law of desire and The law of energy. Planning and Preparation – The law of planning.

Unit III

Resources – The law of maximization – Time and its management: health, courage, strengths and weaknesses, attitude, will and skill, enthusiasm,

initiative, creativity/resourcefulness/ingenuity, experience, appearance, orderliness and neatness, courtesy, politeness and manners, charisma, live life, have luck and skills.

Unit IV

Self– discipline – The law of time preference and The law of direction. Action – The law of applied effort and The law of compensation. Persistence.

Unit V

Prayers – The partnership with God – work with commitment towards the goal – work and prayer. Values – to attain stability in life – Benjamin Franklin's thirteen virtues.

Text Book

Rao, C.N. (2014). 10 Fundamental Rules of Success. India: V &S Publisher.

ReferenceBooks:

1. Bellamy, D.R. (1999). 12 Secrets for Manifesting your Vision, Inspiration and Purpose. India: Master Mind Books.
2. Iyer, S.S. (2009). Managing for Value. New Delhi: New Age International Publishers.
3. Sharma, S.P. (1999). Success Through Positive Thinking. Delhi: Pustak Mahal
4. Raj, A.S. (2015). Personality Development. Delhi: Firewall Media.

Semester – II

Electromagnetic Theory (Core – IV)

Course code: PP2021

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. To provide knowledge on the propagation of electromagnetic radiation
2. To develop theoretical knowledge, skills on solving analytical problems in electromagnetism.

CO	Upon completion of this course, students will be able to	PSO addressed	CL
CO – 1	summarize the fundamental laws of electrodynamics based on Maxwell's equations.	PSO – 1	U
CO – 2	enumerate the concept of energy in electrostatic and magnetostatic fields.	PSO – 2	K
CO – 3	illustrate the electrical properties of materials; solve the wave equation as plane waves in source.	PSO – 5	Ap
CO – 4	analyze the wave polarization and reflection/transmission of plane waves in homogenous media.	PSO – 4	An

Unit – I: Electrostatics 15 hours

Coulomb's law; the electric field – line, flux and Gauss's Law in differential form – the electrostatic potential; conductors and insulators; Gauss's law – application of Gauss's law – curl of E – Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges – capacitors. Potentials: Laplace equation in one dimension and two dimensions – Dielectrics – induced dipoles – Gauss's Law in the presence of dielectrics.

Unit– II: Magnetostatics 15 hours

Lorentz force – magnetic fields – magnetic forces – currents – Biot– Savart Law – divergence and curl of B – Ampere's Law – Electromagnetic induction – comparison of magnetostatics and electrostatics – Magnetic vector potential. Magnetization: effect of magnetic field on atomic orbit – Ampere's Law in magnetized materials – ferromagnetism.

Unit– III: Electromotive Force 15 hours

Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation in free space and linear isotrophic media – continuity equation – Poynting theorem. Electromagnetic waves in vacuum: Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization.

Unit– IV: Electromagnetic Waves 15 hours

The wave equation for E and B – Monochromatic Plan waves – energy and momentum in electromagnetic waves – electromagnetic waves in matters –TE waves in rectangular wave guides – the co– axial transmission line. Potentials: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potential form.

Unit– V: Application of Electromagnetic Waves 15 hours

Boundary conditions at the surface of discontinuity – Reflection and refraction of E.M waves at the interface of non – Conducting media – Kinematic and dynamic properties – Fresnel's equation – Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of incidence – Reflection and transmission co– efficients at the interface between two non–Conducting media – Brewster's law and degree of polarization – Total internal reflection.

Skill Development

1. Make a model, displaying the applications of electromagnetism in day– to– day life.
2. Use various mathematical tools to solve Maxwell's equation in problems of wave propagation and radiation.
3. Apply the concept of electromagnetism to study the magnetic susceptibility of paramagnetic substance in the form of a liquid.

Book for Study

1. Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Cambridge University Press, 2017.

Books for Reference

1. Electromagnetic Field Theory – K.A. Gangadhar, P. M. Ramanathan, Khanna Publishers. 2009.
2. Electromagnetic Theory and Electrodynamics, SathyaPrakash, KedarNath RamNath and Co, 2017.
3. Electromagnetics, B.B Laud, Wiley Eastern Company, 2000.
4. Basic Electromagnetics with Application, Narayana rao, (EEE) Prentice Hall, 1997.
5. Fundamentals of Electromagnetic Theory, Third edition, Narosa Publishing House, New Delhi
6. John R.Reitz, Frederick J Milford and Robert W.Christy, 1998.
7. Electromagnetics , B.B Laud, Wiley Eastern Company, 2000.

Semester – II

Quantum Mechanics – II (Core –V)

Course code: PP2022

No. of hours per week	No. of credits	Total No. of hours	Marks
6	5	90	100

Objective

To develop several approximation methods, for bounds states and scattering states and apply them to illustrative problems.

CO	Upon completion of this course, students will be able to:	CL
CO – 1	enumerate time independent perturbation theory and use approximation methods. (variation principle and WKB method) to solve simple problems (ground state helium, barrier penetration, etc)	K
CO – 2	analyze time dependent perturbation theory to discuss absorption and emission of radiation for harmonic perturbation.	An
CO – 3	nterpret quantum theory of atomic and molecular structure.	U
CO – 4	formulate Klein– Gordan and Dirac equations and discuss the applications. (particle in a Coulomb field, Spin of electron)	C

Unit– I: Approximation Methods for Time Independent Problems 15 hours

Time independent perturbation theory: Basic concepts – Non– degenerate energy levels – first and second order – Anharmonic oscillator – First– order correction – Ground state of Helium– Effect of electric field on the ground state and n=2 of hydrogen– Degenerate Energy Levels– Stark effect in hydrogen molecule– Spin– Orbit interaction.

Unit– II: Approximation Methods for Time Dependent Perturbation Theory 15 hours

Time dependent perturbation theory: First order perturbation – Harmonic perturbation – Transition to continuum states – Fermi Golden Rule – Absorption and Emission of radiation – The Electromagnetic field– Hamiltonian operator– Electric dipole approximation– transition probability– Einstein's A and B coefficients – Selection rules– forbidden transitions.

Unit– III: Variation and WKB Method 15 hours

Variation method :Variational principle – Ground state of Helium and Deuteron– WKB Approximation : WKB method – Connection formula – Solution near a turning point – Validity of the WKB method – Barrier penetration – Alpha emission– Bound states in a potential well.

Unit–IV: Quantum Theory of Atomic and Molecular Structure 15 hours

Spin functions – Helium atom– Ground state– First excited state– Central field approximation: – Determination of central field: Thomas Fermi method– Hartree– Fock approximations –

Molecular Orbital method–

Born– Oppenheimer approximation – MO treatment of hydrogen molecule Ion (H_2+) – Molecular orbital theory of Hydrogen molecule.

Unit– V: Relativistic Quantum Mechanics & Quantization of the Field 15 hours

Klein – Gordon Equation – Interpretation of the Klein– Gordon equation – Particle in a Coulomb field – Dirac's equation for a free particle – Dirac matrices – Plane wave solution – Negative energy states – Spin of the Dirac particle – Magnetic moment of the electron – Spin– orbit interaction. Quantization of the Field – Lagrangian equation– Hamiltonian equation– Schrodinger equation– Quantization of Electromagnetic fields

Skill Development

1. Draw the energy levels including the spin orbit interaction for n = 3 and n = 2 states of hydrogen atom and calculate the spin orbit doublet separation of the 2p, 3p and 3d states.
2. Solve the one dimensional infinite potential well problem using WKB method and compare with the exact solution.
3. Evaluate the rates of stimulated and spontaneous emission for the transition
4. 3p $\rightarrow$ 2s (H_α line) of hydrogen atom, taking the atoms are at a temperature of 1000K.

Books for Study

1. A Text book of Quantum Mechanics – G. Aruldhas, Prentice Hall of India Pvt., Ltd., 2019.
2. A Text book of Quantum Mechanics – P. M. Mathews and K. Venkatesan, Tata McGraw – Hill Publications, Second Edition, 2010.

Books for Reference

1. . Quantum Mechanics – Satya Prakash, Kedar Nath Ram Nath and Co. Publications, 2018.
2. Quantum Mechanics V. K. Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
3. Quantum mechanics – Franz Schwabl, Narosa Publications, Fourth Edition, 2007.
4. Molecular Quantum mechanics – P.W.Atkins and R.S. Friedman,, Oxford University Press publication, Fifth Edition, 2010.
5. Quantum Mechanics – Theory and Applications, A. K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
6. 6.Quantum Mechanics – Quantum Mechanics: Concept and applications, Nouredine Zettili, 2009, John Wiley & sons Ltd, 2nd edition.

Semester-II

Condensed Matter Physics– I (Core –VI)

Course code: PP2023

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objective

To give strong foundation in the conceptual understanding of the development of solid state physics with appropriate theoretical background.

CO	Upon completion of this course the students will be able to :	CL
CO– 1	differentiate between different lattice types and explain the concepts of reciprocal lattice and crystal diffraction	U
CO– 2	analyze various crystal imperfections and ordered phases of crystal	An
CO– 3	explain the theory of lattice vibrations and analyze the thermal properties of solids	An
CO – 4	formulate the problem of electrons in a periodic potential	Ap

Unit– I: Crystal Physics: Crystal Structure 15 hours

Lattice representation – Simple symmetry operations – Bravais Lattices, Unit cell, Wigner Seitz cell – Miller planes and spacing – Characteristics of cubic cells – Structural features of NaCl, CsCl, Diamond, ZnS – Close packing.

Crystal Binding*:* Interactions in inert gas crystals and cohesive energy – Lennard – Jones potential – Interactions in ionic crystals and Madelung energy – Covalent bonding – Heitler – London Theory – Hydrogen bonding – metallic bonding.

Unit– II: Diffraction of Waves and Particles by Crystals 15 hours

X– rays and their generation – Moseley's law – Absorption of X– rays (Classical theory) – Absorption Edge – X– ray diffraction – The Laue equations – Equivalence of Bragg and Laue equations – Interpretation of Bragg equation – Ewald construction – Reciprocal lattice – Reciprocal lattice to SC, BCC and FCC crystals– Importance properties of the Reciprocal lattice – Diffraction Intensity – The Powder method – Powder Diffractometer – The Laue method – The Rotating Crystal method – Neutron Diffraction – Electron diffraction.

Unit– III: Crystal Imperfections And Ordered Phases Of Matter 15 hours

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections– Polorans – Excitons. Ordered phases of matter: Translational and orientation order – Kinds of liquid crystalline order – Quasi crystals – Superfluidity.

Unit– IV: Lattice Dynamics 15 hours

Theory of elastic vibrations in mono and diatomic lattices – Phonons – Dispersion relations – Phonon momentum. Heat Capacity: Specific heat capacity of solids – Dulong and Petit's law – Vibrational modes – Einstein model – Density of modes in one and three dimensions – Debye Model of heat capacity. Anharmonic Effects: Explanation for Thermal expansion, Conductivity and resistivity – Umklapp process.

Unit– V: Theory of Electrons 15 hours

Energy levels and Fermi– Darac distribution for a free electron gas – Periodic boundary condition and free electron gas in three dimensions – Heat capacity of the electron gas – Ohm's law, Matthiessen's rule – Hall effect and magnetoresistance – Wiedemann – Franz law. Nearly free electron model and the origin and magnitude of energy gap – Bloch functions – Bloch theorem – Motion of an electron in a periodic potential – Kronig – Penney model – Approximate solution near a zone boundary –Metals, semiconductors and insulators

Skill Development

1. Calculate lattice parameters and crystal structure of a material using the given data
2. Display various models of crystal systems
3. Draw the band structure of a material using the given data

Books for Study

1. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley India Pvt. Ltd. , New Delhi, 2005.
2. Rita John, Solid State Physics, Tata Mc Graw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid– State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid State Physics – Principles and Applications, Pearson, 1999.

