MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

M.Sc. PHYSICS (Affiliated Colleges)

LEARNING OUTCOME BASED CURRICULUM

(For those who joined from 2021-2022 onwards)

VISION AND MISSION OF THE UNIVERSITY

VISION

" To provide quality education to reach the unreached **"**

MISSION

- To conduct research, teaching and outreach programmes to improve conditions of human living

- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity

- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.

- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development

- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

VISION AND MISSION OF DEPARTMENT

VISION

To make the students excel in the fields of education, fundamental and advanced research in Physics by providing quality education so that they can compete and contribute to the varying technology.

MISSION

1. To teach the students to analyze problems ranging from the basics of Physics to advanced level.
2. To give the students adequate hands on experience to work in applied fields.
3. To train the students to act as a useful member or effective leader of a team in multidisciplinary setting.

PREAMBLE

Physics, one of the most important basic sciences, seeks to explore the Universe and answer some of the pertinent questions that remain unanswered. Besides, the advancement in Physics is the most important cause for the rapid strides of technology. This M.Sc. programme lays emphasis on the courses that constitute this core component, while providing students with optional papers covering almost all branches of Physics. The diverse lab experiments allow students to understand the fundamental aspects of the subject. The mandatory project work offers a glimpse in the frontier areas of research.

PROGRAMME STRUCTURE

Semester	Course. No.	Course. Status	Course. Title	Contact Hrs./Week	Credits
I	1	Core- 1	Classical Mechanics	6	4
	2	Core- 2	Mathematical Physics - I	6	4
	3	Core- 3	Integrated Electronics	5	4
	4	Core- 4	Nonlinear Dynamics	5	4
	5	Core- 5 Practical1	General Physics Experiments -I	4	3
	6	Core- 6 Practical2	Electronics Experiments -I	4	3
			Subtotal	30	22
II	7	Core- 7	Mathematical Physics - II	5	4
	8	Core- 8	Electromagnetic Theory	5	4
	9	Core- 9	Microprocessor 8085 & Microcontroller 8051	5	4
	10	Core- 10	Statistical Mechanics	4	4
	11	FW/ST	Field Work/ Study Tour	3+2**	3
	12	Core-11 Practical3	General Physics Experiments-II	4	2
	13	Core-12 Practical4	Electronics Experiments -II	4	2
			Subtotal	30	23
III	14	Core- 13	Quantum Mechanics- I	6	4
	15	Core- 14	Atomic and Molecular Spectroscopy	6	4
	16	Core- 15	Condensed Matter Physics	5	4
	17	Core- 16	Numerical Methods & Programming in C++	5	4
	18	Core- 17 Practical5	Advanced Physics Experiments -I	4	2
	19	Core- 18 Practical6	Microprocessor Experiments	4	2
			Subtotal	30	20
IV	20	Core- 19	Quantum Mechanics- II	5	4
	21	Core- 20	Nuclear and Particle Physics	5	4
	22	Core- 21	Research Methodology	4*	4
	23	Core- 22 Practical7	Advanced Physics Experiments-II	4	2
	24	Core- 23 Practical8	C++Programming	4	2
	25	Elective-I	Elective I(a) Optoelectronics(OR) Elective I(b) Materials Science(OR) Elective I(c) Nano Physics(OR) Elective I(d) Renewable Energy Sources.	3	3
	26	Core- 24	Project	5+5**	8
			Subtotal	30	27

*One hour must be given for Tutorial

**Extra hours for Field Work/Study Tour/Project

Total Credits	: 22 + 23 + 20 + 27 = 92
Total number of Core Courses	: 24 (15T + 8P + 1Proj.)
Total number of Field Work /Study Tour	: 1
Total number of Elective Courses	: 1
Total hours	: 120

EVALUATION SCHEME

M.Sc Physics curriculum is divided and studied in 4 semesters. The external evaluation will be based on the examination to be conducted by the university at the end of each semester. Practical examinations will be conducted at the end of each semester.

A. Each paper carries an internal component

B. There is a pass minimum of 50% for P.G. external and overall components

Theory External: Internal Assessment = 75:25

Practical External: Internal Assessment = 50:50

C. Internal Assessment

Internal marks for Theory shall be allocated in the following manner.

The average of the best two tests from three compulsory tests	15 Marks
Seminar	06 Marks
Assignment	04 Marks
Total	**25 Marks**

Note: Each test will be of one hour duration.

D. Practical

Duration of Practical Exam: 6 hours

Internal marks for practical shall be allotted in the following manner.

Experimental work	20 Marks
Record	10 Marks
Model Test	20 Marks
Total	**50 Marks**

The scheme for all external practical papers shall be as follows.

1	Formula, Circuit diagram, Knowledge	25	Writing Program and Knowledge	25
2	Observation, Calculation, Result	20	Typing, Execution, error correction	20
3	Record	05	Record	05
	Total	**50 Marks**	**Total**	**50 Marks**

E. Project Work/Field Work

Components	Marks
Project Report/Field Work Report	50 Marks
Viva -Voce	50 Marks
Total	**100 Marks**

Note:

i. Students should carry out individual project only.
ii. Project report/ Field Work Report evaluation and Viva-Voce will be conducted by both the External examiner and the Guide at the end of the semester.

F. The question paper pattern for all theory papers shall be as follows.

Duration of Exam: 3 Hours

Section	Type of questions	Mark
Part-A	Multiple choice question (Two question from each unit compulsory)	1×10=10 Marks
Part-B	Internal Choice questions (One question from each unit: either/or)	5×5=25 marks
Part-C	Internal Choice questions (One question from each unit: either/or)	8×5=40 marks
	Total	**75 Marks**

G. Duration and Eligibility for admission to the course

M.Sc Physics is a two-year postgraduate degree programme. Candidates shall be admitted to the course provided if he/she has obtained a Bachelor's degree in Physics with a minimum of 55% marks. The medium of instruction as well as examination will be in English.

MODEL QUESTION PAPER

Class : II M.Sc. Physics Max Marks : 75

Subject : Nuclear and Particle Physics Time : 3 hrs

SECTION A – (10x1=10 marks)

Answer ALL Questions.

Choose the correct answer:

1. The ground state of deuteron is a

(a) pure S stae (b) pure D state

(c) mixture of S and D states (d) none of the above

2. The scattering cross-section of an impenetrable sphere of radius a, in the limit of zero energy is .....

(a) $4\pi a^2$ (b) $4\pi a^3$

(c) $4\pi a$ (d) $4/3\pi a^2$

3. In which of the following decay the atomic number increases?

(a) α - decay (b) β^- decay

(c)) β^+ decay (d) γ decay

4. Electrons emitted in β decay have their spins preferentially---------- to their direction of travel.

(a) parallel (b) perpendicular

(c) anti-parallel (d) none of the above

5. Which of the following is not a magic number?

(a) 2 (b) 8

(c) 28 (d) 18

6. Even-even nuclei have total ground state angular momentum I=

(a) 1/2 (b) 0

(c) 1 (d) 3/2

7. $_7N^{14} + {}_2He^4 \rightarrow {}_8O^{17} +$ ----------

(a) $_2He^4$ (b) $_0n^1$

(c) $_1H^1$ (d) $_1H^2$

8. If Q is negative the reaction is called

(a) exoergic (b) endoergic

(c) exomeric (d) endomeric

9. The gravitational effect depends on the

(a) colour (b) charge

(c) magnitude of the inertia (d) velocity

10. The anti-quarks are represented as

(a) row matrices (b) square matrices

(c) column matrices (d) diagonal matrices

SECTION B – (5x5=25 marks)

Answer ALL Questions, choosing either (a) or (b)

11 (a). Discuss in detail the excited states of the deuteron and prove that no bound state exists for $l > 0$.

(OR)

(b). Explain about p-p scattering at low energies arrive an expression for cross section.

12 (a). Give a brief note on internal conversion.

(OR)

(b). Discuss about the multipole radiation.

13 (a). Explain Bohr Wheeler theory of nuclear fission.

(OR)

(b) Explain in detail about collective model of Bohr.

14 (a). State and prove reciprocity theorem.

(OR)

(b). Derive four factor formula.

15 (a). Using tree diagram explain the classification of elementary particles.

(OR)

(b). Explain quark model and its significance.

SECTION C - (5x8=40 marks)

Answer ALL Questions, choosing either (a) or (b)

16 (a). Discuss in detail the n-p scattering at low energies and derive an expression for total scattering cross section using partial wave analysis..

(OR)

(b). Explain shape independent effective range theory in n-p scattering.

17 (a). Discuss in detail Gamow's theory of α decay.

(OR)

(b). Describe Fermi theory of beta decay.

18 (a). Derive Weisacker's Semiempirical mass formula.

(OR)

(b). Arrive magic numbers using Shell model.

19 (a). Derive Q-equation and discuss its solutions.

(OR)

(b). Derive Breit Wigner resonance formula.

20 (a). Explain about various types of particle interactions among elementary particles.

(OR)

(b) Discuss in detail SU(3) symmetry and explain it in Boson Octet and Baryon Octet.

	Part A	Part B	Part C

Knowledge level	4, 5,8	12(a), 13(b),15(a)	18(b), 19(b), 20(a)
Understanding level	1,6,9,10	11(b), 12(b), 14(b), 15(b)	17(a), 17(b) 20(b)
Problem solving level	2,3,7	11(a), 13(a), 14(a)	16(a), 18(a), 19(a)

Programme Outcomes (PO):

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

PO1	Appreciate the nuances of basic sciences to conceive innovative ideas to enrich the existing technology.
PO2	Build new perspectives to look at day to day activities from science point of view.
PO3	Take part in finding solutions for complex problems by applying appropriate techniques using modern scientific tools.
PO4	Understand the impact of science in matters pertaining to sociology, economics and environmental issues for sustainable development.
PO5	Comprehend the basic and advanced concepts in Science to acquire theoretical knowledge as well as practical skills.
PO6	Develop a research oriented learning that cultivates analytical and integrative critical thinking skills.
PO7	Improve sustainable learning at the individual and group level by visiting industries and R & D organizations.

Programme Specific Outcomes (PSO):

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

PSO1	Acquire competent knowledge in fundamental concepts of Physics and adapt them to recent technological development with confidence.
PSO2	Explore the impact of Physics in real world situations and modern applications.
PSO3	Promote observational and computational techniques for a bright career.
PSO4	Employ relevance of Physics in the social context with clear insight.
PSO5	Acquire skills in model designing and attempt new projects in an interactive environment.
PSO6	Enhance logical thinking and adopt new technology for developing innovative methods to deal with recent trends in Physics.
PSO7	Develop scientific temper to undertake research using appropriate methodology.

Title of the Course : CLASSICAL MECHANICS

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Understand and apply the Lagrangian formalism to simple dynamical systems	K-2, K-3
CO2	Study about motion in a central force field in a Lagrangian formalism, classification of orbits, two body collisions and non-inertial frames	K-3, K-5
CO3	Apply Hamilton's equations and solve dynamical systems. Apply the properties of Lagrange and Poisson's bracket and canonical transformations for solving simple systems	K-3, K-5
CO4	Analyze the motion of rigid bodies using the theory of Rigid body dynamics.	K-3, K-4
CO5	Understand the basic concepts of general and special theory of relativity	K-2, K-4

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
6	0	4	0

Preamble: This course imparts knowledge about Lagrange's equation, Pseudo forces, Hamilton's equation and Maxwell field equations and their applications.

Unit I: Fundamental Principles and Lagrangian Formulations

Mechanics of a particle and a system of particles - conservation laws - Constraints -Generalized coordinates - Principle of virtual work - D' Alembert's principle and Lagrange's equation - Applications of Lagrange's equation - Hamilton's principle - Lagrange's equation from Hamilton's principle-examples- conservation theorems and symmetry properties.

Unit II: Central Force and Non-inertial frame

Motion in a central force field in a Lagrangian formalism - Reduction of two body problem to the equivalent one body problem - Classification of orbits for inverse square forces-Virial theorem – Differential equation for the orbits-Two body collisions-Classical scattering in a laboratory and center of mass frames - Non inertial frames - Rotating frame of reference-Pseudo forces-Coriolis force and effects of coriolis force on the moving bodies.

Unit III: Hamilton's Formulations

Hamilton's equation from variational principle - Principle of least action - applications Legendre transformations – Canonical transformations - Lagrange and Poisson brackets - Equation of motion and conservation theorems in Poisson brackets – Hamilton – Jacobi method, Application to harmonic oscillator - Hamilton's characteristic function – separation of variables action – angle

variables – Kepler problem in action angle variable.

Unit IV: Rigid body dynamics

Mechanics of a rigid body - Displacement of a rigid body - Orthogonal transformation -Eulerian angles - infinitesimal rotation - Coriolis effect - Kinematics of a rigid body – Moments and products of inertia - Kinetic energy of a rigid body - Euler's equation of motion – Torque free motion - Spinning top.

Oscillatory motion: Theory of small oscillation-periodic motion-frequencies of vibration and normal modes-linear triatomic molecules.

Unit V: Relativity

Postulates of special theory of relativity - Lorentz transformation equation – kinematic effects of Lorentz transformation - Variation of mass with velocity - Equivalence of mass and energy-Relativistic Lagrangian and Hamiltonian - Minkowski's space - Four vectors - Covariant four dimensional formulation of the law of mechanics - Covariance of Maxwell field equations under Lorentz transformation.