Books for Reference

1. J. Blakemore, Solid State Physics, 2nd Edition, W. B. Saunders Co, Philadelphia, 1974.
2. C. M. Kachhava, Solid State Physics, Tata Mcgraw Hill, New Delhi, 1990.
3. N. W. Aschroft and N. D., Mermin, Solid State Physics, Rhinehart and Winton, New York. 1976.
4. M. Tinkham, Introduction to Superconductivity, Tata Mcgraw Hill, New Delhi, 1996.

Semester – II

Experimental Design (Elective –II (a))

Course code: PP2024

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objectives

1. To enhance comprehension capabilities of students through understanding of electronic devices.
2. To understand the physical construction, working and operational characteristics of semiconductor devices.

CO	Upon completion of the course, students will be able to:	CL
CO– 1	understand the principle and working of transducers	U
CO– 2	examine the measurement systems and errors in it	E
CO– 3	analyse the X ray measurements and to find TEM, SEM, EDS, FESEM, AFM, UV Vis, IR, FTIR characterizations	An
CO– 5	get an introduction and idea on optical fibres	U

Unit– I: Measurements, Measurement Systems and Error in Measurements

15 hours

Measurements: Measurement and its significance; Methods of Measurements – Direct and Indirect methods; Instruments – Mechanical, Electrical and Electronic Instruments; Classification of instruments – Deflection and Null type instruments. Noise in Measurements*:*

Signal to Noise ratio; Sources of Noise, Johnson noise, Power Spectrum Density, Noise

Factor and Noise Figure. Error in Measurements*:* Gross Errors, Systematic Errors and Random Errors; Statistical Treatment of Data – Arithmetic Mean, Dispersion from the Mean, Rang, Deviation, Average Deviation, Standard Deviation and Variance.

Unit– II: Transducer and their Classification 15 hours

Transducer: Electric Transducer and its Advantages; Classification of Transducer – Principle of Transduction, Primary and Secondary, Active and Passive, Analog and Digital, Transducer and Inverse Transducer; Characteristics and Choice of Transducer – Input, Transfer and Output; Principle, Construction, Working, Advantages and Disadvantages of the following Transducer's: Resistive, Stain Gauges, Resistance Thermometers, Thermistors, Thermocouple, LVDT, Capacitive and Piezo– electric Transducers; Opto– Electronic Transducers – Photo– Voltaic cell, Photo– Conductive cell, Photo– Diodes and Photo– Transistors.

Unit– III: Opto– Electronic Instruments 15 hours

Introduction of Optical Systems: Refraction, Refractive index, Reflection, Absorption, Transmittance, Radiometry and Photometry; Terms relating to Radiometry and Photometry; Laws of Illumination; Optical Sources and Detectors; Optical Fibers – Principle, Acceptance angle and Numerical Aperture; Fiber Optic Sensor – Factors affect and Advantages.

Unit– IV: Vacuum Techniques and X – Ray Measurements 15 hours

Vacuum Techniques: Units of Pressure Measurement, Characteristics of Vacuum and its Application; Vacuum Systems – Pump– down sequence, Construction, Vacuum Pumps and Vacuum Gauges; Pumping Speed for a Vacuum System; Thin Film Deposition Techniques(Principle, Construction, Working, Advantages and Disadvantages): Thermal Evaporation, Sputtering, Spray Pyrolysis, Chemical Vapour Deposition, Molecular Beam Epitaxy; Film Thickness Monitors and Film Thickness Measurements; X – Ray Measurements: The Electronic Structure of Atoms, Multi– Electron Atoms, X – Ray Fluorescence, Fine Structure, Absorption and Emission Processes

Unit– V: Characterization of Materials and Radiation Detection Electron Microscopes: Transmission Electron Microscope(TEM), Scanning Electron

15 hours

Microscope (SEM), Electron Microprobe Analysis(EDS), Field Emission Scanning Electron Microscopy(FESEM), Atomic Force Microscope(AFM); Spectroscopy: UV– Vis Spectroscopy, Infra– red Spectroscopy, Fourier Transform Spectroscopy, Raman Spectroscopy, Auger Electron Spectroscopy. Radiation Detection: Principle and Types.

Skill Development

1. Demonstration on SEM, TEM FESEM to understand the characterization techniques lively.
2. Industrial visit to Regional Research Lab (RRL), Thiruvananthapuram.

Book for Study

1. Measurement, Instrumentation and Experiment Deign in Physics and Engineering – Michael Sayer and Abhai Mansingh – PHI (2005).

Books for Reference

1. A Course in Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney and Puneet Sawhney – Dhanpat Rai & Sons (1995).
2. Characterization of Materials – P. K. Mitra – PHI (2014).

Semester – II

Introductory Astronomy, Astrophysics & Cosmology (Elective – II b)

Course Code: PP2025

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

Objective

To give strong origin in the historical evolution of Universe and principles of physics in the formation of astronomical objects like stars and planets with appropriate cosmological background.

CO	Upon completion of this course, students will be able to:	CL
CO – 1	perceive the historical evolution of solar system and universe.	E
CO – 2	describe the principles of physics in the formation of astronomical objects like planets, satellites, asteroids and comets.	U
CO – 3	gain experience with measurement techniques and equipment and develop the ability to assess uncertainties and assumptions.	An
CO – 4	interpret the observations of galaxies, dark matter, quasars and pulsars.	Ap
CO – 5	achieve a good understanding of physical laws and principles in cosmology.	C

Unit I : History of Astronomy 15 hours

Introductory History of Astronomy– Ptolemy's Geocentric Universe– Copernicus' Heliocentric Universe– Tycho Brahe and Galileo's Observations– Kepler's Laws of Planetary Motion– Newtonian Concept Of Gravity– Highlights of Einstein's Special and General Theory Of Relativity– Curved Space Time– Evidence of Curved Space Time– Bending Of Light– Time Dilation

Unit II : Stars & Galaxies 15 hours

Stars and Galaxies– Distances– Trigonometric Parallax– Inverse Square Law– Magnitude of Stars– Apparent Magnitude– Absolute Magnitude and Luminosity– Color and TemperatureComposition of Stars– Velocity, Mass and Sizes of Stars– Types of Stars– Temperature Dependence– Spectral Types– Hertzsprung– Russell (HR) Diagram– Spectroscopic Parallax

Unit III : Lives And Death of Stars 15 hours

Stellar Evolution– Mass Dependence– Giant Molecular Cloud– Protostar– Main Sequence StarSubgiant, Red Giant, Supergiant– Core Fusion– Red Giant (Or) Supergiant– Planetary Nebula(Or) Supernova– White Dwarfs– Novae And Supernovae– Neutron Stars– Pulsars– Black Holes– Detecting Black Holes– The Sun– Its Size and Composition– Sun‟s Interior ZonesSun‟sSurface– Photosphere– Chromosphere– Corona– Sun's Power Source– Fusion Reaction Mechanism.

Unit IV: Cosmology I 15 hours

Introduction to Cosmology– Basic Observations and implications– Olbers' Paradox – Expanding Universe – Gravitational Redshift– Doppler Effect– Hubble's Law and the Age of the Universe – Cosmological Principle– The Perfect Cosmological Principle– Observation and interpretation of Cosmic Microwave background Radiation (CMBR)– Evidence Supporting the General Big Bang Theory– Salient features of Steady State Theory

Unit V: Cosmology II 15 hours

Fate of the Universe– Dependence on Mass (Curvature of Space)– Critical density– Open Universe– Closed Universe– Homogenous and Isotropic Freidman– Robertson– Walker Universes– Deriving the Geometry of the Universe from the Background Radiation– Flatness Problem– Horizon Problem– Inflation and its effect on the universe– The Cosmological Constant.

Skill Development

1. Summer Internship Program for PG students in the field of Astronomy and Cosmology in National Astro Physics centres located in Kadaikanal and Banglore.
2. Making the students to go for industrial visit on various Planetarium and also the Science centers in Chennai, Trivandrum and Bangalore.
3. Exhibit models of Universe, Cosmos, galaxy and black holes.

Books for Study

1. Bhatia. V.B. (2001). Text book of Astronomy and Astrophysics with Elements of Cosmology, (1st ed.). New Delhi: Narosa publishing House.
2. Singhal. R.P. (2009). Elements of Space Physics, (1st ed.). New Delhi: PHI Learning Private limited.
3. Baidyanath Basu. (2006). An introduction to Astrophysics. (1st ed.). New Delhi: Prentile Hall of India PVT Lt publications.
4. Abhyankar, K.D. (1989). Astrophysics – Stars and Galaxies. (1st ed.). New Delhi: Tata – McGraw Hill Publications.

Books for Reference

1. Thomas T., Arny. (1996). *Explorations –An Introduction to Astronomy*, (1st ed.). California: Mosby Version publications.
2. Narlikar, J.V. (1995). *Structure of the Universe.* (1st ed.). New York: Oxford University Press.
3. George O., Abell. (1986). *Exploration of the universe*. (1st ed.). New Delhi: Saunder's college publishing.
4. Frark, H., Shu. (1982). *The Physical Universe An Introduction to Astronomy*. (1st ed.).
5. California: University science books, Mill valley.

Semester – II

Laser Physics (Elective –II (c))

Course code: PP2026

No. of hours per week	No. of credits	Total No. of hours	Marks
6	4	90	100

OBJECTIVES

1. To develop knowledge in the basics of lasers.
2. To enhance comprehension in the principles of lasers.
3. To explore the control of laser properties.
4. To familiarize with the diverse applications of lasers.

UNIT – 1: Wave Propagation In Anisotropic Media 15 hours

Double refraction– plane waves in anisotropic media– wave refractive index– ray refractive index– the ray velocity surface– The index ellipsoid.

UNIT– 2: Lasing Mechanism– I 15 hours

The Einstein Coefficients– Light amplification– The threshold condition– Laser rate Equations Variation of laser power around Threshold– Optimum output coupling– Line broadening mechanisms.

UNIT– 3: Lasing Mechanism II 15 hours

Modes of a rectangular cavity and the open planar resonator– The quality factor– The ultimate linewidth of the laser– Mode selection– Q– switching– Mode locking in lasers– Modes of a confocal resonator system– General spherical resonator– Higher order modes.

Some laser systems:

Ruby lasers– Neodynmium based lasers– The He– Ne laser– The argon ion laser– The CO2

laser – Dye lasers– Excimer lasers– Semiconductor lasers.

UNIT– 4: Electrooptic And Acousto– Optic Effects 15 hours

Index ellipsoid in the presence of an external electric filed– Electrooptic effect in KDP crystal: Longitudinal mode– Raman Nath and Bragg regimes of diffraction– A simple experimental setup to observe Raman– Nath Diffraction– Theory for Raman Nath Diffraction– Raman Nath acousto– optic modulator –Acousto– optic spectrum analyser.

UNIT– 5: Non– Linear Optical Phenomena 15 hours

Harmonic Generation – Second Harmonic Generation – Phase Matching – Third Harmonic Generation – Optical Mixing – Parametric Generation of Light.

Skill Development

1. Calculate the refractive index of various materials
2. Apply the SHG principles to study NLO effects

Books for Study

1. Optical electronics A.K.Ghatak and K.Thyagarajan, Cambridge University press 1991.

Books for Reference

1. Principles of Lasers and Optics, William S.C. Chang, Cambridge University Press, 2005
2. Laser and Non– Linear Optics, B.B. Laud, New Age International Publisher.

Semester II
Life Skill Training - I
Course Code: LST201

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To understand the fundamental rules of success
- To practice integrity in day to day life

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the importance of soft skills	PSO-	U
CO-2	apply the tools and techniques for effective communication	PSO-	A
CO-3	analyseand improve mental health	PSO-	Y

Unit I

Soft and Hard Skills - significance of soft skills.

Communication Skills - Types of communication - elements of communication - constituents of communication - characteristics of effective communication.

Unit II

Body Language - Body language interpretation -tips for better body language.

Interpersonal Skills - Tools for effective conversation and building interpersonal skills.

Unit III

Listening Skills - Listening types - tips for listening - listening and leadership.

Soft Skills and Johari Window -Johari windows - advantages of Johari window.

Unit IV

Change Management -Change Vs Zones - tips for managing change.

Stress Management - Types, causes of stress, symptoms of stress and tackling stress.

Unit V

Motivation - Types of motivation - Hierarchy of needs - tips for motivation.

Time Management - Pareto's principle - tools and techniques for time management.

(Compilation will be provided to the students)

Reference Books:

1. Melgosa, J. (2013). Positive Mind. (3rd ed.). Spain: Safeliz.

2. Shukla, A. (2010). The 4-Lane Expressway to Stress Management. New Delhi: Unicorn Books.
3. Pease, A. (1990). Body Language. India: Sudha Publications Pvt. Ltd.

Semester II&III
Service Learning Programme (SLP): Community Engagement Course
Course Code:SLP201

Credits	Total no. of hours	Total marks
2	30 (15 classroom + 15 field)	100 (50 + 50)

Objectives

- To develop an appreciation of rural culture, life-style and wisdom among students
- To learn about the status of various agricultural and rural development programmes
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and there by improve quality of learning

Learning Outcomes

After completing this course, student will be able to

- Gain an understanding of rural life, culture and social realities
- Develop a sense of empathy and bond so mutuality with local community
- Appreciate significant contributions of local communities to Indian society and economy
- Learn to value the local knowledge and wisdom of the community
- Identify opportunities for contributing to community's socio-economic improvements

Credit: 2credits, 30hours, atleast 50% in field, compulsory for all students.

Contents:

Course Structure:

2 Credits Course (1Credit for Classroom and Tutorials and 1 Credit for Field Engagement)

S.No.	Module Title	Module Content	Assignment	Teaching/ Learning Methodology	No.of Classes
1	**Appreciation of Rural Society**	Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul	Prepare a map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village.	- Class room discussions - Field visit** - Assignment	2 4 2

		of India lies in villages'(Gandhi), rural infrastructure		Map	
2	**Understanding ruraleconomy &livelihood**	Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets	Rural household economy, its challenges and possible pathways to address them	- Field visit** - Group discussions in class -Assignment	3 4 1
3	**Rural Institutions**	Traditional rural organisations, Self-help Groups, Panchayatiraj institutions (GramSabha, GramPanchayat, Standing Committees), local civil society, local administration	How effectively are Panchayatiraj institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual)	Classroom - Field visit** - Group presentation of assignment	2 4 2
4	**RuralDevelopmentProgrammes**	History of rural development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swatchh Bharat, PM Awaas Yojana ,Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.	Describe the benefits received and challenges faced in the delivery of one of these programmes in the rural community; give suggestions about improving implementation of the programme for the rural poor.	- Classroom - Each studentselect soneprogram for fieldvisit** Written assignment	2 4 2

****Recommended** field-based practical activities:

- Interaction with SHG women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the worksite
- FieldvisittoSwachhBharatprojectsites,conductanalysisandinitiateproblemsolvingmeasures
- Conduct Mission Antyodaya surveys to support under Gram

Panchayat Development Plan(GPDP)

- Interactivecommunityexercisewithlocalleaders,panchayatfunctionaries,grass-rootofficials and local institutions regarding village development plan preparation and resource mobilization
- Visit Rural Schools/ mid-day meal centres, study Academic and infrastructural resources and gaps
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Attend Parent Teacher Association meetings and interview school dropouts
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
- Organize awareness programmes, health camps, Disability camps and cleanliness camps
- Conducts oil health test, drinking water analysis, energy use and fuel efficiency surveys
- Raise understanding of people's impacts of climate change, building up community's disaster preparedness
- Organise orientation programmes for farmers regarding organic cultivation,rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing

Teaching & Learning Methods

A large variety of methods of teaching must be deployed:
UGC will prepare an ICT based MOOC for self-paced learning by students for the1 credit to be conducted in the classroom.
Reading & classroom discussions, Participatory Research Methods & Tools, Community dialogues, Oral history, social and institutional mapping, interactions with elected panchayat leaders and government functionaries, Observation of Gram Sabha, Field visits to various village institutions.

Recommended Readings

Books:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, NewDelhi,2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs/
4. M.P. Boraian, Best Practices in Rural Development**,** Shanlax Publishers, 2016.

Journals:

1. Journals of Rural development, (published by NIRD & PR Hyderabad)

2. Indian Journal of Social Work, (byTISS,Bombay)
3. Indian Journal of Extension Education (by Indian Society of Extension Education)
4. Journal of Extension Education (by Extension Education Society)
5. Kurukshetra (Ministry of Rural Development, GoI)
6. Yojana (Ministry of Information and Broadcasting, GoI)

Semester: III
Core VII – Electronics
Course code: PP2031

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To impart in depth knowledge about Semiconductors, diodes, Transistors, OperationalAmplifiers, Memories and converters etc
2. To provide knowledge in the basic structure and working concepts of electronicdevices.
3. To acquire application skills involving digital integrated circuit.

Course Outcome

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO 1	Understand the basic operation, and features related to diodes, transistor, op– amps, converter and interpret the	PSO– 1	U
CO 2	Explain about the internal circuitry and logic behind semiconductor memory devices.	PSO– 2	U
CO 3	Assess the working of diodes, transistor, op– amps and converters.	PSO– 3	E
CO 4	Design various filter circuits.	PSO– 6	C
CO 5	Interpret the Internal Architecture of memory devices	PSO– 4	An

Unit I 15 hrs

Semiconductor Diodes: Introduction to Semiconductor– Intrinsic Semiconductor– Extrinsic Semiconductor– P– type– N– Type – PN Junction diode –Crystal Diode – Zener diode– LED – Varactor Diode – Tunnel diode Photo diode – schottky diode – Impatt diode– Characteristics and Applications.

Unit II **15 hrs**

Transistor Biasing and opto Electronic Devices: Thevenin's and Norton's theorems – Transistor action– PNP– NPN transistors – Transistor biasing and stabilization– Need for biasing– DC load line– operating point– Bias stability– Two port Network – Hybrid model – h parameters — JFET – UJT– SCR.

Unit III **15 hrs**

Operational Amplifier Applications: Operational Amplifier– CMRR– Slew rate – Instrumentation amplifier – V to I and I to V converter – Op– amp stages– Equivalent circuits – Sample and Hold circuits. Applications of Op– Amp: Inverting, Non– inverting Amplifiers– circuits – Adder– Subtractor– Differentiator– Integrator– Electronic analog Computation solving simultaneous and differential equation –. Schmitt Trigger – Triangular wave generator – Sine wave generator – Active filters: Low, High and Band pass first and second order Butterworth filters – wide and narrow band reject filters.

Unit IV **15 hrs**

Semiconductor Memories: Classification of memories and sequential memory –Static Shift Register and Dynamic Shift Register, ROM, PROM and EPROM principle and operation Read & Write memory – Static RAM, dynamic RAM, Content Addressable Memory – principle, block diagram and operation. Programmable Logic Array (PLA) – Operation, Internal Architecture. Charge Couple Device (CCD) – Principle, Construction, Working and Data transfer mechanism.

Unit V **15 hrs**

A/D and D/A Converter: Sampling theorem– Time division multiplexing – Quantization – DAC– Weighted resistor method – Binary Ladder network – ADC – successive approximation, Dual slope and Counter method – Voltage to Frequency conversion and Voltage to Time conversion .

Text Books

1. Jain,R.P. (2007). *Modern Digital Electronics*.New Delhi:Tata McGraw Hill.
2. Coughlin,R.F.Driscol,F.F. (1996)*Op– Amp and linear integrated circuits*.NewDelhi: Prentice Hall of India.
3. Ramakant, A. Gayakwad. (2015) *Op– Amps and Linear Integrated Circits.* – Pearson Education: Fourth Edition.
4. Albert MalvinoDavid J Bates.(2007) *Electronic Principles*, 7 th Edition,New Delhi: McGraw Hill.
5. Mehta,V.K. (2001)*Principles of Electronics.* 6thRevised Edition, S.Chand and Company.
6. David A. Bell.(2007)*Electronic Devices and Circuits*. 4th Edition, Prentice Hall.

Reference Books

1. Mehta V.K., Rohit Mehta. (2016). *Principles of Electronics*. New Delhi: S.Chand andCompany.
2. Vijayendran.V., Viswanathan.S. (2011). *Introduction to Integrated Electronics Digital andAnalog*. (1st ed.).Chennai: (printers and Publishers) Pvt. Ltd.
3. Thomas L.Floyd. (1999). *Digital Fundamentals*.(3rd ed.). New Delhi: UBS– PublishersDistributers LTD.
4. Millman J. Halkias, C.C. (1991). *Integrated Electronics*. New Delhi: Tata McGraw– HillPublishing Company Limited.
5. Ryder, J.D. (2004). *Electronics: Fundamentals and Applications*. United States: PrenticeHall International, INC., Englewood Cliffs.
6. Salivahanan, S., Kumar, N.S. (2012). *Electronic Devices and Circuits*. (3rd ed.). New Delhi: Tata McGraw– Hill Publishing Company Limited.
7. Donald .P. Leach, Albert Paul Malvino, Goutam suba. (2006). *Digital Principles and Applications.* New Delhi: Tata, Mc Graw Hill publishing company, Ltd..
8. Malvino A.P. and Brown J.A. (1997). *Digital Computer Electronics*. (3rd ed.). NewDelhi: TataMcGraw Hill Publishing Company.

Semester III

Core VIII: Condensed Matter Physics – II

Course code: PP2032

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objective

1. To develop analytical thinking to understand the phenomenon that decide various properties of solids thereby equip students to pursue higher learning confidently.

Course Outcome

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	Understand the theory of dielectrics and analyze thedielectric properties of materials	PSO – 1	An
CO – 2	Explain various types of magnetic phenomenon andtheir properties and applications	PSO – 4	E
CO – 3	Elaborate the properties and applications	PSO – 4	C
CO – 4	Apply the obtained concepts to challenges	PSO – 6	Ap

Unit I 15 hrs

Theory of Dielectrics: Dipole moment – Polarization – The electric field of a dipole – Local electric field at an atom – Clausius – Mosotti equation – Dielectric constants and its measurements – Polarizability – The Classical theory of electronic polarizability – Ionic

polarizabilities – Orientational polarizabilities – The polarizability catastrophe – Dipole orientation in solids – Dipole relaxation and dielectric losses – Debye Relaxation time – Relaxation in solids – Complex dielectric constants and the loss angle – Frequency and temperature effects on Polarization – Dielectric breakdown and dielectric loss

Unit II **15 hrs**

Theory of Ferroelectrics and Piezo Electrics: Ferroelectric Crystals – Classifications of Ferroelectric crystals – Dipole theory of ferroelectricity – LandauTheory of the phase transition – Second order Transition – First Order Transition – Ferroelectric Transition – One– Dimensional Model of the Soft Mode of Ferroelectric

Transitions – Antiferroelectricity – Ferroelectric domains – Ferroelectric domain wall motion – Piezoelectricity – Phenomenological Approach to Piezoelectric Effects – Piezoelectric Parameters and Their Measurements – Piezoelectric Materials

Unit III **15 hrs**

Magnetic properties of Materials: Terms and definitions used in magnetism – Classification of magnetic materials – Atomic theory of magnetism – The quantum numbers – The origin of permanent magnetic moments – Langevin's classical theory of diamagnetism – Sources of paramagnetism – Langevin's classical theory of paramagnetism – Quantum theory of paramagnetism – Paramagnetism of freeelectrons – Ferromagnetism – The Weiss molecular field – Temperature dependence of Spontaneous magnetization – The physical origin of Weiss Molecular field – Ferromagnetic domains – Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

Unit IV **15 hrs**

Superconductivity: Occurence of super conductivity – Destruction of superconductivity by magnetic fields – Meissner Effect – Type I and Type II Super conductors – Heat Capacity – Energy gap – Microwave and infrared properties – Isotope effect – Thermodynamics of the superconducting transition – London equation – CoherenceLength – BCS theory of superconductivity, BCS groundstate– Fluxquantisationinasuperconductionring– Durationofpersistencecurrents– Single particle tunnelling – DC Josephson effect – AC Josephson effect – Macroscopic quantum

interference – High temperature super conductors – Applications.