Books for study:

1. Classical mechanics -III Edition – Helbert Goldstein, Charles P. Poole, Johnsafko (Pearson, Chennai 2011).

Books for Reference:

1. Classical Mechanics by G. Aruldhas (PHI Learning Private Limited)

2. Classical Mechanics - N. C. Rana and P.S. Joag (Tata Mc – Graw hill, New Delhi1991)

3. Classical Mechanics - T. L. Chow (John-Wiley, NewYork, 1995)

4. Nonlinear Dynamics - M. Lakshmanan and S. Rajasekar (Springer, Berlin 2003)

E-Reference:

https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/

https://freevideolectures.com/course/4077/nptel-theoretical-mechanics/4

https://courses.lumenlearning.com/physics/chapter/6-4-fictitious-forces-and-non-inertial-frames-the-coriolis-force/

https://www.classcentral.com/course/relativity-theory-6543

https://onlinecourses.nptel.ac.in/noc19_ph15/preview

https://onlinecourses.nptel.ac.in/noc20_ph18/preview

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	2	3	3	2	1	3	3	2	2	2	3	1
CO2	3	3	3	2	3	2	1	3	3	2	2	3	3	2
CO3	3	3	3	2	3	3	1	3	3	3	2	3	3	2
CO4	3	3	3	3	3	3	1	3	3	2	2	3	3	2
CO5	3	3	3	2	2	3	1	3	3	2	2	3	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester I / Ppr.no.2 / Core – 2

Title of the Course : **MATHEMATICAL PHYSICS – I**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Comprehend the concepts of vector spaces, learn about Gradient, Divergence and Curl in orthogonal curvilinear and explain the physical applications of line, surface and volume integrals	K-2, K-3, K-5
CO2	Derive second order differential equations of various types, their solutions and define Beta and Gamma functions and find its relations	K-3, K-4, K-5
CO3	Understand the formation and solution of partial differential equations like heat flow equation and wave equation and apply the knowledge to specific physical phenomenon	K-2, K-3, K-5
CO4	Describe the concept of tensors, contravariant and covariant tensors, metric tensors, Christoffel symbols and applications of tensors to physics	K-2, K-3, K-4, K-5
CO5	Derive probability distributions such as Binomial, Poisson and Gaussian distributions and solve problems in statistics	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
6	0	4	0

Preamble: This course introduce knowledge about linear vector spaces, tensor concepts and usage of partial differential equation in physics. It also disseminate knowledge on special functions and give basic idea of application statistics and probability.

UNIT I: Vector Analysis

Introduction – Linear vector space – linearly dependent and independent set of vectors - Basis and expansion theorem – Schmidt's Orthogonalization process – Gradient of a scalar field – Divergence and curl of a vector function – Physical significance - Gauss Divergence theorem and its proof– Deduction of Gauss's law – Stoke's theorem and its proof - Deduction from Stoke's theorem-Green's Theorem and its proof.

UNIT II: Special Functions –I

Introduction – Second order linear differential equation – Power series method of solution–Linear independence of solution – Legendre's differential equation and solution–Generating function - Rodrigue's formula – Orthogonal properties – Recurrence relations for Pn(x) – Laguerre's differential equation and Laguerre polynomials – generating function – Rodrigue's formula –

recurrence relations – orthogonal property of Laguerre polynomials – Beta and Gamma functions.

UNIT III: Partial Differential Equations

Introduction – Laplace's equation and its solution in Cartesian co-ordinates – Heat flow equation – Examples of two dimensional steady heat flow – Solution of heat flow equation by the method of separation of variables – Variable linear heat flow infinite and infinite bars – Equation of motion for the vibrating string – D' Alembert's solution – Fourier series solution – Waves on strings – Vibrations of rectangular and circular membranes.

UNIT IV: Tensor Analysis

Introduction – Notations and conventions in tensor analysis-Einstein's summation convention - contravariant and convariant tensors – Tensor of higher ranks –-Algebraic operations of tensors – Symmetric and asymmetric tensors – Metric and associated tensors – Tensor form of gradient, divergence, Laplacian and curl – Christoffel symbols – kinematics in Riemann space – Riemann – Christoffel tensor – Simple applications of tensors – Hooke's law – Tensors in rigid bodies – Tensors in EM theory – Invariance of Maxwell's equations.

UNIT V: Probability and Statistics

Probability - Addition rule of Probability – Multiplication Law of Probability – Probability distributions – Binomial distribution – Poisson distribution – Normal or Gaussian distribution – distribution of sum of normal variables – Applications of Binomial, Poisson and Normal distributions – Central limit theorem – Introduction to statistics – measures of central tendency and dispersion – Quartile, mean and standard deviations – Measures of skewness – Karl Pearson's coefficient of skewness – Bowley's coefficient of skewness.

Books for study:

1. Mathematical Physics, Satya Prakash, Sultan Chand & Sons, Reprint 2006.
2. Comprehensive Statistical Methods, P. N. Arora and Sumeet Arora, Sultan Chand & Sons., (2012).(Unit V For Theoretical Distributions theory and only physics related problems.)

Books for Reference:

1. Essential Mathematical Methods for Physicists, George B. Arfken, Hanes J. Weber, Frank E. Harris, 7th Edition, Elsevier (2012).
2. Mathematical Physics, H. K. Dass and R.Verma, S. Chand & Co Pvt. Ltd.(1997).
3. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International Pub. (1995).
4. Mathematical Physics, B. D. Gupta, Vikas Publishing House Pvt. Ltd. Reprint (2013).
5. Mathematical Physics, S. L. Kakaniand C. Hemarajini, II Edition, CBS Publishers and Distributers Pvt. Ltd., (2010).
6. Vector Spaces and Matrices in Physics, M. L. Jain, Alpha Science International (2001).
7. Special Functions for Scientists and Engineers, W. W. Bell, Dover Publications (2004).
8. Vector and Tensor Analysis, Harry Lass, McGraw Hill Pub, (1950)

E-Reference:

1. https://youtu.be/pMFv6liWK4M
2. https://youtu.be/kj-qTWhH5N4
3. https://youtu.be/9P8T9rnclH4
4. https://youtu.be/rlpziTbJZk0

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	3	2	3	3	1	2	3	3	1	2	2	3
CO2	1	2	3	2	3	3	1	2	3	3	1	2	2	3
CO3	1	2	3	2	3	3	1	2	3	3	1	3	2	3
CO4	1	2	3	2	3	3	1	2	3	3	1	3	2	3
CO5	1	2	3	2	3	3	1	2	3	3	1	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester I / Ppr.no.3 / Core – 3

Title of the Course: **INTEGRATED ELECTRONICS**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Understand the basic concepts of Integrated circuits, its fabrication technology and develop skills to apply it to VLSI Technology	K-2, K-3
CO2	Know about of the architecture, functioning, specifications and various applications of standard digital integrated circuits and design various combinational and sequential logic circuits	K-1, K-2, K-3, K-6
CO3	Develop skills to design simple circuits using OP-AMP and to solve problems related to it. Gain knowledge to apply it to multiplier circuits and various filter circuits	K-2, K-3, K-5
CO4	Aware of the architecture, understand functions and applications of IC 555 Timer, IC566, IC 565 PLL	K-1, K-2, K-3
CO5	Understand the functioning of various electronic circuits and know about Electronic Measurement and Control to Design simple circuits and mini projects	K-2, K-3, K-6

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course imparts knowledge about Design of linear ICs, Design of different kinds of filters, op amp systems and their working, designing different kinds of counters, Implement Multiplexers with electronic measurement and control.

Unit I: Devices, Applications and Integrated Circuits:

FET-Types of FET- Characteristics and applications of FET, MOSFET, SCR, DIAC, TRIAC – High frequency device - Integrated Circuits - IC Fabrication Technology - Steps in Fabrication - Integrated Resistors and Capacitors – VLSI Technology.

Unit II: Digital Electronics:

Logic Families - DTL, RTL, TTL, ECL, I^2L, CMOS, NMOS and PMOS – DTL type AND, OR, NAND and NOR gates - RTL and TTL type NAND - CMOS NOR and CMOS NAND - Flip Flops: RS - RST- D - JK- JK Master/Slave - counters – Asynchronous and Synchronous Counters – Registers: Types of registers, serial in – serial out, serial in –parallel out, parallel in – serial out, parallel in –parallel out.

Unit III: OP AMP and Applications:

Characteristics and Parameters - DC Analysis of IC OP AMP - Applications of OP AMP – Amplification (OP Amp based feedback Amp)- Instrumentation amplifier - Sample and Hold System - Analog Multiplexer - Integrator - Differentiator - Design of Analog circuits for the solution of Simultaneous and Differential Equations-Filters: First and Second order LOW, HIGH and BAND pass filters.

Unit IV: Timer, VCO, PLL, and Applications:

Timer-555 Timer IC-Internal Architecture and Working - Modes of Operation: Monostable and Astable operation – Applications –Voltage Control Oscillator – IC 566 – PLL Concept – PLL IC 565 – Application – Frequency multiplier – FSK Modulation and Demodulation.

Unit V: Electronic Measurement and Control:

Sensors and Transducers - Measurement and Control - Signal Conditioning and Recovery – Impedance Matching – Noise and Noise Sources – Filtering and Noise Reduction – Shielding and Grounding – Fourier Transform – Lock – in Detector/Amplifier - Box-Car Integrator or Averager – Modulation Techniques.

Books for Study:

1. Integrated Electronics Analog and Digital Circuits and Systems, Second Edition, Jacob Millman, Christos C Halkias, Chetan Parikh, Tata Mc Graw Hill Education Private Limited, New Delhi.

2. Analog and Digital Electronics, U.A. Bakshi, A.P.Godse, TechnicalPublications, Pune.

Books for Reference:

1. Introduction to Semi Conductor Devices M. S. Tyagi, John Wiley and Sons.
2. Electronic instrumentation, P. P. L. Regtien, VSSD Publications, 2005

Online References:

1. https://nptel.ac.in/course.html
2. https://onlinecourses.nptel.ac.in/noc21_ee31/preview
3. http://www.nptelvideos.in/2012/11/digital-integrated-circuits.html
4. https://youtu.be/lpXNCwsnxjM?list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	2	2	3	2	1	3	3	3	3	3	3	2
CO2	3	3	2	2	2	2	1	3	3	2	3	3	3	2
CO3	3	3	2	2	2	2	1	3	3	2	3	3	3	2
CO4	3	3	2	2	2	2	1	3	3	2	3	3	3	2
CO5	3	3	2	2	2	2	1	3	3	3	3	3	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester I / Ppr.no.4 / Core – 4

Title of the Course: **NONLINEAR DYNAMICS**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Acquire basic knowledge of nonlinear differential equation and will develop skills of finding solutions to different differential equations and interpreting the solution	K-2,K-3,K-4
CO2	Capable of finding fixed points and determine the stability of the respective systems and able to understand the different routes to chaos	K-2, K-4, K-5
CO3	Analyze linear and nonlinear circuits	K-2, K-3,K-4
CO4	Acquire basic knowledge about fractals and their non-integer dimensions. It gives an insight in to the application of fractals in Hollywood films and communication	K-2, K-3,K-5
CO5	Gives proper understanding about soliton solutions which are useful in fibre optic communication	K-2, K-3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course helps to understand the different behaviors of linear and nonlinear systems.

UNIT I: Nonlinearity, linear and nonlinear oscillators

Dynamical systems-linear and nonlinear forces - Mathematical implications of nonlinearity - Working definition of nonlinearity - Effects of nonlinearity - Linear oscillators and predictability - Damped and driven nonlinear oscillators.

UNIT II: Equilibrium points, bifurcations and chaos

Equilibrium points - General criteria for stability – Classification - Some simple bifurcations - Saddle node, pitch fork and trans critical bifurcations - Discrete dynamical systems – Logistic map - Equilibrium points and their stability - period doubling phenomenon in logistic map-chaos.

UNIT III: Chaos in nonlinear electronic circuits

Linear and nonlinear circuit elements - Nonlinear circuits - Chua's diode - Autonomous case - Bifurcations and chaos - Chaotic dynamics of MLC circuit - Analogue circuit simulation – Some other useful nonlinear circuit - Colpitt's oscillator.

UNIT IV: Fractals

Self-similarity - Properties and examples of fractals - Fractal dimension - Construction and properties of some fractals - Middle one third cantor set - Koch curve - Sierpinski triangle – Julia set – Mandelbrot set - Applications of fractals.

UNIT V: Solitons

Linear waves - Linear non dispersive wave propagation - Linear dispersive wave propagation - Nonlinear dispersive systems - An Illustration of the Wave of Permanence - John Scott Russel's Great Wave of Translation - Cnoidal and Solitary waves - Korteweg de vries equation - Properties of solitons - applications of solitons.

Book for Study:

1. Nonlineardynamics, Integrability, Chaos, Patterns, M. Lakshmanan and S. Rajasekar, Springer, Berlin, 2003.

Books for Reference:

Chaos in nonlinear oscillator, controlling and synchronization, M. Lakshmanan and K. Murali (World Scientific, Singapore, 1997).

Deterministic Chaos, H. G. Schuster, (Verlag, Weinheim, 1998).

Related online resources:

1. https://youtu.be/TRjV9vfDsho
2. https://youtu.be/gB9n2gHsHN4
3. https://youtu.be/56gzV0od6DU
4. https://youtu.be/DFKm0K5O7ak

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	2	2	2	2	1	3	2	3	2	2	3	2
CO2	2	3	3	2	2	2	1	3	3	3	2	2	2	2
CO3	2	3	3	2	2	2	1	3	3	2	2	2	3	2
CO4	2	2	2	3	2	2	1	3	3	2	3	2	2	2
CO5	3	3	2	3	2	2	1	3	3	2	3	2	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester I / Ppr.no.5 /Practical -1

Title of the Course : **GENERAL PHYSICS EXPERIMENTS – I**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Strengthen the understanding of interference and diffraction	K-2, K-3
CO2	Learn to calibrate electromagnet and determine the magnetic susceptibility of magnetic salts	K-3, K-5
CO3	Evaluate basic properties of semiconductor material	K-2, K-5
CO4	Learn testing of electrical circuit elements	K-2, K-4
CO5	Compare theoretical concepts learned in the class with hands on experiments	K-2, K-3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Susceptibility

a. Determination of susceptibility of the given paramagnetic solution by Quinke's Method for various normalities,
b. Determination of Magnetic Moment and Bohr Magnetron from graph and by calculation for various normalities.

2. Cauchy's Constant

a. Determination of λ and μ for different lines of mercury spectrum.
b. Calculation of Cauchy's constant using least square fit and graphical method.

3. Michelson's Interferometer

Determination of wavelength of a source and thickness of a thin transparent medium by forming interference pattern.