Unit V **15 hrs**

Physics of Nanosolids: Definition of nanoscience and nanotechnology – Preparation of nanomaterials – Surface to volume ratio – Quantum confinement – Qualitative and Quantitative description – Density of states of nanostructures – Excitons in Nano semiconductors – Carbon in nanotechnology – Buckminsterfullerene – Carbon nanotubes – Nano diamond – BN nano tubes – Nanoelectronics – Single electron transistor – Molecular machine – nanobiometrics.

Text Books

1. Charles Kittel.(2004).*Introduction to Solid State Physics*. 7th Edition,New Delhi: WileyIndia Pvt. Ltd.
2. Rita John.(2014).*Solid State Physics.* New Delhi:Tata Mc Graw Hill Publications.
3. Wahab M. A.(1999).*Solid State Physics – Structure and Properties of Materials.*NewDelhi: Narosa.
4. Patterson,J.D. Bailey,B.C. (2007).*Solid– State Physics: Introduction to the Theory*,springer Publications.
5. Ali Omar,M. (1999).*Elementary Solid State Physics – Principles and Applications.*Pearson.

Reference Books

1. Blakemore, J.(1974). *Solid State Physics*, 2nd Edition, Philadelphia: W. B. Saunders Co.
2. Kachhava,C. M. (1990).*Solid State Physics*, New Delhi: Tata Mcgraw Hill.
3. AschroftN. W., Mermin,N. D.(1976).*Solid State Physics*, New York: Rhinehart andWinton.
4. Tinkham,M.(1996). *Introduction to Superconductivity.* New Delhi : Tata Mcgraw Hill.

5. Chattopadhyay, K.K.Banerjee, A.N.(2014) *Introduction to Nanoscience and Nanotechnolog*. Delhi: PHI Learning private Ltd.
6. Dekker, A. J. (1975).*Electrical Engineering Materials*. Prentice Hall of India.
7. Pillai, S.O.(1994)*Problems and Solutions in Solid State Physics*.New Delhi:New Ageinternational Publishers.
8. Bain, A.K. Chand,P. (2017) *Ferroelectrics*. Wiley.
9. Kwan Chi Kao.(2004)*Dielectric phenomena in solids with emphasis on physical concepts of electronic processes*. Elsevier Academic Press.
10. Alexander O. E. Animalu. (1978)*Intermediate Quantum Theory of Crystalline solids.* New Delhi :Prentice Hall of India.
11. Eleftherios N. Economou. (2010)*The Physics of Solids – Essentials and Beyond*. Springer.

Semester III

Project

Course code: PP20PR

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To enable students to design experiment, analyse data and interpret results.
2. To develop skills to identify subject related problems in the neighbourhood and reportto the scientific community.

Course Outcome

COs	Upon completion of this course the studentswill be able to:	PSO addressed	CL
CO – I	explore new areas of research in physics	PSO – 5	Ap
CO – 2	analyze a research problem and construct tools for data collection.	PSO – 6	An
CO – 3	write research reports and present results in the scientific community.	PSO – 7	Ap
CO – 4	develop skills to serve in science related industries and agencies.	PSO – 5	Ap
CO – 5	develop skills to publish articles in reputed journals.	PSO – 4	An

Guidelines

- All the students must undertake project work at the final year (III semester).
- The students, with the consent of the Supervisor, HOD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.

Distribution of marks for project

Internal : External = 40:60

Internal Components

Internal Viva= 20 marksRegularity and Systematic work = 20 marks

External Components

Dissertation = 30 marksInnovation = 10 marks

Presentation and Viva = 20 marks

Evaluation	**Marks**	**Month/ Date**	**Evaluator**
Proposed title, review of literature and objectives.	–	3rd Week of III Semester	–
I Review	10	July	Supervisor
II Review	10	August	Supervisor
Internal	20	September/ October	Supervisor
Final– External (Dissertation and Innovation)	40	October /November	Ext. examiner
* Final– Project Viva (group & open)	20	October /November	Ext. examiner
Total marks	**100**		

*Mode of presentation by Power Point

Project framework

1. The Project format should be in:

- **Font – Times New Roman**
- **Heading – Font size 14 (Bold) – Uppercase**
- **Sub headings – Font size 12 (Bold) — Lowercase; should be numbered.(Eg: Introduction 1; Subheading 1.1; 1.2)**
- **Text, the content of the dissertation — Font size – 12 (Normal).**
- Citation – Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designated by the name of the *fast* author followed by the year of publication, placed inside brackets at the appropriate places in the text.

ii) A paper, a monograph or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

iii) A paper, a monograph or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside bracketsat the appropriate places in the text.

- **Line space – 1.5**
- **Margin – 2" on the left and 1" on the right, Gutter – 0.5.**
- **Page Numbering — Bottom middle alignment; excluding initial pages and reference**
- **Total number of pages – Minimum 30 – Maximum 50 (excluding initial pages andreference).**
- **The Tables and Figures should be included subsequently after referring them in thetext of the Report.**

II. Project Report must be completed within the stipulated time .

III Submission of Project Report:

- one soft copy (PDF format in CD)
- three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The Project Report **will have three main parts:**

I. Initial Pages – in the following sequence

i. Title Page
ii. Certificate from the Supervisor
iii. Declaration by the candidate endorsed by the Supervisor and HOD
iv. Acknowledgement (within one page – signed by the candidate).
v. Table of Contents
vi. List of abbreviations
vii. Abstract

II. Main body of the dissertation

i) Introduction with Literature review and Objectives
ii) Methodology
iii) Results
iv) .Discussion
v) Summary
vi) References

The guidelines for reference

Journal Article : with Single Author

Waldron, S 2008, "Generalized Welch bound equality sequences are tight frames", IEEETransactions on Information Theory, vol. 49, no. 9, pp. 2307– 2309.

Journal Article : with Two Authors

Conley, TG & Galeson, DW 1998, "Nativity and wealth in mid– nineteenth century cities", Journal of Economic History, vol. 58, no. 2, pp. 468– 493.

Journal Article: with more than two Authors

Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, „Bounds on the sum capacity of synchronous binary CDMA channels", Journal of Chemical Education, vol. 55, no. 8, pp. 3577– 3593.

Books

Holt, DH 1997, Management Principles and Practices, Prentice– Hall, Sydney. Centre forResearch, M S University – Ph.D. Revised Guidelines Page | 39 / 41

E– book

Aghion, P &Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam.Available from: Elsevier books. [4 November 2004].

Semester III

Elective III (a): Bio Physics

Course Code: PP2033

Hours/Week	Credits	Total Hours	Marks
6	4	90	100

Learning Objectives

1. To understand the organization of cell structure and different types of cell.
2. To understand the principles and applications of various microscopic and separationtools in cell biology.
3. To understand the fundamentals of macromolecular structure and the analytical techniques in characterizing biomolecular interactions and its structure.

Course Outcome

COs	Upon completion of this course, students will be ableto:	PSO addressed	CL
CO – 1	understand the basic structural unit and its different types.	PSO – 1	U
CO – 2	acquire the basic knowledge on various microscopes used to analyse the cell structure.	PSO – 2	U
CO – 3	analyse the structure of DNA, RNA and Proteins.	PSO – 1	A
CO – 4	explain the techniques used to separate the biomolecules.	PSO – 4	E
CO – 5	determine the interaction of molecules by using different optical and diffraction techniques.	PSO – 4	Ap

Unit I 15 hrs

Cell Organization: Cell as the basic structural unit– Origin & organization of Prokaryotic and Eukaryotic cell– Cell size & shape– Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell)– Internal architecture of cells– cell organelles– compartment & assemblies membrane system– Ribosome– Polysomes– Lysosomes– Peroxisomes– Connection between cell & its environment– Extracellular Matrix.

Unit II 15 hrs

Tools in Cell Biology: Light microscope– Resolving Power– Phase contrast microscope– Detection of small differences in refractive indices– Interference microscope– , Dark field microscope– Polarization microscopeFluorescence microscope– Cytophotometry methods– Flowcytometry& cell sorting– Electron microscopy– specimen preparation– Scanning Electron Microscopy (SEM)– Transmission Electron Microscopy (TEM)– Applications.

Unit III 15 hrs

Macromolecular Structure: Nucleic acid structure: Chemical structure of the nucleic acid – Conformational possibilities of monomers and polymers– Double helix structure of DNA– Polymorphism of DNA– DNA nanostructures and the structure of transfer RNA.

Proteins structure: Amino acids and the primary structures of proteins – Secondary – Tertiary – Quaternary structure and virus structure.

Unit IV 15 hrs

Separation Techniques: Centrifugation: Principle of centrifugation –Analytical ultracentrifugation – Differential centrifugation – Density gradient centrifugation. Chromatography: Principles of chromatography– Paper chromatography – Thin layer chromatography (TLC) – Gas liquid chromatography (GLC) – High performance liquid chromatography (HPLC).

Electrophoresis: Principles – Factors affecting the migration of substances – Supporting

media in electrophoresis – Gel electrophoresis – Polyacrylamide gel electrophoresis (PAGE) – Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS– PAGE).

Unit V 15 hrs

Optical & Diffraction Techniques: Circular Dichroism and optical rotator dispersion– : Plane, circular and elliptical polarization of light– Absorption by oriented molecules– Dichroic ratio of proteins and nucleic acids– Circular dichroism (CD) – optical rotatory disperson (ORD) – Relation between CD and ORD– Application of ORD in conformation and interactions of biomolecules. Crystallization of proteins– preparation of heavy metal derivatives– Patterson synthesisisomorphous replacement methods– structure factors of centro– symmetric and noncentrosymmetric crystals– General remarks on Protein– Structure determination from X– ray diffraction data– Neutron diffraction– , Electron diffraction– , Synchrotron diffraction, Application in Biomolecular structural studies.

Text Books

1. Geoffrey M.Cooper. (2013).*The Cell: A Molecular Approach.* ASM Press.
2. Veerakumari,L. (2006) . *Bioinstrumentation*, MJP Publishers.
3. Deb,A.C. (2011). *Fundamentals of Biochemistry*, New central book agency.

Reference Books

1. VasanthaPattabhi, Gautham,N.(2009). *Biophysics*. Narosa Publishing.
2. Mishra,VK. (2010). *Biophysics.* P.S. Enterprises.
3. Subramanian,M.A. (2005). *Biophysics.* MJP Publishers.

Semester III

Elective III (b): Microprocessor and Microcontroller

Course Code: PP2034

Hours/Week	Credits	Total Hours	Marks
6	4	90	100

Learning Objectives

1. To provide an extensive knowledge about the architecture and assembly languageprogramming of microprocessors 8085 & 8086 and microcontroller 8051.
2. To gain hands on experience in interfacing of 8085 microprocessor.

Course Outcome

COs	Upon completion of this course, students will be able to	PSOs addressed	CL
CO– 1	Identify/ Explain the operation of various components of the microprocessor 8085 and microprocessor 8086	PSO– 1	A
CO– 2	Relate and explain the various addressing modes and the instruction set of 8085 microprocessor	PSO– 1	R
CO– 3	Develop skill in writing simple programs for 8085 microprocessor	PSO– 2	C
CO– 4	Explain the architecture of 8051 microcontroller	PSO– 1	U
CO– 5	Understand the various interrupts of 8085 microprocessor	PSO– 2	U

Unit I 15 hrs

Microprocessors 8085 Architecture: Intel 8085 microprocessor: Introduction – Pin configuration– Architecture and its operations – Machine cycles of 8085– Interfacingof memory and I/O devices– Instruction classification: number of bytes, nature ofoperations– Instruction format– Vectored and non– vectored interrupts.