4. Anderson's Bridge

Determination of self-inductance of
a. Two different coils of self inductance L1, L2
b. When connected in series (Ls)
c. When connected in parallel (Lp)
d. Verification of Ls and Lp using L1 and L2.

5. **Thickness of a thin material**

a. Determination of thickness of a very thin material using LASER diffraction and by Air wedge method.

b. Determination of thickness of the above material as a function of load using Laser beam.

6. **Temperature co-efficient and Band Gap**

Determination of Temperature co-efficient and band gap of a given Semiconductor (Thermistor) using Carey-Foster Bridge

7. **Refractive index of liquid**

a. Determination of refractive index of liquid by forming Newton's Rings.

b. Determination of refractive index of the above liquid by hallow prism.

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	3	2	2	3	3	1	3	2	3	2	2	3	2
CO2	3	2	2	2	3	3	1	3	2	3	2	2	3	2
CO3	2	3	2	2	3	2	1	3	3	2	2	2	3	2
CO4	2	3	2	3	3	2	1	3	2	2	2	2	3	2
CO5	2	3	2	2	3	2	1	3	2	3	2	2	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester I / Ppr.no.6 /Practical -2

Title of the Course : **ELECTRONICS EXPERIMENTS – I**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Measure parameters of basic circuit elements using multimeters and utilize CRO	K-2, K-3
CO2	Analyze the working of IC741 and apply it to generate waveforms	K-2, K-3
CO3	Differentiate and design analog and digital circuits	K-3, K-4
CO4	Construct the circuits independently	K-3, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Series Voltage Regulator
Construction of a series voltage regulator using transistor (as an error amplifier) - Study the regulation factors (line regulation, load regulation) -to find out the percentage of regulation.

2. Schmitt Trigger
Designing of a Schmitt trigger circuit using transistors -Trace the input and output waveforms - Draw Hysteresis curve and calculate hysteresis voltage both theoretically and experimentally.

3. Wave Form Generators
Construction of a triangular and a ramp wave generator using OP Amp and construction of 555 timer based square wave generator. Theoretical calculation of the frequency of the output wave for various R and C values with experimental verification.

4. Counters and Decoders
Construction and study of Modulus counters (2 to 9) using IC 7490 or any equivalent IC. Use a 7 segment decoder and a 7 segment display to show output.

5. Analog to Digital Conversion
Construction of ADC converter using Comparator and an Encoder ICs -Measurement of the digital outputs for various input voltages - Resolution measurement.

6. Construction of Constant Current Source
Construction of a constant current source using OP Amp and transistor/FET (floating and grounded load). I-R characteristics.

7. FET Characteristics and Amplifier

Drain and Transfer characteristics of FET - FET parameters from the characteristics. Designing of a voltage amplifier using FET - Frequency response and bandwidth of the amplifier.

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	3	2	3	2	1	3	2	2	2	2	2	2
CO2	2	3	3	2	3	2	1	3	2	2	2	3	3	2
CO3	2	3	2	2	3	2	1	3	2	2	2	2	2	2
CO4	3	3	3	2	2	2	1	3	2	3	2	3	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.7 /Core – 7

Title of the Course : **MATHEMATICAL PHYSICS – II**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Explain special type of matrices, determine its rank and evaluate its eigenvalues and eigenvectors, and perform diagonalization process	K-1, K-2, K-3, K-5
CO2	Understand the basics of algebra with complex variables,identify the singularities of a function and determine the differentiable functions and find its derivatives. Also solve definite integrals using contour integration techniques	K-2, K-3, K-4, K-5
CO3	Derive Bessel and Hermite's differential equations and find their solutions and study their properties	K-2, K-3, K-5
CO4	Evaluatethe coefficients of Fourier series and deriveFourier, Laplace, Inverse Laplace transforms and alsoillustrate the properties of Fourier and Laplace transforms	K-3, K-4, K-5
CO5	Describe the concept of group, its types and multiplication tables, prove great orthogonality theorem and construct character tables of a group and also apply group theory to physical situations	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course introduces knowledge about matrix formulation, applicative knowledge of complex numbers and special functions. It also gives basic idea of fourier series, Laplace transform and group theory

Unit1: Matrices

Introduction to Matrix – Special types of matrices – transpose – conjugate – transposed conjugate – symmetric and antisymmetric matrices – Hermitian and skew Hermitian matrices – determinant – adjoint – orthogonal and unitary matrices – inverse of a matrix – Rank of matrix and some of its theorems – Cramer's rule – Characteristic equation – Cayley Hamilton theorem and related problems – Eigen values and eigenvectors of a matrix – Diagonalization of Matrices - Solving differential equations.

Unit II: Complex Analysis

Introduction – Some definitions – Functions of complex variable – Limit, continuity and differentiability – Analytic function – Cauchy-Riemann differential equation – Harmonic functions – line integrals – Cauchy's integral theorem – Cauchy's integral formula – derivatives of an

analytic function – Taylor's theorem – Laurent's theorem – Residues and their evaluations – Cauchy's residue theorem – evaluation of definite integrals – definite integrals of trigonometric functions of cosθ and sinθ – certain improper real integrals.

Unit III: Special functions – II

Bessel differential equation and solution – Bessel functions of first and second kind – Limiting values of Jn(x) and Yn(x)– Evaluation of Jn(x) for various n values– recurrence relations – generating function – Orthogonal property – Modified Bessel functions – Spherical Bessel functions and its orthogonal property – Hermite differential equation and solution – Hermite polynomials – Rodrigue's formula – recurrence formula – Orthogonal property of Hermite polynomials.

Unit 1V: Fourier series, Fourier Transform and Laplace's transform

Introduction – Fourier series – Related problems and uses – Fourier transform – properties of Fourier's transform – Fourier transform of a derivative – Fourier sine and cosine transforms of derivatives – Laplace transform (LT) – properties of LT – LT of derivative and integral of a function – LT of periodic function – inverse LT – properties of inverse LT – application of LT to electrical circuits.

Unit V: Group Theory

Basic definition of group – Multiplication table – Subgroups, cosets and classes –Point groups and space groups – Homomorphism and Isomorphism – Reducible and Irreducible representations – Theorems on representation – Schur's lemma I and II – Thegreat Orthogonality Theorem – Character table – Construction of character tables for C2V and C3Vgroups–Rotation groups SO(2) and SO(3) – Special Unitary group SU(2).

Books for study:

1. Mathematical Physics, Satya Prakash, Sultan Chand & Sons, Reprint (2006).
2. Mathematical Physics, B. D. Gupta, Vikas Publishing House Pvt. Ltd., Reprint (2013).

Books for Reference:

1. Mathematical Physics, S. L. Kakaniand C. Hemarajini, II Edition, CBS Publishers and Distributers Pvt. Ltd., (2010).
2. Elements of group theory for Physicists, A. W. Joshi, 3rd Edition, Wiley Eastern Ltd., (1988).
3. Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, Wiley, (2014).
4. Essential Mathematical Methods for Physicists, George B. Arfken, Hanes J. Weber, Frank E. Harris, 7th Edition, Elsevier (2012).
5. Mathematical Physics, H. K. Dassand R.Verma, S. Chand & Co Pvt. Ltd. (1997).
6. Vector Spaces and Matrices in Physics, M. L. Jain, Alpha Science International (2001).
7. Special Functions for Scientists and Engineers, W.W. Bell, Dover Publications (2004).

Online References:

1. https://youtu.be/yimILa0m008
2. https://youtu.be/qTDDFMAt7j4
3. https://youtu.be/DotPCf6srlk
4. https://youtu.be/7UvtU75NXTg
5. https://youtu.be/JYxNC5DgdXc

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	3	2	3	3	1	3	3	3	1	2	2	3
CO2	2	2	3	2	3	3	1	2	3	3	1	2	2	3
CO3	2	2	3	2	3	3	1	2	3	3	1	3	2	3
CO4	2	2	3	2	3	3	1	2	3	3	1	3	2	3
CO5	2	2	3	2	3	3	1	3	3	3	1	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.8 /Core – 8

Title of the Course : **ELECTROMAGNETIC THEORY**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Have a basic understanding of electrostatics and by applying boundary conditions to solve boundary-value problems in dielectrics	K-2, K-3, K-4, K-5
CO2	Infer magnetic vector potential, bound currents and magnetized materials	K-2, K-3, K-4, K-5
CO3	Apply Maxwell equations in explaining the electromagnetic field due to time varying charge and current distribution	K-3, K-4, K-5
CO4	Express the idea of electromagnetic wave propagation through reflection, refraction, electromagnetic boundary conditions, wave guides and transmission lines	K-3, K-4, K-5
CO5	Explain charged particle dynamics and radiation from localized time varying electromagnetic sources	K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: The scope of this course is to understand the connection between the electric and magnetic force fields thereby gaining knowledge about the applications of Maxwell's equations in electromagnetic wave propagation and electromagnetic radiation.

Unit I: Electrostatics

Coulomb's law-Gauss law and its applications -Poisson's equation and Laplace's equation – work done to move a point charge – energy of a point charge and continuous charge distribution – method of images – electric field in dielectric materials – induced dipoles and polarizability – susceptibility, permittivity and dielectric constant of linear dielectrics -Boundary value problems with linear dielectrics.

Unit II: Magnetostatics

Lorentz force law – Biot - savart's law and Ampere's law – magnetic vector potential Multipole expansion of the vector potential – Effects of a magnetic field on atomic orbits – magnetization – bound currents and its physical interpretation – magnetic field inside matter – Ampere's law in magnetized materials -a deceptive parallel – boundary conditions– magnetic susceptibility and permeability in linear and non-linear media.

Unit III: Electrodynamics

Electromagnetic induction – Faraday's law – induced electric field – Neumann formula –Energy in magnetic fields - Maxwell's equation – differential and integral form – Boundary conditions on field vectors D, E, B and H – the continuity equation - Poynting's theorem–Maxwell's stress tensor – Conservation of momentum.

Unit IV: Electromagnetic waves

The wave equation – sinusoidal waves – polarization - wave equation for E and B – monochromatic plane waves – energy and momentum in electromagnetic waves – propagation in linear media – reflection and transmission at normal and oblique incidence – electromagnetic waves in conductors – reflection at conducting surface – frequency dependence of permittivity – waveguides –TE waves in rectangular wave guides–coaxial transmission line.

Unit V: Potentials, fields and radiation

Scalar and Vector Potentials – Gauge Transformations –Lorentz and Coulomb Gauge – Retarded potential – Lienard – Wiechert potentials – What is radiation? - Electric dipole radiation – magnetic dipole radiation – power radiated by a point charge – Larmor formula and Lienard's generalization.

Book for Study:

1. Introduction to Electrodynamics, David J Griffiths. Prentice Hall of India. IV Edition, 2014.

Books for Reference:

1. Classical electrodynamics, J. D. Jackson.,Wiley Eastern Publication. II edition, 1975.

2. Foundations of electromagnetic theory, J. R. Reitz, E. J. Milford and R. W. Christy, Addison – Wesley publishing company, II edition, 2008.

3. Electromagnetic fields and waves, P. Lorrain and D. Corson, CBS Publishers and distributors, II edition, 1986.

4. Electromagnetics, B. B. Laud, New Age International Pvt. Ltd. 1987.

5. Electromagnetic Waves and Radiating Systems, E. C. Jordon and K. G. Balmain, II edition, Prentice Hall of India, 1998.

Related online resources:

1.https://nptel.ac.in/courses/115/101/115101005/#https://nptel.ac.in/courses/108/104/108104087/ 2. https://nptel.ac.in/courses/115/104/115104088/https://nptel.ac.in/courses/117/103/117103065/

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO2	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO3	3	3	3	1	3	2	1	3	3	2	1	2	3	3
CO4	3	3	3	1	3	2	1	3	3	2	1	2	3	3
CO5	3	3	3	1	3	2	1	3	3	2	1	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.9 /Core – 9

Title of the Course : **MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Recall the basic concept of microcomputers, Describe the architecture of 8085 with registers, memory in microprocessors, bus cycle, addressing modes.	K-1, K-3
CO2	Understand assembly language program in 8085 microprocessor using the internal organization, Analyze and Evaluate assembly language programs.	K-2,K-4, K-5
CO3	Understand and Illustrate how the different peripherals are interfaced with Microprocessor and the need for different interfacing devices.	K-2, K-3, K-4
CO4	Compare and analyze the properties of Microprocessors and Microcontrollers. Describe the architecture and functional block of 8051; analyze the data transfer information through serial and parallel ports.	K-2,K-3, K-4
CO5	Understand microcontroller based system design for various applications.	K-2, K-3,K-6

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course imparts knowledge about basics about Microcomputers, microprocessors architecture, instruction set with timing cycle by executing simple programs, with peripheral interfacing and microcontrollers.

Unit I: Introduction to 8085

Introduction to Microcomputers, microcomputer organization - assembly, machine and high level languages.Microprocessor 8085 - Pin diagram and description - Bus System, Control Signals, Status Signals- Clock System - Latching of Address Bus - Interrupt System - Direct Memory Access - Internal architecture - ALU-Registers organization -Special Purpose Registers and Counters - Flags –Program Status Word.

Unit II: Programming 8085

Assembly Language Programming - Assembler - Instruction Format of 8085-Instruction Set – Addressing Modes - Instruction Cycle, Machine Cycle and T-Slates - Timing Diagram of Read, Write machine Cycles and some basic Instructions – 8 bit and 16 bit addition and subtraction – Loops and Branching - Multiplication and Division in 8085 - Searching and Sorting - Finding smallest/biggest number in an array –Time delay calculation – Stack and Subroutines - Software Interrupts and ISR-Data Transfer Schemes.

Unit III: Interfacing and peripheral devices

Address Space of 8085- Address space partition- Memory Interfacing - Memory map and Address decoding- Interfacing of RAM (2K x 8 & 4K x 8) and ROM (2R x 8 & 4K x 8) - I/O mapped I/O and Memory Mapped I/O interfacing Schemes – Ports – Interfacing chips: Non programmable Port 8212 – Programmable Peripheral Interface (PPI) 8255 architecture, Control Signals and operating Modes – Programmable Interval Timer (PIT) 8253.

Unit IV: Microcontroller 8051

Introduction - Comparison of Microcontroller & Microprocessor - Pin Diagram and description – Block Diagram of 8051 and Internal Architecture - Clocks - Registers- Flags Internal Memory, SFR and I/O Ports -External Memory and decoding- Instruction Set and Addressing Modes of 8051- Features available in 8051: Timer and Counters, Timer Modes Serial Port and Serial Data Transfer.

Unit V: Microprocessor based system design and Applications

Design considerations - Sensors and Transducers - Sample and Hold Circuits- Interfacing Keyboard and multiplexed seven segment displays - DAC and ADC interfacing - Square, Rectangular and Ramp Wave Generation- Temperature measurement and control -Digital Clock- Stepper Motor Control.

Books for Study:

1. Fundamentals of Microprocessor and Microcontrollers by B. Ram - Dhanpat Rai Publications, 5th Edition.

2. Microprocessor and microcontroller system (First Edition) by Godse and Godse, Technical Publication, Pune.

3. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2nd Ed. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. Mc Kinlay, Pearson India.

Books for Reference:

1. Microprocessor Architecture, Programming and Applications with the 8085, Ramesh S. Gaonkar - 4th Ed. Penram International.

2. The 8051Microcontroller Architecture, Programming and Applications – Kenneth J. Ayala – Penram International Publishing.

Online References:

1. https://onlinecourses.nptel.ac.in/noc21_ee18/preview
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee42/
3. http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html
4. https://www.digimat.in/nptel/courses/video/108105102/L01.html

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	2	3	2	3	3	3	3	3	3	3	1
CO2	3	3	3	2	3	2	3	3	3	3	3	3	3	1
CO3	3	3	3	2	3	2	3	3	3	3	3	3	3	1
CO4	3	3	3	2	3	2	3	3	3	3	3	3	3	1
CO5	3	3	3	2	3	2	3	3	3	3	3	3	3	1

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.10 /Core -10

Title of the Course : **STATISTICAL MECHANICS**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Acquire the basic ideas about phase space and statistical distributions	K-2, K-3
CO2	Gain knowledge on the mathematical concepts in distribution laws, equipartition of energy and entropy relation	K-2, K-5
CO3	Understand the transition from classical to quantum statistical mechanics	K-2, K-4
CO4	Analyze the theories of specific heat of solids and gas degeneracy	K-2, K-4
CO5	Impart the knowledge about phase transitions and the critical exponents	K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: The basic concepts involved in statistical mechanics, classical and quantum statistics, applications of quantum statistics, phase transition in certain physical problems are expected to study. The theory of statistics and quantum ideas are prerequisites. Postulates of quantum mechanics, Maxwell Boltzmann distribution law, theory and applications of quantum statistics are studied.

Unit 1: Basic concepts

Phase space - Phase space diagram of an oscillator - Volume in phase space - Ensemble – Micro canonical ensemble - Canonical ensemble - Grand canonical ensemble - Density of distribution in phase space -Liouvilles theorem - Postulate of equal a priori probability - statistical, mechanical, thermal and particle equilibrium - Connection between statistical and thermodynamics quantities.

Unit 2: M-B Distribution law

Microstates and Macrostates - Stirling's approximation - Thermodynamic probability - General statistical distribution law - Classical Maxwell Boltzmann distribution law - Evaluation of constants in the Maxwell Boltzmann distribution law - Maxwell's law of distribution of velocities- Principle of equipartition of energy - Boltzmann entropy relation- Probability of magnetic moment distribution of independent atoms.

Unit 3: Quantum Statistics

Postulatory foundations of quantum mechanics - Transition from classical statistical mechanics to quantum statistical mechanics - Indistinguishability and quantum statistics -Exchange symmetry of wave functions- Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics

results of three statistics - Thermodynamics interpretation of the parameters $\alpha\alpha$ and $\beta\beta$ - Black body radiation and the Planck radiation law.

Unit 4: Applications of Quantum Statistics

Specific heat of solids - Dulong and Petit's law –Einstein theory of specific heat of solid - Debye theory of specific heat of solid - Criticism of the Debye's theory - Ideal Bose Einstein gas- Energy and Pressure of the gas - Gas degeneracy - Bose-Einstein condensation- Thermal properties of Bose Einstein gas- Ideal Fermi Dirac gas – Energy and pressure of the gas -Thermodynamics functions of degenerate Fermi Dirac gas.

Unit 5: Phase Transition and low temperature

Phase transition - Phase transitions of first and second kind- Critical exponent - One dimensional Ising model - Production of low temperature - Measurement of low temperature.

Book for Study:

1. Elementary Statistical Mechanics Dr. S.L. Gupta and Dr. V. Kumar, Pragati Prakashan, Meerut 22nd Edition 2008.

Books for Reference:

1. Fundamentals of statistical mechanics B. B. Laud New Age International Publishers 2005
2. An Introductory course of Statistical Mechanics Palash B. Pal Narosa First reprint 2009
3. Statistical Mechanics by Kerson Huang
4. Statistical Mechanics by Sears and Salinger.

Related online resources:

1. Phase space: https://youtu.be/emte489vQfg
2. Phase transition: https://youtu.be/WPYIC_StUOQ

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	1	2	2	2	3	3	1	2	2	2	2	2	3	2
CO2	2	2	2	1	3	2	1	2	2	2	2	2	3	2
CO3	3	2	2	2	3	3	1	3	2	3	2	3	3	2
CO4	3	2	3	2	3	2	1	3	2	3	2	3	2	2
CO5	2	3	2	2	2	3	1	3	2	2	2	3	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.11 /Field Work / Study Tour

Title of the Course : **FIELD WORK / STUDY TOUR**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Identify global issues in the local or national community	K-2, K-4
CO2	Gather data through interviewing and observation of subjects in the field	K-2, K-4
CO3	Act as a useful member or effective leader of a team in multidisciplinary settings	K-2, K-3, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	3	1	3	3	3	3	1	2	2	3	2	2	2
CO2	2	2	1	3	2	2	3	1	2	3	3	2	2	2
CO3	2	3	2	3	3	2	3	2	2	2	3	3	2	2

Strongly Correlated – 3; Moderately Correlated – 2;
Weakly Correlated – 1; No Correlation – 0;

Field work – Guidelines

"Field work" shall be a group activity with a maximum number of 5 students in each group. At the end of the semester, each group shall submit a report for the course on "Field work " which shall have a minimum of 15 to 20 pages. Faculty members may have students more than one group equally depending on the students strength. Evaluation scheme for the "Field work" course is similar to that of Project work.

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.12 / Practical – 3

Title of the Course : **GENERAL PHYSICS EXPERIMENTS – II**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Enhances the understanding of optical phenomena interference and diffraction	K-2, K-3
CO2	Apply the above phenomena to study the basic physical properties of materials	K-3, K-5
CO3	To learn the thermal behaviour of biased diodes	K-3, K-4
CO4	Analyze the given XRD pattern	K-3, K-4
CO5	Understand the basic principles involved in optical communication	K-2, K-3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Hyperbolic fringes
Determination of Young's modulus, Bulk modulus, Rigidity modulus, poisson's ratio and compressibility of the given material by forming Hyperbolic fringes.

2. Ultrasonic Interferometer
Determination of velocity of ultrasonic sound in the given liquid and compressibility of the liquid.

3. Young's Double Slit
Determination of wave length of the light source or width of the double slit using LASER source for
a) standard kit b) lab/custom made double slit

4. Mutual Inductance
Determination of mutual inductance between a pair of coils. Study of variation of mutual inductance for various distances and angles between the coils and determination of coefficient of coupling in each case. Graphical determination of break in coupling for distance and angle.

5. XRD -Crystallographic Parameters
a) Braggs' Law of Diffraction - derivation,
b) Definition of Crystallographic Parameters – d - Spacing and lattice parameters.
c) Relation between d - Spacing and lattice parameters in cubic and hexagonal crystal systems.
d) Crystal parameters for the given XRD spectra (cubic and hexagonal)

6. Optical Fibre Characteristics
Determination of
a. Numerical aperture and acceptance angle
b. Attenuation in the fibre and
c. Loss due to air gaps and coupling.

7. Temperature co-efficient of a forward biased diode
Measure the resistance of a forward biased diode at different temperatures and hence find the temperature co-efficient. Plot the necessary graph for the determination of band gap energy.

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	1	3	2	1	1	3	2	2	1	2	2	2
CO2	3	3	2	2	3	2	2	3	2	2	3	2	2	2
CO3	2	2	2	2	3	3	1	2	2	2	1	3	2	2
CO4	2	3	2	2	2	2	1	2	2	2	1	2	3	2
CO5	2	2	1	2	2	2	1	2	2	2	1	2	3	2

Strongly Correlated – 3; Moderately Correlated – 2;
Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester II / Ppr.no.13 / Practical – 4

Title of the Course : **ELECTRONICS EXPERIMENTS – II**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Design amplifier, oscillator and wave shaping circuit for defined specification	K-2, K-3, K-4
CO2	Explore how to filter signals with resistors and capacitors and exposed to the usage of semi log graph	K-2, K-3
CO3	Study the behavior of different types of electronic devices	K-2, K-3
CO4	Solve mathematical problems using electronic circuits	K-3, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Filters
Design and construction of II order Active Filters (Low pass, High Pass and band pass) using IC 741 for a particular frequency -Draw frequency response curve for each case.

2. UJT Characteristics and Relaxation Oscillator
Characteristics study of UJT -construction of a relaxation Oscillator using UJT to produce the saw tooth wave. Frequency response of the output for various R and C values.

3. Phase Shift and Phase Shift Circuit
Design a Phase shifter circuit using Op-Amp -Measurement of the Phase shift of the input wave for various R and C combinations -Comparison of the experimental output with theoretical values.

4. Digital to Analog Conversion
Construction of Weighted Resistor and R-2R Ladder Network D/A converters using IC 741- Graphing input and output voltages -Resolution Measurement.

5. SCR Characteristics and power control
Characteristics study of SCR -Construction of a power controller device using SCR.

6. Code Converters
Construction of Code converters using ICs -Tabulate input and output for various decimal numbers
a. BCD to Excess-3
b. BCD to Gray
c. Excess-3 to BCD
d. Gray to Excess-3

7. Analog Computation.
Solve the given 2 variable simultaneous equations by constructing the Analog computers using Op-Amps.

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	2	1	3	2	1	3	2	2	1	2	2	2
CO2	2	2	1	1	3	2	1	2	2	3	2	2	2	2
CO3	2	3	2	2	2	2	1	3	2	3	2	2	2	2
CO4	3	2	3	2	3	2	1	3	2	2	2	3	2	2

Strongly Correlated – 3; Moderately Correlated – 2;
Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.14 / Core – 13

Title of the Course : **QUANTUM MECHANICS – I**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Analyze the inadequacy of Classical mechanics to explain black body radiation, photoelectric effect, specific heat of solids and Compton effect and discuss the basic postulates of Quantum mechanics. Also derive Schrodinger wave equation and find its solution	K-2, K-3, K-4, K-5
CO2	Apply Schrodinger wave equation to one and three dimensional problems and develop abstract operator method for harmonic oscillator problem	K-2, K-3, K-4, K-5
CO3	Explain the different types of operators and develop basic ideas of complex abstract space and matrix theory in Quantum Mechanics	K-3, K-4, K-5
CO4	Derive the fundamental commutation relations, eigen values and eigen states of angular momentum operators, construct angular momentum matrices and discuss the theory of addition of angular momenta	K-3, K-4, K-5
CO5	Discuss the degenerate and non-degenerate perturbation theory for stationary states and also derive the time independent and dependent perturbation theories and apply it to selected examples of quantum systems	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
6	0	4	0

Preamble : This course imparts knowledge about solving Eigenvalue problems and perturbation. It also gives exposure to matrix formalism and its applications in LHO and angular momentum.

UNIT I: Wave mechanical Concepts and general formalism of quantum mechanics

Shortcomings of classical and old quantum theories – wave particle duality – de Broglie concept – Heisenberg uncertainty principle – Illustration of uncertainty relation -Principle of complementarity – Applications of uncertainty principle – Phase and group velocities – Time dependent and independent Schrodinger wave equations and solutions – Eigen value problem; degeneracy – Physical interpretation of wave function – admissibility conditions on the wave function – Normalization and Probability interpretation – Box normalization – Expectation values: Ehrenfest's theorem – Postulates of quantum mechanics.

UNITII: Exactly solvable eigen value problems

One dimensional Square well potential; rigid and finite walls – One dimensional Harmonic oscillator: Schrodinger and Abstract Operator methods – Schrödinger equation for spherically symmetric potentials – Condition on solutions and eigen values – Spherical harmonics – Rigid rotator – Radial equation of Central potential and solution – Hydrogen atom; eigen values and eigen functions – Three dimensional square well potential.

UNIT III: Operator formalism and Matrix theory in Quantum Mechanics

Definition of an operator – Commuting and non – commuting operators – Different types of operators – Hermitian operators and properties – Projection operators –Dirac's bra and ket notations – Linear vector space and Hilbert space – Poisson brackets and equation of motion – Transformation theory; unitary matrix – Transformation of Hamiltonian with unitary matrix U, V and W – Matrix theory of the Linear Harmonic Oscillator – Physical meaning of matrix elements.

UNIT IV: Theory of Angular Momentum

Introduction – Angular momentum operators – Components of orbital angular momentum L – Commutation relations among the components of L, L^2 and L_z – Ladder operators $L_{\pm}$ and commutation relations – Total angular momentum J and its commutation relations – Eigen values and eigen functions of L^2 and L_z – Spectrum of eigen values of J^2 and J_z – Angular momentum matrices – Construction of angular momentum matrices for j = 3/2 – Coupling of two angular momenta – Clebsch – Gordan coefficients – Evaluation of CG coefficients for j=½ and 1 – Coupling of three and four angular momenta – Racah coefficients – 6j and 9j symbols.