Unit II **15 hrs**

8085 Assembly Language Programming: Instruction set: Data transfer operations – Arithmetic operations Logical operations – Branching and machine control operations– Addressing modes– Writing assembly language programs: Looping, counting and indexing– Counters and time delays – Stack – subroutine– Translation from assembly language to machine language

Unit III **15 hrs**

Microprocessor 8086: Intel 8086 microprocessor: Introduction – Architecture – Pin configuration– Operating modes: Minimum mode, Maximum mode. Memory addressing: 8– bit data from even and odd address bank, 16– bit data from even and odd address bank– Addressing modes– Interrupts: Hardware interrupts – Software interrupts –Interrupt priorities– Simple programs.

Unit IV **15 hrs**

Microcontroller 8051 Architecture and Programming: Introduction to microcontroller and embedded system– Difference between microprocessor and microcontroller– 8051 microcontroller: Pin configuration, Architecture and Key features. 8051 Data types and directives Instruction set: Data transfer instructions – Arithmetic instructions – Logical instructions– Branching instructions– Single bit instructions. Addressing modes– Simple programs using 8051 instruction set.

Unit V **15 hrs**

Interfacing of Microprocessor 8085: Basic concepts of programmable device – 8255 Programmable Peripheral Interface (PPI) – interface of ADC and DAC– 8257 Direct Memory Access (DMA) controller– Basic concepts of serial I/O and data communication – interface of 8251 Universal Synchronous Asynchronous Receiver Transmitter (USART)

Text Book

1. Ramesh Goankar. (2013). *Microprocessor Architecture. Programming and Applications with the 8085.* (6th ed.). India: Penram International Publishing Pvt. Ltd.

Reference Books

1. Ram, B. and Sanjay Kumar. (2013). *Fundamentals of Microprocessors and Microcontroller*. (7th ed.). India: Dhanpat Rai Publications (P) Ltd.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin, D. Makinlay. (2009). *The 8051 Microcontroller and Embedded Systems.* (2nd ed.). New Delhi: Pearson Education.

Semester III

Elective III (c) : Solar Energy Utilization

Course Code: PP2035

Hours/Week	Credits	Total Hours	Marks
6	**4**	**90**	**100**

Learning Objectives

1. To provide knowledge on the fundamental aspects of solar energy Utilization.
2. To understand different approaches on the process and use of nanomaterials in fuelCell technology

Course Outcome

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	understand the basic concept of heat transfer	**PSO – 2**	**U**
CO – 2	Design the solar collectors and solve the optical loss.	**PSO – 6**	**C**
CO – 3	relate the different types of solar water heaters.	**PSO – 1**	**R**
CO – 4	analyze the use of nanostructures and nanomaterials in fuel cell technology	**PSO – 4**	**An**
CO – 5	Evaluate the photo voltaic principles and compare the types of solar cells	**PSO – 5**	**E**

Unit I 15 hrs

Heat Transfer & Radiation Analysis: Conduction– Convection and Radiation – Solar Radiation at the earth's surface – Determination of solar time – Solar energy measuring instruments.

Unit II **15 hrs**

Solar Collectors: Physical principles of conversion of solar radiation into heat flat plate collectors – General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.

Unit III **15 hrs**

Solar Heaters: Types of solar water heater – Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.

Unit IV **15 hrs**

Solar Energy Conversion: Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo – electric conversion – process flow of silicon solar cells– different approaches on the process– texturization, diffusion, Antireflective coatings, metallization.

Unit V **15 hrs**

Nanomaterials in Fuel Cell Applications: Use of nanostructures and nanomaterials in fuel cell technology – high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts– Use of nanotechnology in hydrogen production and storage.

Text Books

1. Rai,G.D. (1987).*Solar energy utilization*.Delhi: Khanna publishers.
2. Sukhatme,S.P. (1984).*Solar energy – principles of thermal collection &storage*.Delhi: TMH.
3. Maheshwar Sharon, Madhuri Sharon (2010) *Carbon "Nano forms andApplications",*McGraw– Hill.

Reference Books

1. Romer,R.H. Freeman,W.H.(1976).*Energy – An Introduction to Physics.*

Semester III
Life Skill Training - II
Course Code: LST202

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

1. To aid students in making right choices and decisions
2. To create awareness on practical methods that lead to personal and societal development

Course Outcome (CO)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Identify the root cause of social evils and it's consequences	PSO-	An
CO-2	Understand the importance of personal and emotional well being	PSO-	Un
CO-3	Empathise with the needy and disabled	PSO-	Ap

Unit I

Corruption - causes and types. Seeds and remedies of corruption.

Casteism - causes and consequences.

Communalism - characteristics - causes and remedial measures.

Regionalism - characteristics - causes and remedial measures.

Unit II

Abortion - reason and methods. Birth control

Alcoholism - alcoholism and causes of drinking. Harmful effects of liquor.

Drug addiction - causes - effects and control of drug addiction.

Unit III

Depression - signs - causes and treatments.

Suicide - signs and treatments. Child labour.

Unit IV

Divorce - causes and effects. Steps to avoid divorce.

Dowry system in India - Legislations to inhibit dowry system. Cases and problems.

Unit V

Care and concern for the aged and disabled - need to take care of elders. Caring of someone with physical disability.

HIV and aids - basic facts - causes - prevention and treatment.

Text Book:

(Compilation will be provided to the students)

Reference Books:

1. CN. Shankar Rao, India Social Problems - A Sociological Perspective. S. Chand and Company Limited. New Delhi. 2015.
2. CN. Shankar Rao, Sociology of Indian Society. S. Chand and company limited. New Delhi. 2004
3. Gawain, Shakti and Laurel King. Living in the Light. - A Guide to Personal Transformation. Natraj Publishing. Canada. 1998.

Semester IV

Core IX:Nuclear and Elementary Particle Physics

Course Code: PP2041

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To know about the fundamental principles and concepts governing nuclear and particle physics and their social, economic and environmental implications.
2. To understand the concept of elementary particles.

Course Outcome

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO– 1	Understand the properties of Nuclear forces and outline their behavioral formulation.	PSO – 1	U
CO– 2	Analyze the different nuclear models of the nucleus and examine the application of the shell model of nucleus.	PSO – 4	E
CO– 3	Explain the characteristics and effect of radioactive decay phenomena. (alpha,beta ,gamma)	PSO – 1	U
CO– 4	Discuss the outcome of various types of nuclear reactions.	PSO – 4	C
CO– 5	Examine the Particle Physics phenomena andtheir basic theoretical description.	PSO – 3	An

Unit I 15 hrs

Nuclear Forces: Characteristics of Nuclear Forces – Exchange forces and tensor forces – charge independence– Spin dependence of Nucleus Forces – Meson theory of nuclear forces– Ground state of deuteron– Nucleon– nucleon scattering singlet and tripletparameters – Nucleon– Nucleon scattering: Cross– section, Differential Cross– section, Scattering Cross– sections – magnetic moment– Quadrupole moment –S and D state admixtures – Effective range theory of n– p scattering at low energies.

Unit II 15 hrs

Nuclear Models: Binding energy & mass defect – Weizacker's formula – mass parabola – Liquid drop model – Bohr – Wheeler theory of fission– Activation energy for fission– Shell model– Spin –Orbit coupling– Spins of nuclei– Magnetic moments – Schmidt lines– Electric quadrupole moments – Collective model of Bohr and Mottelson:Nuclear vibration – Nuclear rotation –Nelson model.

Unit III 15 hrs

Nuclear Reactions: Nuclear reaction – Q– value – Nuclear reaction cross section – Direct Nuclear Reactions: Knock out reaction, Pick– up reaction, Stripping reaction – Compound nucleus theory – Formation – Disintegration energy levels – Partial wave analysis of Nuclear reaction cross– section – Resonance Scattering and Reaction cross– section (Breit– Wigner dispersion formula) – Scattering matrix – Reciprocity theorem – Breit – Wigner one level formula – Resonance scattering – Absorption cross section at high energy.

Unit IV 15 hrs

Radioactive Decays: Alpha decay – Beta decay –Energy release in beta decay – Fermi theory of beta decay – Shape of the beta spectrum – decay rate Fermi– Curie plot
– Fermi & G.T Selection rules – Comparatives half – lives and forbidden decays– Gama decay – Multipole radation – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.

Unit V 15 hrs

Elementary Particle Physics: Classification of elementary particles – Types of interaction betweenelementary particles – Hadrons and leptons – Symmetry and conservation laws – Strangeness and associate production – CPT theorem –classification of hadrons – Quark model – Isospin multiples – SU(2)– SU(3) multiplets– Gell– Mann – Okubo mass formula for octet and decouplet hadrons – Phenomenology ofweak interaction hadrons and leptons– Universal Fermi interaction – Elementary concepts of weak interactions.

Text Books

1. Cohen.B. L. (1971). *Concepts of Nuclear Physics*, Bombay :TMGH.
2. Krane.K. (1987). *Introductory Nuclear Physics*, New York: Wiley.
3. Devanathan.V. (2012). *Nuclear Physics*, Narosa Publishing house.
4. Griffiths.D,(2008). *Introduction to Elementary Particles*, 2nd Ed, Vch: Wiley.
5. Ghoshal. S.N. (1994). *Nuclear Physics*,II edition, New York: S. Chand and Co.
6. Tayal.D.C. (2018). *Nuclear Physics*, V edition, New Delhi: Himalaya Publishing House Pvt., Ltd.

Reference Books

1. Irving Kaplan.(2012). *Nuclear Physics.* Narosa Publishing House.
2. Srivatsava,B.N. (2016). *Basic Nuclear Physics and Cosmic Rays*,Edition: XVII,Meerut:Pragati Prakashan publications.
3. Pandya.M.L. P.R.S Yadav, (2016).*Elements of Nuclear Physics*, Meerut: Kedar Nath Ram Nath publications.

Semester IV

Core X : Spectroscopy

Course Code: PP2042

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To gain knowledge about the basic principles of spectroscopy.
2. To gain insight about the spectroscopic instruments and its applications.

Course Outcome

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	apply basic spectroscopic techniques. (Microwave, IR, Raman and NMR)	**PSO – 4**	**U**
CO – 2	infer basic spectroscopic techniques. (Microwave, IR, Raman, ESR, NQR and NMR)	**PSO – 6**	**Ap**
CO – 3	understand the molecular interactions in different spectroscopic methods.	**PSO – 1**	**An**
CO – 4	analyze the characteristics of rotational spectra and vibrational energy of molecules.	**PSO – 3**	**An**
CO – 5	utilize various spectroscopic methods suitable for characterizing molecules.	**PSO – 6**	**C**

Unit I 15 hrs

Microwave Spectroscopy: Rotation of Molecules – Rigid Rotor (Diatomic Molecules) – Expression for the Rotational Constant – Intensity of Spectral Lines – Effect of Isotopic

Substitution – Molecular Parameters (Bond Length, Bond Angle, Dipole Moment) from Rotation Spectra – Techniques and Instrumentation.

Unit II **15 hrs**

Infrared Spectroscopy: Vibrational energy of a diatomic molecule– Infrared selection rules– Vibrating diatomic molecule– Diatomic vibrating rotator– Vibrations of polyatomic molecules– Fermi resonance– Rotation vibration spectra of polyatomic molecules– Normal modes of vibration in crystal– Interpretation of vibrational spectra– Group frequencies– IR spectrophotometer– Instrumentation– Sample handling techniques– Fourier Transform Infrared spectroscopy– Applications

Unit III **15 hrs**

Raman Spectroscopy: Introduction– Theory Of Raman Scattering– Rotational Raman Spectra– Vibrational Raman Spectra– Mutual Exclusion Principle– Raman Spectrometer– Sample Handling Techniques– Polarization Of Raman Scattered Light– Structure Determination Using IR And Raman Spectroscopy– Raman Investigation Of Phase Transitions– Resonance Raman Scattering– Nonlinear Raman Phenomena– Preliminaries– Hyper Raman Effect– Stimulated Raman Scattering– Inverse Raman Effect– Coherent Anti– Stokes Raman Scattering.

Unit IV **15 hrs**

Nuclear Magnetic and Electron Spin Resonance Spectroscopy: Basic principles – Quantum theory of NMR – magnetic resonance – relaxation processes – chemical shifts – spin– spin coupling – Spectra and molecular structure – Fourier Transform NMR –Instrumentation – Applications.

Basic principles – Quantum theory – g– factor – Nuclear Interaction and Hyperfine structure – Relaxation effects – Hyperfine interaction – line widths – ESR spectrometer

– Instrumentation – applications.

Unit V **15 hrs**

Nuclear Quadrupole Resonance and Mossbauer Spectroscopy: Basic theory – Nuclear Electric quadrupole interaction – Energy levels – Transition frequency-

Excitation and Detection – Effect of magnetic field – Instrumentation – applications. Mossbauer effect – recoilless emission and absorption – hyperfine interaction – chemical isomer shift – magnetic hyperfine and electric quadruple interactions –Instrumentation – applications.

Text Books

1. Aruldhas. G. (2005). *Molecular structure and spectroscopy*. (2nd ed). New Delhi: Prentice– Hall of India private Ltd.
2. Colin N.Banwell, Elaine M.Mc Cash.(1995). *Fundamentals of Molecular Spectroscopy* (Fourth Edition), Tata McGraw– Hill Publishing Company Ltd.

Reference Books

1. Graybeal, J.D. (1988)*Molecular Spectroscopy*, McGraw– Hill, New York,.
2. Hollas, Michael, *Modern Spectroscopy (Fourth Edition)* John Wiley, New York, 2004.
3. R.P Straughen, S.Walker, Spectroscopy Vols.I,II and III, Chapman & Hall, London, 1976.

Semester IV

Core XI : Thermodynamics and Statistical Mechanics

Course Code: PP2043

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To provide a phenomenological introduction to thermodynamics through thermodynamics postulates, quantities and relations.
2. To understand the micro and macroscopic properties of the matter through the statistical probability laws and distribution of particles and study the transport properties, different phases of maters, equilibrium and nonequilibrium process.

Course Outcomes

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	understand the basic concepts related to thermodynamics, microstates and macrostates	**PSO – 4**	**U**
CO – 2	apply principles to find relation between grand canonical and canonical partition functions	**PSO – 1**	**Ap**
CO – 3	solve the Bose– Fermi– Dirac and Maxwell Boltzmann Einstein, – distributions	**PSO – 4**	**C**
CO – 4	analyze the origin of transport and non– equilibrium processes	**PSO – 3**	**An**
CO – 5	understand the concept of heat capacities and phasetransitions	**PSO – 4**	**U**

Unit I **15 hrs**

Thermodynamics, Microstates and Macrostates: Basic postulates of thermodynamics – Phase space and ensembles – Fundamental relations anddefinition of intensive variables – Intensive variables in the entropic formulation – Equations ofstate – Euler relation, densities – Gibbs– Duhem relation for entropy – Thermodynamic potentials–Maxwell relations – Thermodynamic relations – Microstates and macrostates – Ideal gas –Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems– Density of states and volume occupied by a quantum state

Unit II **15 hrs**

Microcanonical, Canonical and Grand Canonical Ensembles: Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbsparadox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics – Partition function and free energy of an ideal gas –The grand partition function – Relation between grand canonical and canonical partition functions – One–orbitalpartition function

Unit III **15 hrs**

Bose– Einstein, Fermi– Dirac and Maxwell– Boltzmann Distributions: Bose– Einstein and Fermi– Dirac distributions – Thermodynamic quantities – Non–interactingBose gas and thermodynamic relations – Chemical potential of bosons – The principle ofdetailed balance – Number density of photons and Bose condensation – Thermodynamic relationsfor non– interacting Fermi gas – Fermi gas at zero and low temperature – Fermi energy and Fermimomentum – Maxwell– Boltzmann distribution law for microstates in a classical gas – Physicalinterpretation of the classical limit – Fluctuations in different ensembles

Unit IV **15 hrs**

Transport and Non– Equilibrium Processes: Derivation of Boltzmann transport equation for change of states without and with collisions –Boltzmann equationfor quantum statistics – Equilibrium distribution in Boltzmann equation –Transport processes; One

speed and one dimension – All speeds and all directions – Conservedproperties – Distribution of molecular velocities – Equipartition and Virial theorems – Randomwalk – Brownian motion – Non– equilibrium process; Joule– Thompson process – Free expansionand mixing – Thermal conduction – The heat equation.

Unit V **15 hrs**

Heat Capacities, Ising Model and Phase Transitions: Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas –Heat capacity of Bose gas –One– dimensional Ising model and its solution by variational method– Exact solution for one– dimensional Ising model – Phase transitions and criterion for phasetransitions – Classification of phase transitions by order and by

symmetry – Phase diagrams forpure systems – Clausius– Clapeyron equation – Gibbs phase rule

Text Books

1. Sinha. S.K. (2007).*Introduction to Statistical Mechanics*. New Delhi: Narosa PublishingHouse Pvt.Ltd.
2. Saxena, A.K. (2010). An *Introduction to Thermodynamics and Statistical Mechanics*.New Delhi: Narosa Publsihing House Pvt.Ltd.
3. Kerson Huang.(1986). *Statistical mechanics*. Wiley Eastern Ltd.

Reference Books

1. Reif. (2010). *Fundamentals of Statistical and Thermal Physics*. Paperback. Sarat BookDistributors.
2. Laud.B.B.(2012).*Fundamentals of Statistical Mechanics*. Paperback. New Age International Private Limited.
3. Kittel.C.(2004). *Elementary Statistical Physics*.John Wiley & Sons.
4. Reif.F. (2010). *Statistical and Thermal Physics*.Fifth Edition.McGraw Hill.
5. Gupta & Kumar. (2003).*Statistical Mechanics*. 20th Edition, Meerut: Pragati Prakashan.
6. Agarwal.B.K. and Meisner. (2016). *Statistical Mechanics*. Second Edition. New

Delhi:New Age International Private Limited.

7. Gopal.E.S.R. (1974).*Statistical Mechanics and Properties of Matter* (Theory and \ Applications). Ellis Horwood Ltd.

Semester: IV

Elective IV(a) :Materials Physics and Processing Techniques

Course code: PP2044

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To impart knowledge on various materials growth, synthesis and processing techniques
2. To learn the structural, morphology, and surface characterization techniques.

Course Outcome

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO– 1	Remember basic principles in material physics	PSO – 1	R
CO– 2	Understand various material fabrication methods	PSO – 2	U
CO – 3	Analyse different characterization used for materials processing	PSO– 4	An
CO– 4	Apply different methods of material processiing	PSO– 5	Ap
CO– 5	Evaluate the materials and characterization tools	PSO – 4	E

Unit I 15 hrs

Crystal Growth: Significance of crystal growth– Naturally occurring crystal growth processes– Crystal growth processes in laboratory and industrial scale– Classification of crystal growth methods Growthfrom solutions – Nucleation: Homogeneous and heterogeneous, Solubility phase diagram Saturation– Supersaturation– Metastable zone width– Slow evaporation and slow cooling methods, Growth from gel– Growth from flux–

Growth from melt– Bridgeman– Stockbarger method– Czochralski pulling method– Growth from vapour– Sublimation method.

Unit II **15 hrs**

Plasma Processing: Basics Of Plasma: Introduction, Types Of Plasma; Properties Of Plasma; V– I Characteristics; Advantages Of Plasma Processing. Thermal Plasma: Principles Of Plasma Structure Of Sprayed Deposits, Plasma Spheroidization; Plasma Decomposition; Treatment Of Hazardous Wastes – Synthesis Of Ultrafine/Nanopowders. Plasma Melting And Remelting– Nonthermal Plasma: Glow Discharge Plasma, Plasma Reactors For Surface Treatment: Corona&DBD Atmospheric Pressure Surface Treatment Reactors

Unit III **15 hrs**

V**acuum techniques:** Units and range of vacuua – Formulas for important quantities

– Qualitative description of pumping process – Surface processes and outgassing – Gas flow mechanism – Classification of pumps :Positive displacement pumps – Kinetic pumps – Entrapment pumps – Classification of pressure gauges : Total pressure gauges
–Hydrostatic pressure gauges – Thermal conductivity gauges –Ionization gagues –Vacuum system : simple rotary, diffusion, turbo molecular, ultrahigh vacuum and cryo– pumped systems.

Unit IV **15 hrs**

Growth Technique Of Thinfilms And Nanomaterials: Plasma arc discharge– sputtering– chemical vapour deposition– pulsed laser deposition– molecular beam epitaxy– Electrochemical deposition– SILAR method Solid– State Reaction – Sol– Gel Technique – Hydrothermal growth – Ball Milling – Combustion synthesis – Sonochemical method – Microwave synthesis – Coprecipitation

Unit V **15 hrs**

Characterization Tools: Working principles and instrumentation – XRD – XPS – AES– SIMS – RBS– LEED – AFM – SEM – STM

Text Books

1. Maissel, Glange. (1970).*Handbook of Thin Film Technology.*First Edition. McGraw Hill.
2. Roth,A.(1990).*Vacuum Technology*. Third Edition , North Holland.
3. Pipko A, Pliskosky, V. (1984).*Fundamentals of Vacuum Techniques.* First Edition. MIRPublishers.
4. Chopra,K. L. (1969). *Thin Films Phenomena*.First Edition . McGraw Hill.
5. Avasthi,D. K. Tripathi,A. Gupta,A. C. (2002).*Ultra High Vacuum Technology.* Allied Publishers Private Limited.
6. Kasturi Lal Chopra, Suhit Ranjan Das.(1983).*Thin Film Solar Cells*. New York : PlenumPress.

Reference Books

1. Chambers, A, Fitch, R.K. Halliday, B.S.(1998)*Basic Vacuum Technology*. 2 ND Edition,IOP Publishing Ltd.
2. Roth,A.(1990).*Vacuum Technology*. 3 rd Edition. Elsevier Science.
3. Suryanarayana,C.(Edited). (1999).*Non– equilibrium processing of materials* (Chapter –6) Pergamon.
4. Ananthapadmanabhan,P.V.Venkataramani,N. (1999).*Thermal plasma processing Pergamon materials.* series Vol 2.
5. Reece Roth, J. (2001).*Industrial plasma engineering – Applications to Nonthermal plasmaprocessing*. (Vol. 2) Bristol: Institute of Physics Publishing.
6. Maher I. Boulos, PierreFauchais, Emil Pfender. (1994).*Thermal plasmas– Fundamentalsand Applications*. (Vol. 1) Springer Science.

Semester IV

Elective IV (b): Advanced Nano Physics

Course code: PP2045

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1.To understand the theoretical aspects of low dimensional semiconductor systems. 2.To learn the structures, properties, characterization and applications of nanomaterials.

Course Outcome

COs	Upon completion of this course the students will be able to :	PSO addressed	CL
CO– 1	Identify how basic physics can be used to describe thebehaviour of electrons in nano– scale materials.	PSO– 1	R
CO– 2	Explain the variation in the electron distribution in nanostructures for different dimensions(Quantum well, Quantum wires & quantum dots)	PSO– 3	U
CO– 3	Analyze magneto electronics and applications of Nanotechnology in various fields.	PSO– 6	An
CO – 4	Explain Laser effect in Quantum well, Quantum wires and quantum dots .	PSO– 2	U
CO– 5	Compare the structure and properties of Carbon nanostructures	PSO– 6	E

	and their applications in the emerging nanotechnology		
CO – 6	Discuss the fabrication and characterization techniques of nanomaterials	**PSO– 2**	**U**
CO – 7	Develop key concepts in Single electron transistor, Spintronics and Giant magnetoresistance	**PSO– 4**	**C**

Unit I 15 hrs

Introduction to Nano and Types of Nanomaterials: Need and origin of nano – Nano and energetic – Top– down and bottom– up approaches– Introductory ideas of 1D, 2D and 3D nanostructured materials Quantum well: Quantum well infrared detector– quantum well laser– quantum cascade laser– Quantum wire: Production– VLS growth mechanism– structure and uses– Quantum dots: Description– Exciton confinement in quantum dots – Epitaxially self– assembled quantum– dot– Application: Quantum dot laser.