UNIT V: The Perturbation theory

Time Independent Perturbation Theory: – Theory for non – degenerate case – Application – the perturbed harmonic oscillator – Theory for degenerate levels – First order Stark effect in Hydrogen atom – Time Dependent Perturbation Theory: – Dirac's theory–Transition probability – Constant perturbation – Harmonic perturbation – Transition to a discrete state – Transition to a continuum state (Fermi's Golden Rule) – Selection rules for dipole transition – Adiabatic perturbation – Sudden approximation –Application to semi classical theory of radiation – Calculation of Einstein coefficients.

Books for Study:

1. A Text book of Quantum Mechanics – P. M. Mathews and K. Venkatesan, Tata Mc Graw Hill

Edn. Pvt. Ltd. Publications, New Delhi, 2011.

2. Quantum Mechanics – Leonard I. Schiff, McGraw-Hill International Publication, NewYork,1996.

3. Quantum Mechanics – G. Aruldhas, Printice Hall of India publications, New Delhi, 2009.

Books for Reference:

1. Quantum Mechanics I: Fundamentals – S. Rajasekar and R. Velusamy, CRC Press,Taylor and Francis group – Boca Raton, London.
2. Quantum Mechanics – S. Devanarayanan, Sci. Tech. Publications Pvt. Ltd., Chennai,2005.
3. Quantum Mechanics – Satya Praash, Kedar Nath Ram Nath & Co., Meerut, 2012.
4. Quantum Mechanics – V. Devanathan, Narosa Publishing House, New Delhi, 2005.
5. Quantum Mechanics – Theory and Applications, A. K. Ghatak and Lokanathan; (5thEdition) – Macmillan India Ltd. Publication.
6. Quantum Mechanics – Eugen Merzbacher (3rd Edition), John Wiley and Sons, New

York, 2004.
7. Quantum Mechanics – S. L. Gupta, V. Kumar, H.V. Sharma, R.C. Sharma, Jai Prakash Nathand Co., Meerut, India, 2005.
8. Quantum Mechanics – G. R. Chatwaland S. K. Anand, Himalaya Publishing House, New Delhi, 2011.
9. Quantum Mechanics – V. K. Thankappan, Wiley Eastern Ltd., New Delhi, 1985.
10. Principles of Quantum Mechanics, R Shankar, 2nd Edition, Springer, 1994.

Related online resources:

https://youtu.be/7I3cqOk0t-4

https://youtu.be/jb8XvtEgAyk

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO2	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO3	3	3	3	1	3	2	1	3	3	2	1	2	2	3
CO4	3	3	3	1	3	2	1	3	3	2	1	2	3	3
CO5	3	3	3	1	3	2	1	3	3	2	1	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.15 / Core – 14

Title of the Course : **ATOMIC AND MOLECULAR SPECTROSCOPY**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Describe theories explaining the spectra of Hydrogen like atoms and ions, magnetic moment, angular momentum and the origin of the observed spectra	K-2, K-3, K-4
CO2	Identify quantum behaviour of atoms such as normal and anomalous Zeeman, Paschen-Back, Stark and Doppler effects and explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields	K-3, K-4, K-5
CO3	Understand the rotational and vibrational spectroscopic techniques and apply the same in analyzing the molecular spectra	K-3, K-4, K-5
CO4	Apply the concepts of electronic and resonance spectroscopic techniques in analyzing its fine structure, magnetic moment of nuclei, dipolar interactions, chemical shift etc.	K-3, K-4, K-5
CO5	Understand the concepts of Raman spectra and apply it to analyze vibrational-rotational Raman spectra of molecules. Also by understanding the concepts of Lasers and apply it to laser resonators	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
6	0	4	0

Preamble: The scope of this course is to provide sufficient knowledge on most common atomic and molecular spectroscopic methods and properties derived from them and also to provide an over view of microwave, IR, Raman, electronic and resonance spectroscopic techniques.

Unit I: Atomic Spectra

The hydrogen atom and the three quantum numbers - spectra of hydrogen like ions, alkali metal vapours – forbidden transitions and selection rules – space quantization – magnetic moment and space quantization of angular momentum – the stern – Gerlach experiment.

Unit II: Atoms in External Fields

The normal Zeeman effect – the anomalous Zeeman effect – the magnetic moment of the atom and the 'g' factor – emitted frequencies in anomalous Zeeman transitions – the Paschen - Back effect – normal Stark effect – Stark effect in a strong electric field – Width of spectral lines – natural width of a spectral line – the Doppler effect – external effects –hyperfine structure of spectral lines –Zeeman effect of hyperfine structure.

Unit III: Microwave and Infrared Spectra

Rotational spectra of rigid diatomic molecules – isotope effect in rotational spectra –intensity of rotational lines–non-rigid rotator– vibrational excitation effect - Vibrational energy of a diatomic molecule – infrared spectra preliminaries – infrared selection rules – vibrating diatomic molecule – diatomic vibrating rotator.

Unit IV: Electronic Spectra and Resonance spectroscopy

Introduction – Vibration coarse structure – Franck - Condon principle – intensity of vibrational electronic spectra – rotational fine structure of electronic vibration spectra – magnetic properties of nuclei – resonance condition – NMR instrumentation – relaxation processes – Bloch equations – dipolar interaction – chemical shift – Introduction to ESR –principle of ESR – ESR spectrometer –total Hamiltonian hyperfine structure.

Unit V: Raman Spectra and Lasers

Raman Effect – Classical Theory of Raman Effect – Quantum Theory of Raman Effect– Rotational Raman Spectra – Vibration Raman Spectra – Vibration – Rotational Raman Spectra – Intensity Alternation in Raman Spectra – Spontaneous and Stimulated emission, Absorption – Einstein coefficients – The Laser idea – Properties of Laser beams –Rate equations of a two, three and four level Laser – Methods of obtaining population inversion – Laser resonators.

Books for study:

1. B. P. Straughan & S. Walker, Spectroscopy: Vol. I, Chapmen and Hall (1976). (Unit I & II)

2. G. Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall of India, New Delhi (2002). (Unit III & IV).

3. Vimal Kumar Jain, Introduction to Atomic and Molecular Spectroscopy, Narosa Publishing House, New Delhi, 2015.

Books for Reference:

1. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 4th edition, Mc Graw-Hill, NewYork (2004).

2. G. M. Barrow, Introduction to Molecular Spectroscopy, Mc Graw Hill (1986).

3. E. H. White, Introduction to Atomic Spectra, Mc Graw – Hill (2005).

4. Manas Chanda, Atomic Structure and Chemical Bond, Tata Mc Graw - Hill, New Delhi (2003).

Related online resources:

1.https://nptel.ac.in/courses/104/101/104101099/https://nptel.ac.in/courses/115/101/115101003/

2. https://nptel.ac.in/courses/104/106/104106122/

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	2	3	3	1	3	3	2	1	1	3	3
CO2	3	3	3	2	3	3	1	3	3	2	1	1	3	3
CO3	3	3	3	2	3	3	1	3	3	2	1	2	3	3
CO4	3	3	3	2	3	3	1	3	3	2	1	2	3	3
CO5	3	3	3	2	3	3	1	3	3	2	1	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.16 / Core – 15

Title of the Course :**CONDENSED MATTER PHYSICS**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Analyze the Crystal structure by applying crystallographic parameters	K-3, K-4, K-5
CO2	Gain knowledge about vibration of crystals and density of states with some models	K-2, K-3, K-4
CO3	Understand the concept of energy bands and gaps with theoretical background	K-2, K-4, K-5
CO4	Acquire knowledge about the available magnetic materials with necessary theories	K-3, K-4
CO5	classify condensed matter upon its electrical and transport properties, and understand the superconductivity phenomenon	K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course provides knowledge on crystals and gives an idea of vibration of lattice. It also helps to understand electrical and magnetic properties of solids, energy band and the classification of solids.

Unit I: Crystallography and crystal binding

Bragg's law – scattered wave amplitude – Brillouin zones – Fourier analysis of the basis – quasi crystals – crystals of inert gases – ionic crystals – covalent crystals – metals –hydrogen bonds – atomic radii – analysis of elastic strains – elastic compliance and stiffness constants – elastic wave in cubic crystals.

Unit II: Phonons and thermal properties

Vibrations of crystals with mono atomic basis – two atoms per primitive basis –quantization of elastic waves – phonon momentum – inelastic scattering by phonons – density of states in 3 dimension – Debye model for density of states – Debye T^3law –Einstein model of the density of states – thermal conductivity – thermal resistivity of phonon gas – Umklapp processes.

Unit III: Free electron theory, Energy bands and Semiconductor crystals

Energy levels in one dimension – free electron gas in three dimensions – heat capacity of the electron gas – electrical conductivity and Ohm's law – Hall effect – thermal conductivity of metals – Bloch functions – Kronig – Penney model – band gap – equations of motion of electron and hole – Fermi surfaces – energy band calculation – De Hass – Van Alphen Effect.

Unit IV: Dia, Para, Ferro and Anti Ferromagnetism

Langevin diamagnetism equation – quantum theory of diamagnetism – quantum theory of paramagnetism – Hund rules – Paramagnetic susceptibility of conduction electrons ferromagnetic order – magnons–ferromagnetic order – antiferromagnetic order–ferromagnetic domains–origin of domains– nuclear magnetic resonance.

Unit V: Dielectrics, Ferroelectrics and Superconductivity

Macroscopic electric field – local field at an atom – dielectric constant and polarizability – structural phase transitions – ferroelectric crystals – antiferroelectricity – ferroelectric domains – piezoelectricity – occurrence of superconductivity – Meissner effect – thermodynamics of superconducting transition – London equation – coherence length – BCS theory of superconductivity – single particle tunnelling – DC Josephson effects – SQUIDS – recent developments and applications of superconductivity.

Book for study:

1. Introduction to Solid State Physics, Charles Kittel, Seventh Edition Wiley – India sixth reprint 2007.

Books for reference:

1. Solid State Physics – R J Singh, Pearson First Impression 2012.

2. Solid State Physics – Vimal Kumar Jain Ane Books Pvt. Ltd 2013.

3. Solid State Physics – H C Gupta,Vikas Publishing house Pvt. Ltd Reprint 2005.

4. Solid State Physics – S O Pillai New Age International Publishers.

E-Reference:

1.https://www.classcentral.com/course/swayam-advanced-condensed-matter-physics-10001

2.http://www.phys.ttu.edu/~cmyles/Phys4309-5304/lectures5.html

3. https://www.eeemadeeasy.com/magnetic-materials-magnetism-types/

4. https://nptel.ac.in/courses/115/106/115106061/

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	1	3	2	1	3	3	2	1	2	2	2
CO2	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO3	3	3	3	1	3	3	1	3	3	3	2	2	3	2
CO4	3	3	3	1	3	2	1	3	3	2	1	2	3	3
CO5	3	3	3	2	3	2	2	3	3	2	2	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.17 / Core – 16

Title of the Course :**NUMERICAL METHODS AND PROGRAMMING IN C++**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Solve nonlinear equations of higher order which frequently comes in vibration of strings and heat transfer problems	K-2, K-3
CO2	Effectively use methods like matrix inversion and Gauss elimination to solve linear equations	K-2, K-3, K-5
CO3	Apply the skill of curve fitting in obtained spectra like XRD, FTIR, PL and also for base line corrections	K-2, K-3, K-5
CO4	Model physical systems using first and second order differential equations and solve the equations both analytically and numerically	K-4, K-5
CO5	Perform both hand computation and programming	K-2, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble : The scope of this course is to study solving problems in Physics using numerical methods and computer programming.

Unit I: Roots of equations and Solution of linear systems

Solution of Algebraic and transcendental equations: Bisection Method - Method of false position – Newton – Raphson method – Linear Algebraic Equations: Gauss elimination – Gauss – Jordan – Gauss -Jacobi - Inverse of a matrix by Gauss Jordan elimination method.

Unit II: Curve Fitting and Interpolation

Curve fitting: Linear Least square fitting – Nonlinear Fit: Fitting a Polynomial Function, Exponential function – Interpolation: Introduction – forward difference – backward difference - Newton's forward and backward difference formulae - Unequally spaced: Lagrangian interpolation formula.

Unit III: Numerical differentiation and integration

Numerical Differentiation: Finding first and second derivatives using Newton's forward & backward difference formulae. Numerical Integration: Trapezoidal Rule, Simpson's 1/3 rule and 3/8 rule- Monte - Carlo evaluation of integral.

Unit IV: Solution to ordinary and partial differential equations

Solution to ordinary first order Differential Equations - Taylor's Series Method - Euler's Method - Euler's modified method - Runge-Kutta 2^{nd} and 4^{th} Order Methods – Solution to partial differential equations: Introduction – finite difference approximation to derivatives – solution of Laplace's Equation.

Unit V: C++ Programming applications

Programme structure: header files, local, global and static variables - Euler's Method: Charging and discharging of a condenser – Runge - Kutta methods: Radioactive Decay- Newton-Raphson method: Finding the equilibrium point in a Logistic map for a particular parameter 'a' between 1and 2 [x*=ax*(1-x*)] - Gauss elimination method: Currents in Wheatstone's bridge - Linear fitting: least square method - Cauchy's constant; Simpson's and Monte-Carlo methods : Evaluation of (integral) area under the curve -Numerical differentiation: Newton's Law of cooling.

Books for Study:

1. Introductory methods of Numerical Analysis S. S. Sastry, fifth edition, PHI learning private limited, New Delhi.

2. E. Balgurusamy, Object Oriented Programming with C++, Tata Mc Graw Hill, New Delhi (2000).

Books for Reference:

M. K. Venketraman, Numerical Methods in Science and Engineering 2nd Ed., National Publishing Co., Chennai (2010).

M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering computation, 3rd edition, New age international (P) Ltd, Chennai (1998).

E. Balagurusamy, Computer Oriented Statistical and Numerical Methods, Macmillan India Ltd, New Delhi (2000).

Related online resources:

1. https://youtu.be/LbKKzMag5Rc

2. https://youtu.be/Xb9Ypn77LBo

3. https://youtu.be/FfqAIlOxkoY

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	2	2	2	2	1	3	3	3	2	2	2	2
CO2	3	3	2	2	2	2	1	3	3	2	2	1	2	2
CO3	3	3	2	2	2	3	1	3	3	2	2	1	2	2
CO4	3	3	2	2	2	2	1	3	3	2	2	2	2	2
CO5	2	2	2	3	3	2	1	2	2	3	2	3	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.18 / Practical – 5

Title of the Course : **ADVANCED PHYSICS EXPERIMENTS – I**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Gain practical knowledge of various measurements	K-2, K-3
CO2	Analyze UV spectrum of various molecules	K-3, K-4
CO3	Understand the working of phototransistors	K-2, K-3
CO4	Differentiate linear and nonlinear circuit elements	K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Gouy's Method
Determination of Magnetic Susceptibility (Volume and Mass) of the given sample (use a specimen in the form of a long rod/tube filled with powder or liquid).

2. Elliptical Fringes
Determination of Young's modulus, Bulk modulus, Rigidity modulus, Poisson's ratio and Compressibility of the given material by forming Elliptical fringes.

3. Equipotential lines
a) Formation of equipotential lines for different shapes
a) parallel lines b) circular lines c) lines of irregular shape.
b) Determination of Electric field between the equipotential lines.
c) Mapping of Electric field vector between the plates.

4. Phototransistor Characteristics
Characteristic Study of Phototransistor using
a) Light sources of different wave length
b) light sources of different intensities
Plots for a) Spectral response b) Sensitivity c) Linearity

5. Ultraviolet spectral analysis
a) Draw Tau Plot from the given UV spectrum data.
b) Find the band gap energy.

6. Calibration of Hall Probe into Gauss meter
a) Calibration of Hall probe into Gauss meter using a Search coil and
b) Determination of calibration curve for a two axis Hall probe in radial mode

7. Characteristics of Linear and nonlinear circuit element

V-I characteristic curve of a two terminal linear resistor and a nonlinear resistor (Chua's diode)

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	2	2	3	2	2	3	2	3	2	2	3	2
CO2	3	3	3	2	3	2	1	3	2	3	2	2	3	2
CO3	2	2	2	2	3	2	1	3	2	2	2	2	3	2
CO4	2	2	2	2	3	2	1	3	2	2	2	2	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester III / Ppr.no.19 / Practical – 6

Title of the Course : **MICROPROCESSOR EXPERIMENTS**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Write and execute programs for solving simple programs	K-2, K-3
CO2	Demonstrate programming proficiency using the various addressing modes and data transfer instructions	K-3, K-4
CO3	To familiarize with the programming and interfacing microprocessors	K-3, K-5
CO4	Generate waveforms using microprocessors	K-2, K-3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** programs with Algorithm and Flow chart

1. Arithmetic Operations
a) Addition of two 8 bit and two 16 bit numbers
b) Subtraction of two 8 bit and 16 bit numbers
c) Multiplication of two 8 bit numbers –16-bit result.
d) Division of 16 bit by an 8-bit number.

2. Data Manipulation
a) Arrange the given data items in Ascending or Descending order
b) Finding the Minimum and Maximum value in the given data set.
c) Search of a given character/number in the given data set.

3. System Call and Counters
a) Display a character/number on the 7 segment display of the Kit using Monitor Call.
b) Calculation of Time delay for a given interval.
c) Up-Counter to count from 00 upto 'nn' with 1 sec time interval.
d) Down counter to count from 'nn' to 00 with specified counting interval.

4. Block Move and Series Generation
a) Moving a block of data from memory xxxx to yyyy.
b) Fibonacci series generation
c) Tribonacci series generation

5. System Call and Rolling character
a) Calculation of time delay for a given interval.
b) Display a Character on the 7 segment display of the Kit using Monitor Call.
c) Roll a given character from Left to Right / Right to Left on the 7 segment displays with the specified time interval.

6. ADC and DAC conversion

a) Interfacing ADC with 8085 – ADC chip Block diagram – 8085 - ADC interfacing diagram
b) Conversion of analog input to digital – Resolution – Graph between input and output.
c) Interfacing DAC with 8085 – DAC chip Block diagram –8085 DAC interfacing diagram.
d) Conversion of digital input to analog – Resolution – Graph between input and output. Generation

7. DAC interfacing and Wave form generation.

Interfacing DAC with 8085 – DDC Chip Block diagram – 8085 - DAC - 8085 interfacing diagram and Wave Form using DAC
a) Square wave with the specified period
b) Rectangular wave with the specified period
c) Ramp Wave with the specified period
d) Triangular Wave

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO2	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO3	3	3	3	1	3	2	1	3	3	2	1	2	2	3
CO4	3	3	3	1	3	2	1	3	3	2	1	2	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.20 / Core – 19

Title of the Course : **QUANTUM MECHANICS – II**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Analyze the different stationary state approximation methods and apply them to solve the Schrodinger equation for various quantum systems	K-2, K-3, K-4, K-5
CO2	Understand the concept of Scattering theory and evaluate scattering cross-section, scattering amplitude by using Born approximation and partial wave analysis methods	K-2, K-3, K-4, K-5
CO3	Distinguish between bosons and fermions and develop the Pauli's exclusion principle and also explain the theory of identical particles and solvethe dynamics of two electron atom using the idea of identical particles.	K-1, K-3, K-4, K-5
CO4	Establish the Schrodinger and Heisenberg formulations of time development and their applications and explain symmetries in Quantum mechanics and also derive Wigner – Eckart theorem	K-3, K-4, K-5
CO5	Discuss the central concept and principles ofrelativistic quantum mechanicsand explain electromagnetic potentials and derive Dirac equation and Dirac matrices	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course imparts knowledge about approximation method to solve Schrodinger's equation and basic knowledge of scattering. It provides glimpse of relativistic quantum mechanics and introduction to field theory.

Unit I: Approximation Methods

WKB method: Introduction – Principle of WKB method – The connection formulas – Applications of WKB method – barrier penetration – Theory of alpha emission.
Variation method: Introduction – Theory of Variation method – Applications of Variation method – Calculation of ground state energy of helium atom – Vander Waal's interaction.

Unit II: Scattering theory

Introduction – Kinematics of scattering process – wave mechanical picture – Green's functions; formal expressions for scattering amplitude – Born approximation and its validity – Born series – The Eikonal approximation – Partial wave analysis: asymptotic behavior – phase shifts – scattering amplitude in terms of phase shifts – differential and total cross sections – optical theorem – low energy scattering – Resonant and non-resonant scattering – scattering by a square well potential – scattering by a Coulomb potential.

Unit III: Identical particles and spin

Introduction – Physical meaning of identity — Symmetric and anti-symmetric wave functions – Construction from unsymmetrized functions – Distinguishability of identical particles – The Pauli's exclusion principle – Connection with Statistical Mechanics – Collisions of identical particles – Spin angular momentum – Pauli's spin operators and commutation relations – electron spin functions – Spin matrices and Eigen functions – Electron spin functions for system of two electrons – Effect of spin on energy states of an atom.

Unit IV: Equation of Motion and Symmetries

Introduction – Schrodinger picture – Heisenberg picture – Interaction picture - Poisson bracket and commutator bracket – Evaluation of commutator bracket –Introduction to Symmetries in Quantum Mechanics – Conservation laws and degeneracy associated with symmetries – Continuous symmetries – Space and time translations – Rotations – Group theory applied to symmetries – Wigner – Eckart theorem Discrete symmetries – Parity and Time reversal.

Unit V: Relativistic quantum mechanics

Schrodinger's relativistic equation – charge and current densities – electromagnetic potentials – Energy levels in a coulomb field – Dirac's relativistic Equation – Probability density – Dirac matrices – Plane wave solution – Eigen spectrum Spin of Dirac's particle – Significance of negative energy states – concept of antiparticles – electron in a magnetic field – spin magnetic moment – spin orbit energy.

Books for Study:

1. A Text book of Quantum Mechanics – P. M. Mathews and K. Venkatesan, Tata Mc Graw Hill Edn. Pvt. Ltd. Publications, New Delhi, 2011.
2. Quantum Mechanics – Leonard I. Schiff, Mc Graw - Hill International Publication, New York,1996.
3. Quantum Mechanics – Eugen Merzbacher (3rd Edition), John Wiley and Sons, New York,2004.

Books for Reference:

1. Quantum Mechanics – G. Aruldhas, Printice Hall of India publications, New Delhi, 2009.
2. Quantum Mechanics – V. Devanathan, Narosa Publishing House, New Delhi, 2005.
3. Quantum Mechanics I: Fundamentals – S. Rajasekar and R. Velusamy, CRC Press,Taylor and Francis group – Boca Raton, London.
4. Quantum Mechanics – Satya Praash, Kedar Nath Ram Nath & Co., Meerut, 2012.
5. Quantum Mechanics – Theory and Applications, A. K. Ghatak and Lokanathan; (5thEdition) – Macmillan India Ltd. Publication.
6. Quantum Mechanics – G. R. Chatwal and S. K. Anand, Himalaya Publishing House, New Delhi, 2011.
7. Quantum Mechanics – S. Devanarayanan, Sci. Tech. Publications Pvt. Ltd., Chennai, 2005.
8. Quantum Mechanics – S. L. Gupta, V. Kumar, H. V. Sharma, R. C. Sharma, Jai Prakash Nath and Co., Meerut, India, 2005.
9. Quantum Mechanics – V. K. Thankappan, Wiley EasternLtd., New Delhi,1985.
10. Principles of Quantum Mechanics, R. Shankar, 2nd Edition, Springer,1994.

Related online resources:

1. https://youtu.be/WlmxhPCSM1w
2. https://youtu.be/H77bu3we8Mo

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	3	1	3	2	1	3	3	3	1	3	2	3
CO2	3	2	3	1	3	2	1	3	3	3	1	3	2	3
CO3	3	3	3	1	3	2	1	3	3	2	1	3	3	3
CO4	3	3	3	1	3	2	1	3	3	2	1	2	3	3
CO5	3	3	3	1	3	2	1	3	3	2	1	3	3	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.21 / Core – 20

Title of the Course : **NUCLEAR AND PARTICLE PHYSICS**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Recall the basic knowledge about of nucleus, also the characteristics of nuclear force. Understand the ground state properties of deuteron behaviour at ground and excited states, Apply deuteron physics and the Nucleon-Nucleon scattering for explaining the nuclear forces	K-1, K-2, K-3
CO2	Acquire knowledge about nuclear decay processes and their outcomes. Grasp knowledge about Nuclear Fission and their characteristics using selection rules and apply, evaluate it to cluster decay.	K-1, K-2, K-3,K-5
CO3	Gain knowledge about various nuclear models and understand the corresponding nuclear potentials and its dependence on the couplings are learned and can be able to calculate and analyze masses of different nuclei.	K-2, K-3, K-4, K-5
CO4	Understand, apply and analyze various aspects of nuclear reactions in view of compound nuclear dynamics and the energy released	K-2, K-3, K-4
CO5	understand the basic forces in nature, classification of particles, conservation laws and quark models and analyze allowed and forbidden reactions.	K-2, K-3, K-4

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
5	0	4	0

Preamble: This course imparts knowledge about the elementary particles, nuclear structure, nuclear reactions with the help of various nuclear models.

Unit I: Nuclear Forces

Introduction – Ground and excited states of deuteron – magnetic dipole and electric quadrupole moments of deuteron – n-p scattering at low energies – shape independent effective range theory of np scattering – pp scattering at low energies – saturation of nuclear forces - exchange forces –Meson theory of nuclear force.

Unit II: Nuclear Decays

Introduction –- alpha particle spectra - Gamow's theory of alpha decay – line and Continuous spectrum of β decay - Fermi theory of beta decay – Fermi and Gamow - Teller selection rules – parity violation – Gamma decay – multipole transitions in nuclei – selection rules – internal conversion – nuclear isomerism – Introduction to Cluster decay.

Unit III: Nuclear Models

Introduction - Liquid drop model – Weizsackers mass formula – nuclear stability – Bohr Wheeler theory of nuclear fission - magic numbers - evidence for magic numbers – shell model – spin orbit coupling – angular momenta and parities of nuclear ground states – magnetic moments - Schmidt line – collective model.

Unit IV: Nuclear Reactions

Types of nuclear reactions – Q-equation – solution of the equation – compound nuclear theory – reciprocity theorem – nuclear cross section – resonance scattering- Breit –Wigner dispersion formula – nuclear chain reaction – four factor formula.

Unit V: Elementary Particles

Classification of elementary particles - fundamental interactions conservations laws – CPT theorem –SU(3) multiplet – meson octet – baryon octet and baryon decouplet – Gellmann-Okubo mass formula –Quark theory.

Books for Study:

Nuclear Physics, D. C. Tayal, Himalaya Publications.

Elements of Nuclear Physics, M. C. Pandia and R. P. S. Yadav Kedarnath.

Books for Reference:

Concepts of Nuclear Physics, Bernard L Cohen, Tata Mc Graw-Hill

Nuclear Physics an Introduction, S. B. Patel, Wiley Eastern Ltd.

Nuclear Physics, R. R. Roy and B. P. Nigam, New Age International Ltd.