Unit II 15 hrs

Carbon Nanostructures: Carbon molecules and carbon bond – – C60: Discovery and structure of C60 and its crystal – Superconductivity in C60 – Fullerene– Carbon Nano Tubes (CNT): Types– Fabrication: Electric Arc– discharge method– Laser method– Solar production of carbon nanotubes – Chemical vapour deposition– Electronic structure – Electrical properties – Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors, catalysts) – Filling of carbon nanotubes – CNT emitters.

Unit III 15 hrs

Fabrication of Nanomaterials: Synthesis of oxide nanoparticles by sol– gel method – Synthesis of metallic nanoparticles Electrochemical deposition method – Sonochemical reduction method – Lithography – – Atomic layer deposition – Synthesis of semiconductor nanoparticles – Arrested precipitation method– Core shell structures – Bio synthesis of nanoparticles using plants – Preparation of magnetic nanomaterials – Super paramagnetism – Coulomb blockade – Single electron transistor.

Unit IV 15 hrs

Characterization of Nanomaterials: Principles, experimental set– up, procedure and utility of X– ray diffraction (XRD), Scanning electron microscopy (SEM), Atomic force microscopy (AFM), Scanning tunneling microscope (STM) and scanning probe microscopy (SPM) – Fourier transform infrared spectroscopy– Quantum cellular Automata– Spintronics – Giant magnetoresistance – Quantum Hall effect – Quantum spin Hall effect – Fractional quantum Hall effect.

Unit V 15 hrs

Applications: Molecular electronics and nanoelectronics – Nanorobots – – Biological applications of nanoparticles – – Catalysis by gold nanoparticles – Band– gap engineered quantum devices – Nanomechanics –Photo electro chemical cells – Photonic crystals – Plasmon waveguides. Sensors – MEMS/NEMS – Solar cells – Displays – Optical switches – Graphene electronics – Biosensors – Biomarkers and Bio imaging – Targeted drug delivery

Text Books

1. Pradeep.T. (2012). *A Textbook of Nanoscience and Nanotechnology.*New Delhi:Tata McGraw Hill.
2. Kelsall.R.W. Hamley.I.W. (2005).*Nanoscale Science and Nanotechnology.* Chichester:John – Wiley & Sons.
3. Sr. Gerardin Jayam. (2019). *Nano Physics*, (3st ed.). Nagercoil: Department ofPhysics, Holy Cross College.

Reference Books

1. Cao. G. (2004). *Nanostructures and Nanomaterials.* London: Imperial College Press.
2. Poole. C.P. Owens.F.J.(2003).*Introduction to Nanotechnology*. New Delhi: Wiley.

Semester IV

Elective IV (c):X– Ray Crystallography

Course Code: PP2046

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To study the production of X– rays, crystals and its symmetry and their properties.
2. To understand the X– ray intensity data collection techniques, data reduction and structure solution and refinement from crystallographic method.

Course Outcome

Cos	Upon completion of this course students will be able to:	PSO addressed	CL
CO – 1	understand the sources and diffraction of X– rays.	PSO – 1	U
CO – 2	acquire the basic knowledge on crystal systems and various properties of crystals.	PSO – 1	U
CO – 3	explain the crystallographic data collection tools and intensity measurement method.	PSO – 2	E
CO – 4	analyse the structure factor and intensity of diffracted peaks.	PSO – 4	A
CO – 5	obtain the refined crystal structure by applying mathematical calculations.	PSO – 4	Ap

Unit I **15 hrs**

X– rays: X– rays sources – conventional generators– construction and geometry– sealed tube–rotating anode generators–choice of radiation– Synchrotron radiation – X– ray optics: filters– monochromators– collimators– mirrors– safety. Diffraction of X– rays:Lattice– Lattice planes– Miller indices–X– ray diffraction reciprocal lattice–relation between direct and reciprocal space–Bragg's law in reciprocal lattice–sphere of reflection – limiting sphere.

Unit II **15 hrs**

Crystals and their Properties: Crystal systems and symmetry – unit cell – space lattices– non primitive lattices – point groups– space groups–screw axes–glide planes– equivalent positions–matrix representation of symmetry intensity weighted reciprocal lattice – analysis of space group symbols. Crystallization – growing crystals
– choosing a crystal –mosaic structure– absorption– crystal mounting–alignment – measurement of crystal properties.

Unit III **15 hrs**

Data Collection Techniques for Single Crystals: Laue method– single crystal diffraction cameras: rotation and oscillation method – Ewald construction – Weissenberg method – Precession method. Single crystal diffractometers and datacollection strategy: Instrument geometry–crystal in a diffracting position–determination of unit cell– orientation matrix–Intensity Data collection–Unique data–equivalent reflections – selection of data–Intensity measurement methods: Film methods–counter methods: Point detector– Area detectors–CCD's–Image plates–Low temperature single crystal diffractometry.

Unit IV **15 hrs**

Data Reduction: Integration of intensity–Lorenz and Polarization corrections – absorption–deterioration or radiation damage–scaling – Interpretation of Intensity data. Structure factor – Friedel's Law – exponential and vector form – generalized structure factor – Fourier synthesis –Fast Fourier transform – Anomalous scattering and its effect–

Calculation of structure factors and Fourier syntheses.

Unit V 15 hrs

Refinement of Crystal Structures: Weighting – Refinement by Fourier syntheses – Locating Hydrogen atoms– identification of atom types – Least squares – goodness of fit– Least square and matrices– correlation coefficients– Relationship between Fourier and Least squares – Practical consideration in least squares methods.

Text Books

1. G.H. Stout and L.H.Jensen, (1989). Second Edition. *X– ray Structure Determination*:John Wiley Publications.
2. C. Giacovazzo, (2011) *Fundamentals of Crystallography* Second Edition: OxfordPress.
3. Ladd and Palmer Structure (2013) *Determination by X– ray Crystallography*, SecondEdition: Plenum Publishing Corporation.

Reference Books

1. Woolfson, (1997) X– *ray Crystallography*. Second Edition.Cambridge University:Press Publications.
2. Leonid V. Azaroff, (1968) *Elements of X– ray Crystallography*. McGraw Hill Publications.
3. J.P. Glusker, M. Lewis and M. Rossi (1994),*Crystal Structure analysis for Chemistand Biologist* .VCH Publishers Inc.
4. D. Sherwood, and J. Cooper, (2010) *Crystal X– ray and Proteins*. Oxford UniversityPress.
5. F.C. Phillips, John Wiley, (1971) An *Introduction to Crystallography*.

Semester: III & IVPractical – III

Advanced Physics Lab – III (Electronics)

Subject Code: PP20P3

Hours/Week	Credits	Total Hours	Marks
6	3	90	100

Learning Objectives

1. To understand and analyze the working of electronic devices.
2. To acquire skills in designing electronic circuits.

Learning Outcome

LOs	Upon completion of this course, students will be able to:	PSO addressed	CL
LO – 1	Analyse the working of code converters (BCD / Gray, excess 3)	**PSO – 2**	**An**
LO – 2	Design various synchronous and asynchronous sequential circuits and study their working	**PSO – 6**	**Ap**
LO – 3	Analyse the applications of op– amps (sine, triangular wave generator, low, high and band pass filters)	**PSO – 2**	**An**
LO – 4	Analyse the behavior of counters (up/down, mod, ring)	**PSO – 2**	**An**
LO – 5	Analyse the working of electronic circuits (multiplexer, demultiplexer, adder, subtractor)	**PSO – 2**	**An**

Any fourteen

1. Code converters – BCD to Gray, Gray to BCD
2. Darlington pair amplifier
3. FET: Characteristics
4. FET : Amplifier

5. Push – Pull Amplifier
6. Amplitude modulated circuits
7. UJT – Characteristics and saw toothwave generator
8. Phototransistor – Comparison of illumination
9. Schmidt trigger usingIC 555 and IC 741
10. Counters: up, down ring and mod counters
11. Operational Amplifier – A/D converter
12. Operational Amplifer – sine, square, triangular and pulse wave generators
13. Binary adder and subtractor.
14. Operational Amplifier – analog computation
15. Modulus counter – IC7490
16. Multiplexer, Demultiplexer, karnaugh map
17. SCR – Characteristics.
18. BCD to excess 3, excess 3 adder

Reference: Material prepared by the department.

Semester: III & IV

Practical IV –Advanced Physics Lab – IV(Microprocessor and Micro Controller) Course code: PP20P4

Hours/Week	Credits	Total Hours	Marks
6	3	90	100

Learning Objectives

1. To become familiar with the instruction set of Intel 8085 microprocessor and microcontroller.
2. To provide practical hands on experience with Assembly LanguageProgramming and interfacing with 8085 microprocessor.

Learning Outcome

Los	Upon completion of this course, students will be able to:	PSO addressed	CL
LO – 1	Experiment with assembly language programming on 8085 microprocessor (Addition, Subtraction, Multiplication &Division)	**PSO – 2**	**Ap**
LO – 2	Apply assembly language programming on microprocessor (Data Manipulation, square of numbers,counters)	**PSO – 4**	**Ap**
LO – 3	Analyse the interfacing of microprocessor 8085 with I/O devices (A/D& D/A, Stepper motor)	**PSO – 2**	**An**
LO – 4	Apply assembly language programs for 8051 microcontroller.	**PSO – 4**	**Ap**

Any fourteen

1. Assembly language program for Block move and logical operations
2. Assembly language program for Addition, Subtraction, Multiplication, and Division.
3. Arranging an array of data in Ascending and descending orders.
4. Finding the largest, smallest and search for any number of an array using micro processor
5. Factorial of given Number.
6. Sum of series of even numbers and odd numbers from the list of numbers.
7. Fibonaci series.
8. Counters using microprocessor
9. Waveform generation using microprocessor
10. Display of any character (Rolling display)
11. Code conversion using microprocessor
12. AD/DA converters using microprocessor
13. Number of zeros, positive, negative numbers and square of a number using 8085microprocessor
14. Interfacing – Stepper motor using microprocessor
15. Interfacing – Traffic Control
16. Microcontroller – Logic operations, 1's and 2's compliment
17. Microcontroller – Addition, Subtraction, Multiplication, and Division

Reference: Material prepared by the department.

Semester IV
Life Skill Training - II
Course Code: LST202

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:
1. To improve the integral growth of human being towards sustainable development.
2. To create awareness about human rights, values and their significance and their role.

Course Outcome (CO)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Understand the pros and cons of organ donation and transplant.	PSO-	
CO-2	To recognise their rights and address the issues pertaining to human rights violation.	PSO-	
CO-3	To acquire the skills required for a successful personal and professional life.	PSO-	

Unit I

Generation gap - causes. Bridging the generation gap.

Donate life - pros and cons of organ donation - organ donation and transplant.

Unit II

Impact of mass media on society - functions and social impacts of media.

Responsible freedom - freedom and responsibility.

Unit III

Violation of human rights - the right to live free. Freedom to move - freedom of thought and freedom of expression. Right to democracy - types of violations and safeguarding of human rights.

Unit IV

Impact of materialism on youth.

Terrorism - causes - solutions to rid the world of terrorism and remedy.

Unit V

Marriage preparation - Fidelity and permanence. Values to practice for a successful marriage. Tips for a successful marriage.

Professional ethics and human values - work ethics - ethics and character. Civic virtues and respect for others. Types of value and its nature. Professional value and duty ethics - how to face challenges in the work place.

Text Book:

(Compilation will be provided to the students)

Reference Books:

1. Baghel, Dr. Sanjay Singh. *Social Media and Indian Youth*. Apple Books. New Delhi.2015.

2. Bhagwan , Dada. *Generation Gap* . mahavideh Foundation. Ahmedabad. 2000.

3. M. Govindarajan, S. Natarajan and V.S. Senthil Kumar. Professional Ethics and Human Values. PHI Learning Private Limited. New Delhi .2013.

4. Don Miguel Riuz and Heather Ash Amara. *The Seven Secrets to Healthy , Happy Relationships.* Hierophant Publishing . 2018.