Online References:

https://en.wikipedia.org/wiki/Cluster_decay

https://www.youtube.com/playlist?list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a

https://nptel.ac.in/courses/115/104/115104043/

https://nptel.ac.in/courses/115/103/115103101/

https://onlinecourses.nptel.ac.in/noc20_ph19/preview

https://nptel.ac.in/content/syllabus_pdf/115104043.pdf

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	2	2	3	2	2	2	2	3	3	2	2	2	2	2
CO2	3	2	3	3	2	2	2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2	3	3	2	2	2	2	2
CO4	2	2	3	3	2	2	2	3	3	3	2	2	2	2
CO5	3	3	3	3	2	2	2	3	3	3	2	2	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.22 / Core – 21

Title of the Course : **RESEARCH METHODOLOGY**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Analyze the different stationary state approximation methods and apply them to solve the Schrodinger equation for various quantum systems	K-2, K-4
CO2	Understand the concept of Scattering theory and evaluate scattering cross-section, scattering amplitude by using Born approximation and partial wave analysis methods	K-2, K-4, K-5
CO3	Distinguish between bosons and fermions and develop the Pauli's exclusion principle and also explain the theory of identical particles and solvethe dynamics of two electron atom using the idea of identical particles.	K-2,K-4
CO4	Establish the Schrodinger and Heisenberg formulations of time development and their applications and explain symmetries in Quantum mechanics and also derive Wigner – Eckart theorem	K-2, K-3
CO5	Discuss the central concept and principles ofrelativistic quantum mechanicsand explain electromagnetic potentials and derive Dirac equation and Dirac matrices	K-3, K-4

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
3	1	4	0

Preamble: Literature collection activities involved in research problem method of writing the thesis, knowledge about Origin and Latex are expected to learn.

Unit I: Introduction to Research and Defining Research Problem

Objectives of Research – Motivation in Research –Types of Research – Research Approaches - Significance of Research - Research Methods versus Methodology - Research and Scientific Method - Importance of Knowing How Research is Done - Research Process - Criteria of Good Research – Problems Encountered by Researchers in India – Research Problem – Selecting the Problem – Necessity of Defining the Problem – Technique Involved in Defining a Problem.

Unit II: Research Design and Experimental Method

Need for Research Design - Features of a Good Design - Important Concepts Relating to Research Design - Different Research Designs - Basic Principles of Experimental Designs – Concept of cause and effect – Types of variables – experimental control – Characteristics of an experiment – Steps of the Experimental Method - Characteristics of a good Experimental Method.

Unit III: Research Report

Need of Research Report – General format of Research Report – Mechanics of report writing – Evaluation of Research Report – Writing Research Abstract - Writing Research Papers.

Unit IV: Plotting software: Origin: (BFS-3)

Introduction – Importing your data – Designating Worksheet Columns as Error Bars - Plotting Data - Customizing the Data Plot - Customizing the Graph Axes - Adding Text to the Graph – Exploring Data: Transforming Column Values – Sorting Worksheet Data – Plotting a Range of the Worksheet Data – Masking Data in the Graph – Performing a Linear Fit – Creating Multiple Layer Graphs –Working with Excel in Origin.

Unit V: Typesetting Software: Latex (BFS-4)

Introduction to LaTeX – TeX and LaTeX – A typical LaTeX input file – Characters and control sequences – Producing Simple Documents using LaTeX – LaTeX input file – producing ordinary text using LaTeX – Section headings in LaTeX – changing fonts in text mode – Active characters and special symbols in text – Producing Mathematical Formulae using LaTeX – Mathematics mode – characters in mathematics mode – superscripts and subscripts – Greek letters – mathematical symbols – standard functions – fraction and roots – Ellipsis – accents in mathematics mode - Matrices and other arrays in LaTeX - Derivatives, Limits, Sums and Integrals – Lists – tables – Defining your own Control Sequences in LaTeX.

Books for study:

Unit I

Research Methodology – Methods and techniques (2nd Revised Edition) – C. R. Kothari –New Age International Publishers, New Delhi (2005). Chapter 1,2.

Unit II

Research Methodology – Methods and techniques (2nd Revised Edition) – C. R. Kothari –New Age International Publishers, New Delhi (2005). Chapter 3.

Fundamental of Research Methodology and Statistics - Yogesh Kumar Singh- Kothari – New Age International Publishers, New Delhi (2006). Chapter9.

Unit III

Fundamental of Research Methodology and Statistics - Yogesh Kumar Singh - Kothari – New Age International Publishers, New Delhi (2006). Chapter16.

Academic Writing by Dr Ajay Semalty, HNB Garhwal University, India. Module 26, 27, 28 MOOC available in https://swayam.gov.in

Video links:

Academic Writing – Module 26 PART 1 https://youtu.be/vekfTuq0TDk

PART 2 https://youtu.be/03M-

Toaa0LQ Academic Writing – Module 27

PART1 https://youtu.be/vOYrszN3huU

PART 2 https://youtu.be/z3JoemPNg9I

Academic Writing – Module 28 PART1 https://youtu.be/RTJzC4yKrmY

PART 2 https://youtu.be/5cFUynI2hek

Unit IV

http://www.physics.rutgers.edu/~eandrei/389/Origin6_Tutorial.pdf

Unit V

http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/

Books for further reference:

1. Research methodology – A step by step guide for beginners - Ranjit Kumar – SAGE Publications India Pvt. Ltd, New Delhi (2011).
2. Research methodology – Dr. S. Rajasekar, Dr. P. Philominathan, Dr. V. Chinnathambi

https://arxiv.org/pdf/physics/0601009.pdf

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	2	2	2	2	1	2	3	2	2	3	3	2
CO2	3	2	3	2	3	2	1	2	3	2	3	3	3	3
CO3	2	1	2	2	3	3	1	2	3	2	2	3	2	2
CO4	2	2	3	2	1	2	1	2	2	3	2	3	2	3
CO5	2	2	3	2	1	2	1	2	1	2	1	3	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.23 / Practical – 7

Title of the Course : **ADVANCED PHYSICS EXPERIMENTS – II**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Evaluate the basic properties of semiconductor, magnetic and dielectric materials	K-2, K-5
CO2	Find out the fixed points, draw stability and bifurcation diagram	K-2, K-3, K-4
CO3	Form diffraction grating inside liquid	K-2, K-3
CO4	Analyze and interpret experimental data using graphs	K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** Experiments

1. Hall Effect
a. Definition of Hall effect and its application
Determination of
b. Hall voltage
c. Hall coefficient
d. Carrier density
e. Mobility of charge carriers
f. Resistivity

2. Four Probe
a) Four Probe principle
b) Measurement of Resistivity and Energy band gap of two given semiconductor materials

3. Ultrasonic Diffraction
Formation of acoustic grating in a given liquid using a crystal to determine the velocity of ultrasonic wave in the liquid and compressibility of the liquid.
Repeat for another liquid and hence find the ratio of compressibility and velocity.

4. LCR circuit
a) Determination of dielectric constant of two different liquids using LCR circuit
b) Determination of dielectric constant of a given crystal using LCR meter.

5. Hysteresis
Formation and tracing of magnetic hysteresis loop for the given specimen to determine
a) Coercivity

b) Retentivity and
c) Energy loss per unit volume per cycle of the specimen

6. Two Probe Determination of resistivity and band gap energy of the given samples

7. Logistic Map [$x_{n+1} = ax_n (1-x_n)$] determination of equlibrium points
a) for two values of parameter a, 1 <a<3 from given x_0
b) for two values of parameter a, 3<a<3.4 from given x_0
c) for a value of a, 3.544< a< 3.56.
d) Plotting x_n versus n of logistic map for the above parameter values and bifurcation diagra

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	2	2	3	2	1	3	2	2	2	2	3	2
CO2	3	2	2	2	3	2	1	3	2	2	2	2	3	2
CO3	2	2	2	2	3	2	1	3	2	2	2	2	3	2
CO4	2	2	2	2	3	2	1	3	2	2	2	2	3	2

Strongly Correlated – 3; Moderately Correlated – 2;
Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.24 / Practical – 8

Title of the Course : **C++ PROGRAMMING**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Familiar with algorithm and flowchart	K-2, K-3
CO2	Write their own C++ programs, compile and execute	K-3, K-4
CO3	Exposed to practical implementation of numerical methods in programming	K-2, K-5
CO4	Trained to plot graph using software	K-2, K-4

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
0	0	2	4

Any **FIVE** programs with Algorithm and Flow chart

1. Curve Fitting –Fitting a straight line.
a) Principle of least square and fitting a straight line.
b) Principle of linear interpolation
c) C++ program to fit a straight line using the data obtained from Cauchy's Constant Experiment and Interpolation using the fitted equation.

2. Solution of simultaneous equations -Gauss Elimination method.
a) Procedure to solve Simultaneous equations using Gauss Elimination Method
b) Solving unknown branch currents in Wheatstone's bridge using GE method manually.
c) C++ program to solve the equations.

3. Numerical solution of ordinary Differential Equations.
a) Derivation of Exponential law of Radioactive decay.
b) RK 4^{th} order method of solving a given 1^{st} order differential equation.
c) Analytical computation of the mass of the given radioactive sample after a specified period (Given: half life period).
d) C++ program using RK method to solve radioactive problem – Compare output with the analytical result.

4. Area under the Curve
a) Numerical integration – derivation of Simpson's rule
b) C++ programs for Simpson 1/3 rd rule and Monte Carlo integration
c) Comparison of the program output with direct integration.

5. Matrix Multiplication
a) Multiplication of given matrices
b) Rotation matrix definition.
c) C++ program to rotate the given point about the origin using rotation matrix by the given angle.

6. Numerical Differentiation
a) Numerical differentiation – related to any physical problem
b) Derivation of Newton's law of cooling –equation
c) C++ program to verify the Newton's law of cooling from the given experimental data.

7. Solution of Algebraic and Transcendental equations.
a) Solution of the given equations using Newton Raphson Method – manual calculation.
b) C++ program to find the solution using N-R method and verification.

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	1	2	2	1	2	2	1	1	2	3	2	2	2	2
CO2	2	3	3	2	3	2	1	2	2	3	2	2	2	2
CO3	2	3	3	2	3	2	1	2	2	3	2	2	3	2
CO4	2	2	3	2	3	2	1	2	2	3	2	3	2	2

Strongly Correlated – 3; Moderately Correlated – 2;
Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.25 / Elective – 1 (a)

Title of the Course : **OPTOELECTRONICS**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Understand fundamental properties of light and wave-propagation thereby applying it to analyze the resonant cavities at plane boundaries	K-2, K-3, K-4
CO2	Infer the operation principles of different types of integrated waveguides and examine the integrated optical network	K-3, K-4, K-5
CO3	Associate the concept of optical fibre, its construction and importance in communication physics	K-3, K-4, K-5
CO4	Analyze different laser systems and its characteristics, design architectures	K-3, K-4, K-5
CO5	Interpret the process of image formation and reproduction in hologram; Also able to examine different types of holograms	K-2, K-3, K-4

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
3	0	3	0

Preamble: The student should gain knowledge on an optical communication system. The course permits students to measure different kinds of losses in an optical fiber. The student will be able to measure parameters related to LEDs as optical sources and coupling. The performance of different optical detectors can be evaluated by the student. The student will be able to obtain gainful employment in the telecommunication industry.

UNIT I: OPTICAL FIBERS AND OPTICAL COMMUNICATION SYSTEMS

Evolution of fiber optic systems – optic fiber transmission link – nature of light – basic laws of light – optic fiber modes and configurations: fiber types, ray optics representation, modes in step index fibers – linearly polarized modes – single mode fibers – graded index fiber – Fiber materials – Fiber fabrication – fiber optic cables.

UNIT II: SIGNAL DEGRADATION IN OPTICAL FIBERS

Attenuation: Attenuation Units - Absorption losses - Scattering Losses - Bending Losses - Core and cladding Losses – signal Distortion in Optical Waveguides: Information capacity Determination, Group Delay, Material Dispersion, Waveguide Dispersion - Signal Distortion in Single Mode Fibers.

UNIT III: **OPTICAL SOURCES**

Topics from Semiconductor Physics: Energy Bands, Intrinsic and Extrinsic Material, the pn junctions Direct and Indirect Band Gaps, Semiconductor Device Fabrication – Light-Emitting diodes (LED's): LED Structures, Light Source Materials - Quantum Efficiency and LED Power - Modulation of an LED – Laser Diodes: Laser diode Modes and Threshold conditions - Laser

diode.

UNIT IV: POWER LAUNCHING AND COUPLING

Source – to – Fiber Power launching: Source Output Pattern, Power – Coupling Calculation - Power Launching versus Wavelength - Equilibrium Numerical Aperture – Lensing Schemes for coupling Improvement: Non-imaging Microsphere.

UNIT V: PHOTO DETERCTORS

Physical Principles of Photodiodes - The pin Photo detector- Avalanche Photodiodes – Photodetector Noise: Noise Sources, Signal-to-noise Ratio – Detector Response Time.

Book for Study:

1. Gerd Keiser, Opitcal Fiber Communication, Third Edition, Mc Graw Hill International (2000), relevant sections of chapter 1 to 6.

Book for Reference:

1. Jasprit Singh, Optoelectronics: An introduction to materials and devices, Mc Graw Hill, Singapore (1996).

Related online resources:

1. https://youtu.be/p6uMrpX8G7s
2. https://youtu.be/VfKpqFKOccE
3. https://youtu.be/4JKjqveWGlw

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	1	3	3	2	3	3	3	1	3	3	3
CO2	3	3	3	1	3	3	2	3	3	3	1	3	3	3
CO3	3	3	3	1	3	3	2	3	3	3	1	3	3	3
CO4	3	3	3	1	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	1	3	3	1	3	3	3	2	3	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.25 / Elective – 1 (b)

Title of the Course : **MATERIALS SCIENCE**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Understand the applications of phase diagram and the overall transformation kinetics	K-2,K-3, K-5
CO2	Gains knowledge about the elastic, anelastic and viscoelastic behavior	K-2,K-4
CO3	Realize the nature of crystalline solids and also acquires knowledge about the classification of polymers	K-3,K-4, K-5
CO4	Know the concept of various imperfections exists within the crystal lattice	K-3,K-4
CO5	Acquires a good knowledge about the mechanisms of oxidation and corrosion and also the protection methods against fracture	K-3,K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
3	0	3	0

Preamble: The course details about the temperature effect, elastic behavior of materials, solid structure, imperfections in the crystal, the various deformation of materials.

Unit I: Phase diagram

Phase rule - Single component systems - Binary Phase diagrams - Micro structural changes during cooling - The lever rule - Some typical phase diagrams - other applications of phase diagrams Phase transformations - Time scale for phase changes - Nucleation and growth - The growth and the overall Transformation kinetics - applications.