Self– Learning CourseSemester III

Physics for Lectureship Exam – I (PP20S1)

(CSIR/ JRF/ SLET/ GATE)

Hours/Week	Credits	Total Hours	Marks
–	2	–	100

Learning Objective

1. To motivate the students for career opportunities and also for research activities.

Course Outcome

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	familiarize with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.	**PSO – 1**	**U**
CO – 2	model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations	**PSO – 4**	**Ap**
CO – 3	gain insight into the physical nature of electric and magnetic phenomena	**PSO – 1**	**U**
CO – 4	use quantum mechanical principles to analyze advanced Physical phenomena of nature	**PSO – 6**	**Ap**
CO – 5	understand the theory and methods of statistical physics and thermodynamics.	**PSO – 1**	**U**

Unit I

Mathematical methods of physics: Dimensional analysis – Vector algebra and vector calculus – Linear algebra– matrices – Cayley– Hamilton Theorem – Eigenvalues

and eigenvectors. Linear ordinary differential equations of first & second order,Special functions (Hermite, Bessel, Laguerre and Legendre functions), Fourier series – Fourier and Laplace transforms. Elements of complex analysis – analytic functions;Taylor & Laurent series; poles – residues and evaluation of integrals – Elementary probability theory – random variables – binomial – Poisson and normal distributions – Central limit theorem – Green's function – Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions – interpolation – extrapolation – integration by trapezoid and Simpson's rule –

Solution of first order differential equation using, Runge– Kutta method. Finite difference methods –Tensors– Introductory group theory: SU(2), O(3).

Unit II

Classical mechanics: Newton's laws – Dynamical systems– Phase space dynamics– stability analysis. Central force motions– Two body collision – Scattering in laboratory and Centre of mass frames – Rigid body dynamics– Moment of inertia tensor – Non– inertial frames and pseudoforces – Variational principle – Generalized coordinates – Lagrangian and Hamiltonian formalism and equations of motion – Conservation laws and cyclic coordinates – Periodic motion: Small oscillations – Normal modes – Special theory of relativity– Lorentz transformations – relativistic kinematics and mass–energy equivalence – Dynamical systems – Phase space dynamics – Stability analysis – Poisson brackets and canonical transformations – Symmetry – Invariance and Noether's theorem – Hamilton– Jacobi theory.

Unit III

Electromagnetic theory: Electrostatics: Gauss's law and its applications – Laplace and Poisson equations – boundary value problems – Magnetostatics: Biot– Savart law – Ampere's theorem – Electromagnetic induction – Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces – Scalar and vector potentials – Gauge invariance – Electromagnetic waves in free space – Dielectrics and conductors – Reflection and refraction – Polarization – Fresnel's law – Interference –Coherence – Diffraction – Dynamics of charged particles in static and uniform electromagnetic fields – Dispersion relations in plasma – Lorentz invariance of Maxwell's equation – Transmission lines and wave guides – Radiation– From moving charges and

dipoles and retarded potentials.

Unit IV

Quantum mechanics: Wave– particle duality – Schrödinger equation (time– dependent and time– independent) – Eigenvalue problems (particle in a box, harmonic oscillator, etc.) – Tunneling through a barrier – Wave– function in coordinate and momentum representations – Commutators and Heisenberg uncertainty principle – Dirac notation for state vectors – Motion in a central potential: Orbital angular momentum – Angular momentum algebra – Spin – Addition of angular momenta – Hydrogen atom – Stern– Gerlach experiment – Time– independent perturbation theory and applications – Variational method – Time dependent perturbation theory and Fermi's golden rule – selection rules – Identical particles – Pauli exclusion principle – Spin– statistics connection.

Unit V

Thermodynamics and statistical Physics: Laws of thermodynamics and their consequences – Thermodynamic potentials– Maxwell relations – Chemical potential – Phase equilibria – Phase space – Micro– and macro– states – Micro– canonical – Canonical and grand– canonical ensembles and partition functions – Free energy and its connection with thermodynamic quantities – Classical and quantum statistics – Ideal Bose and Fermi gases – Principle of detailed balance – Blackbody radiation and Planck's distribution law.

Reference Book

1. W. Malemnganba Chenglei, 2018, Study Materials UGC CSIR NET/SET (JRF &LS) Physical Sciences, Arihant Publications Ltd.

Question pattern (Answer all the questions)

Internal Test	**Marks**	**External Exam**	**Marks**
Part– A(10x1) (No Choice– simple objective type)	10	Part– A(20x1) (No Choice– simple objective type)	20
Part B (5x2) (No Choice objective type)	10	Part B (10x2) (No Choice objective type)	20
Part C(5x4) (No Choice objective type) Higher order thinking skills	20	Part C(5x4) (No Choice objective type) Higher order thinking skills	20
Total	**40**	**Total**	**60**

Self– Learning CourseSemester IV

Physics for Lectureship Exam – II (PP20S2)

(CSIR/ JRF/ SLET/ GATE)

Hours/Week	Credits	Total Hours	Marks
–	2	–	100

Learning Objective

1. To build confidence to face competitive exams and pursue research.

Course Outcome

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO – 1	understand the physical construction, working and operational characteristics of semiconductor devices	PSO– 1	U
CO – 2	attain knowledge on the structure and dynamics of the molecules through various theories	PSO– 3	A
CO – 3	develop analytical thinking to understand the phenomenon that decide various properties of solids	PSO– 4	C
CO – 4	Know the scientific, environmental and technological applications of nuclear physics	PSO– 7	U
CO – 5	Study the fundamentals of wave mechanics	PSO– 1	U

Unit I

Electronics and experimental methods: Semiconductor devices (diodes, junctions, transistors, field effect devices, homo– and hetero– junction devices) – Devicestructure – Device characteristics – Frequency dependence and applications – Opto– electronic

devices (solar cells, phot – detectors, LEDs) – Operational amplifiers and theirapplications – Digital techniques and applications (registers, counters, comparators and similar circuits) – A/D and D/A converters – Microprocessor and microcontroller basics – Data interpretation and analysis – Precision and accuracy – Error analysis – propagation of errors – Least squares fitting – Linear and nonlinear curve fitting – Chi– square test – Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors) – Measurement and control – Signal conditioning and recovery – Impedance matching – amplification (Op– amp based, instrumentation amp, feedback) – Filtering and noise reduction – Shielding and grounding – Fourier transforms – Lock– in detector – Box– car integrator – Modulation techniques – High frequency devices (including generators and detectors).

Unit II

Atomic & molecular physics: Quantum states of an electron in an atom – Electron spin – Spectrum of helium and alkali atom – Relativistic corrections for energy levels of hydrogen atom – Hyperfine structure and isotopic shift – Width of spectrum lines – LS & JJ couplings – Zeeman – Paschen– Bach &Stark effects – Electron spin resonance – Nuclear magnetic resonance – chemical shift – Frank– Condon principle – Born– Oppenheimer approximation – Electronic – Rotational – Vibrational and Raman spectra of diatomic molecules – selection rules – Lasers: Spontaneous and stimulated emission – Einstein A & B coefficients – Optical pumping – Population inversion – Rate equation – Modes of resonators and coherence length.

Unit III

Condensed matter physics: Bravais lattices – Reciprocal lattice – Diffraction and the structure factor – Bonding of solids – Elastic properties – Phonons – Lattice specific heat – Free electron theory and electronic specific heat – Response and relaxation phenomena – Drude model of electrical and thermal conductivity – Hall effect and thermoelectric power – Electron motion in a periodic potential – Band theory of solids: Metals – Insulators and semiconductors – Superconductivity: Type– I and type– II superconductors – Josephson junctions – Super fluidity – Defects and dislocations – Ordered phases of matter: Translational and orientational order – Kinds of liquid crystalline order – Quasi crystals.

Unit IV

Nuclear and particle physics: Basic nuclear properties: Size – Shape and charge distribution – Spin and parity – Binding energy – Semi– empirical mass formula – Liquid drop model – Nature of the nuclear force – Form of nucleon– nucleon potential – Charge– independence and charge– symmetry of nuclear forces – Deuteron problem – Evidence of shell structure – single– particle shell model – Its validity and limitations – Rotational spectra – Elementary ideas of alpha – Beta and gamma decays and their selection rules – Fission and fusion – Nuclear reactions – Reaction mechanism – Compound nuclei and direct reactions – Classification of fundamental forces – Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.) – Gellmann– Nishijima formula – Quark model – Baryons and mesons – C, P, and T invariance – Application of symmetry arguments to particle reactions – Parity non– conservation in weak interaction – Relativistic kinematics.

Unit V

Quantum mechanics and statistical physics: Spin– orbit coupling – Fine structure – WKB approximation – Elementary theory of scattering: Phase shifts – Partial waves – Born approximation – Relativistic quantum mechanics: Klein– Gordon andDirac equations – Semi– classical theory of radiation – Bose– Einstein condensation – . Diffusion equation – Random walk and Brownian motion – Introduction to non equilibrium processes.

Reference Book

1. W. Malemnganba Chenglei, 2018, Study Materials UGC CSIR NET/SET (JRF & LS) Physical Sciences, Arihant Publications Ltd

Question pattern (Answer all the questions)

Internal Test	**Marks**	**External Exam**	**Marks**
Part– A(10x1) (No Choice– simple objective type)	10	Part– A(20x1) (No Choice– simple objective type)	20
Part B (5x2) (No Choice objective type)	10	Part B (10x2) (No Choice objective type)	20
Part C(5x4) (No Choice objective type) Higher order thinking skills	20	Part C(5x4) (No Choice objective type) Higher order thinking skills	20
Total	**40**	**Total**	**60**

Practical

Internal : 40 marks

External : 60 marks

Total : 100 marks

Internal : 40 marks

Performance of the experiments : 10 Regularity in attending practicals and

Submission of records : 10

Record : 5

Model exam : 15

Total : 40 marks

External : 60 marks Electronics & Non Electronics

Formula, Circuit : 10

Knowledge : 10

Observation & TabulationResult, Accuracy & Unit : 25

: 15

Total : 60 marks

Microprocessor & Computer Programming

Program Knowledge : 20

Debugging & ExecutionInput / Output : 10

Total : 15

: 15

: 60 marks

Summer Training Program (II M.Sc. Physics)

Computer Hardware

Course Code: H20STP

Hours/Week	Credits	Total Hours	Marks
–	1	30	100

Learning Objectives

1. To provide much needed knowledge of computer hardware and networking.
2. To enable to identify and rectify the onboard computer hardware, software and network related problems.

Course Outcome

CO	Upon completion of this course, students willbe able to:	PSO addressed	CL
CO – 1	Demonstrate a basic understanding of computer hardware and software	PSO– 6	An
CO – 2	Assemble and disassemble various models of computer	PSO– 4	Ap
CO – 3	Utilize web technologies	PSO– 5	Ap
CO – 4	Troubleshoot and repair various faults	PSO– 6	An

Unit I

Basics and Basic Electronics: Study of Digital Electronics, Assembling and disassembling of various models of computer, Study of various tools and equipment used in computer repairs, Study of parts inside a computer, Using a multimeter, Use of DC Power supply. Soldering & desoldering of components by using a soldering iron.

Unit II

Hardware Repair: Introduction and study of Printed Circuit Board ,Details of various components on the computer, Testing of various parts and components, Study of different ICs (chips) used on the motherboard, How to recognize various Ics, Reheating and mounting of various chips.

Unit III

Basic and Advanced Troubleshooting: Fault finding, troubleshooting and repairing of various faults, Common repair procedure for hardware related faults,Common repair procedure for software related faults, Water damaged repair techniques, Circuit tracing, jumper techniques and solutions, Troubleshooting through schematic diagrams, Use of internet for troubleshooting faults, Advanced troubleshooting techniques

Guidelines for Summer Training Programme

Each P.G student has to undergo Summer Training Programme for a period of 30 hours during Summer Vacation.

Each student will undertake a Summer training programme / Project related to the subject in universities / Central Laboratories / route organization / Industry during the I year summer vacation for a minimum of 30 hours and present the report along with the evidence of the programme. It will be evaluated after getting the report from the respective institution and the student will be awarded one credit.