Unit II: Elastic behaviour

Atomic model for elastic behavior - The Modulus as a parameter in Design - Rubber like elasticity – An elastic behavior - Relaxation behaviours - Viscoelastic behavior – Spring - Dashpot models.

Unit III: Structure of solids

The crystalline and non-crystalline states - Covalent solids - Metals and alloys - Ionic Solids The structure of silica and silicate – polymers - classification of polymers - Structure of long chain polymers - Crystallinity of long chain polymers.

Unit IV: Imperfections

Crystal imperfections - Point imperfections - The geometry of dislocations - other properties of dislocations - Surface imperfections.

Unit V: Oxidation, corrosion and other deformation of materials

Mechanisms of Oxidation-Oxidation resistant materials-the principles of corrosion protection against corrosion - Plastic deformation - The tensile stress-strain curve - Plastic deformation by slip-Creep-Mechanisms of creep-Creep resistant materials - Ductile fracture - brittle fracture - methods of protection against fracture.

Book for Study:

1. Materials Science and Engineering - A First Course, V. Raghavan, Fifth Edition, Prentice Hall of India, New Delhi, 2011.

Online Reference:

1. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Book%3A_Physical_Chemistry_(Fleming)/08%3A_Phase_Equilibrium/8.02%3A_Single_Component_Phase_Diagrams
2. https://www.youtube.com/watch?v=symExnyQ49M
3. https://www.youtube.com/watch?v=lxNYAxr5lPc
4. https://www.researchgate.net/publication/322892419_Experimental_study_of_concrete_beams_prestressed_with_basalt_fiber_reinforced_polymers_Part_II_Stress_relaxation_phenomenon/figures?lo=1&utm_source=google&utm_medium=organic
5. https://www.sciencedirect.com/topics/engineering/surface-imperfection
6. https://www.fastradius.com/resources/top-5-corrosion-resistant-materials/
7. https://yenaengineering.nl/britle-and-ductile-fracture/

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	2	1	3	2	1	3	3	2	1	2	3	2
CO2	3	2	3	1	3	2	1	3	3	2	1	2	2	3
CO3	3	3	3	1	3	2	1	3	3	2	1	2	3	2
CO4	3	3	3	1	3	3	1	3	3	2	1	2	3	3
CO5	3	3	3	1	3	2	1	3	3	3	1	2	3	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.25 / Elective – 1 (c)

Title of the Course : **NANOPHYSICS**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Understand various chemical and physical methods for the synthesis of diverse types of nano materials (0D, 1D and 2D)	K-2, K-4
CO2	Quantify Mechanical properties of solids in terms of stress and strain and their relationship to each other and analyze synthesis methods for various nano composite materials	K-2, K-4
CO3	Understand different Nano material Characterization and apply it to study the characterization	K-2, K-3
CO4	Able to categorize functional materials in terms of structural, mechanical, thermal, optical and electrical properties	K-2, K-4
CO5	Gain knowledge about the various applications of Nano structured materials in biotechnology, electronics, defense and photonics	K-2, K-3

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

Preamble: The course permits students to study the synthesis, characterization, properties and application of nanomaterials.

L	T	C	P
3	0	3	0

UNIT I

Synthesis of Nanostructured Materials: Idea of band structure extended to nanostructured matierials-0D nanostructures (quantum dots) - 1D nanostructures (quantum wires) - 2D nanostructures (quantum wells) - Carbon Nanomaterials: Fullerenes – CNT - Graphene

UNIT II

Introduction to Nanocomposites: composite material - Mechanical properties of nano composites - stress-strain relationship – toughness – strength – plasticity - synthesis methods for various nano composite materials: sputtering - mechanical alloying - sol-gel synthesis - thermal spray synthesis

UNIT III

Nanomaterial Characterization: Principle & Applications: X-ray diffraction - Debye-Scherer Formula – FTIR - Raman Spectroscopy – SEM – TEM - Differential Scanning Calorimetery (DSC)

UNIT IV

Properties of Nanostructured materials: Mechanical properties - Thermo physical properties -

Electric properties - Electrochemical properties - Optical properties

UNIT V

Applications: Application of Nanostructured materials in biotechnology- electronics- defence - photonics

Books for Study:

1. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J.Owens Wiley India Pvt. Ltd., (2003).
2. Nanostructures &Nanomaterials: Synthesis, Properties & Applications, Guozhong Cao, Imperial College Press (2004).

Books for Reference:

1. Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer (2007).
2. Physics of semiconductor nanostructures – K. P. Jain, Narosa 1997
3. Nanotechnology - Enabled Sensors, Kourosh Kalantar - zadeh and Benjamin Fry, Springer (2008).
4. Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley-VCH Verlag, Weiheim (2003).
5. Elements of X-Ray Diffraction (second edition, Addison – Wesley, London) B. D. Cullity (1977).
6. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press (2005).
7. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).

Related Online Sources:

1. https://youtu.be/5lvjo0rm-F0
2. https://youtu.be/qUEbxTkPIWI
3. https://youtu.be/k61wjab7iUs

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	3	2	2	2	3	3	2	2	2	2	2
CO2	3	3	3	3	2	2	2	3	3	2	2	2	2	2
CO3	3	3	3	3	2	2	2	3	3	2	2	2	2	2
CO4	3	3	3	3	2	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	2	2	2	3	3	2	2	2	2	2

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG –Colleges / M.Sc Physics/ Semester IV / Ppr.no.25 / Elective – 1 (d)

Title of the Course : **RENEWABLE ENERGY SOURCES**

Course Outcomes

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

Course Outcomes		Cognitive level
CO1	Describe the different types of energy sources in India and world as well	K-2, K-3, K-4
CO2	Explain solar cells and biomass conversion	K-3, K-4
CO3	Enumerate the theory of geothermal and tidal energy conversion	K-3, K-4
CO4	Differentiate thermoelectric and thermionic energy sources	K-3, K-4
CO5	Explore the applications of chemical energy sources	K-2, K-3, K-4, K-5

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Course Description

L	T	C	P
3	0	3	0

Preamble: This course gives a brief knowledge about the types of various non-conventional energy sources. The societal application of these energy sources is studied.

Unit I: Introduction
Primary and secondary energy – Commercial and non commercial energy – renewable and non – renewable resources and their importance – World energy use – Indian energy scenario – Long term energy scenario for India.

Unit II: Solar and Biomass Energy
Introduction – extra terrestrial solar radiation – collectors – Solar cells – application of solar energy – Biomass energy – biomass conversion – bio gas production – ethanol production – pyrolysis and gasification – application of biomass energy.

Unit III: Geothermal and Tidal Energy
Introduction - basic theory - geothermal resources types - resource base - application for heating and electricity generation – Tidal energy – Introduction – origin of tides – Power generation scheme.

Unit IV: Other Renewable Energy Sources
Thermoelectric and Thermionic energy resources - basic principles - power generation - nuclear energy – basic principle – power generation (basic ideas only).

Unit V: Chemical Energy Sources
Introduction – fuel cells – design and principle – types – advantages and disadvantages – applications – Batteries – Introduction – Theory – classification of batteries – advantages of batteries for bulk storage.

Books for Study:

1. Non-Conventional Energy Sources, G. D. Rai, Khanna Publishers, New Delhi, 1984

Books for Reference:

1. Solar Energies of thermal processer, A. Duffie and W.A. Beckmann, john – Wiley, 1980.
2. Principle of Solar Engineering, F. Kreith and J. F. Kreider, McGraw-Hill,1978
3. Alternate Energy Sources, T. N. Veziroglu, Vol.5 and 6, Mc Graw - Hill, 1978.
4. Solar energy – Principle of thermal collection and storage S P Sukhatme and J K Nayak, Tata Mc Graw Hill, Tata, 2008

Related online resources:

1. https://youtu.be/UJ8XW9AgUrw
2. https://youtu.be/qSWm_nprfqE
3. https://youtu.be/IdPTuwKEfmA

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	3	3	3	3	3	1	3	3	2	3	2	3	1
CO2	3	3	3	3	3	3	1	3	3	2	3	2	3	1
CO3	3	3	3	3	3	3	1	3	3	2	3	2	3	1
CO4	3	3	3	3	3	3	1	3	3	2	3	2	3	1
CO5	3	3	3	3	3	3	1	3	3	2	3	2	3	1

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

MSU / 2021-22 / PG -Colleges / M.Sc Physics/ Semester IV / Ppr.no.26 / Core – 24

Title of the Course : **PROJECT**

Course Outcomes

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

	Course Outcomes	Cognitive level
CO1	Gain more knowledge in the area of the selected project work	K-2, K-3
CO2	Apply the various research methods to different similar practical situation	K-3, K-4
CO3	Develop the oral, written and visual communication skills	K-4, K-5
CO4	Use the research findings for future studies	K-5, K-6

Cognitive level	Content
K-1	Remember
K-2	Understand
K-3	Apply
K-4	Analyze
K-5	Evaluate
K-6	Create

Mapping of Course outcomes with Programme Outcomes and Programme Specific Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO
CO1	3	2	3	2	3	3	3	3	2	3	2	3	3	3
CO2	2	2	3	2	3	3	3	3	2	3	2	3	3	3
CO3	2	1	3	2	1	2	2	1	1	2	2	1	2	2
CO4	3	3	3	2	3	3	2	3	3	2	2	3	2	3

Strongly Correlated – 3; Moderately Correlated – 2;

Weakly Correlated – 1; No Correlation – 0;

GUIDELINES FOR PROJECT WORK

The aim of project work in M.Sc., 4th semester is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiments, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc.. Project work can be based upon Experimental Physics, Theoretical Physics, or Simulation (quantum based software) in the thrust research areas of the Department.

A student will be attached to one teacher of the Department before the end of the 3rd semester. A report about the work done in the project (format is given below) should be submitted by the student. Assessment of the work done under the project will be carried out on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and performance in the viva-voce examination etc. as per course guidelines.

Format for Preparation of Project Report for M.Sc., Physics

1. **Arrangement of Contents:**

The sequence in which the project report material should be arranged and bound should be as follows:

Cover page and title page
Bonafide Certificate
Abstract
Table of Contents
List of Tables
List of Figures
List of symbols, Abbreviation
Chapters
Appendices
References

Page Dimension and Binding Specifications:

The dimension of the project report should be in A4 size. The project report should be bound using flexible cover of the thick white art paper. The cover should be printed in black letters and the text for printing should be identical.

Total number of Pages should not exceed 70.

2. **Preparation Format**

Cover Page & Title Page – A specimen copy of the Cover page & Title page of the project report are given in **Appendix 1.**

Bonafide Certificate – The Bonafide Certificate shall be in double line spacing using Font Style Times New Roman and Font Size 14

The Certificate shall carry the supervisor's signature and shall be followed by the

supervisor's name, academic designation (not any other responsibilities of administrative nature), department and full address of the institution where the supervisor has guided the student. The term **'SUPERVISOR'** must be typed in capital letters between the supervisor's name and academic designation.

Preface – Preface should be one page synopsis of the project report typed double line spacing, Font Style Times New Roman and Font Size 14.

Table of Contents – The table of contents should list all material following it as well as any material which precedes it. The title page and Bonafide Certificate will not find a place among the items listed in the Table of Contents but the page numbers of which are in lower case Roman letters. One and a half spacing should be adopted for typing the matter under this head.

List of Tables – The list should use exactly the same captions as they appear above the tables in the text. One and a half spacing should be adopted for typing the matter under this head. The tables shall be introduced in the appropriate places in the text.

List of Figures – The list should use exactly the same captions as they appear below the figures in the text. One and a half spacing should be adopted for typing the matter under this head. The figures shall be introduced in the appropriate places in the text.

List of Symbols, Abbreviations and Nomenclature – One and a half spacing should be adopted or typing the matter under this head. Standard symbols, abbreviations etc., should be used.

Chapters – The Chapters may be broadly divided into 5 parts

1. Introduction to Project
2. Literature Survey
3. Methods and methodology/Working / Experimental Techniques
4. Result Analysis
5. Conclusion

1. The main text will be divided into several chapters and each chapter may be further divided into several divisions and sub-divisions.
2. Each chapter should be given an appropriate title.
3. Tables and figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.
4. Footnotes should be used sparingly. They should be typed single space and placed directly underneath in the very same page, which refers to the material they annotate.

Appendices – Appendices are provided to give supplementary information, which is included in the main text may serve as a distraction and cloud the central theme.

1. Appendices should be numbered using numerals, e.g. Appendix 1, Appendix 2, etc.
2. Appendices, Tables and References appearing in appendices should be numbered and referred to at appropriate places just as in the case of chapters.

3. Appendices shall carry the title of the work reported and the same title shall be made in the contents page also.

List of References –The listing of references should be typed 4 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. The reference material should be listed in the alphabetical order of the first author. The name of the author/authors should be immediately followed by the year and other details.
A typical illustrative list given below relates to the citation example quoted above.

References

1. Ariponnammal, S. and Natarajan, S. (1994) „Transport Phonomena of Sm Sel – X Asx", Pramana – Journal of Physics Vol.42, No.1, pp.421-425.
2. Barnard, R.W. and Kellogg, C. (1980) „Applications of Convolution Operators to Problems in Univalent Function Theory", Michigan Mach, J., Vol.27, pp.81-94.
3. Shin, K.G. and Mckay, N.D. (1984) „Open Loop Minimum Time Control of Mechanical Manipulations and its Applications", Proc.Amer.Contr.Conf., San Diego, CA, pp. 12311236.

Table and figures - By the word Table, is meant tabulated numerical data in the body of the project report as well as in the appendices. All other non-verbal materials used in the body of the project work and appendices such as charts, graphs, maps, photographs and diagrams may be designated as figures.

Typing Instructions

The impression on the typed copies should be black in colour. One and a half spacing should be used for typing the general text. The general text shall be typed in the Font style „Times New Roman" and Font size 14.

APPENDIX I

(A typical Specimen of Cover Page & Title Page)

**<Font Style Times New Roman –
Bold> TITLE OF PROJECT REPORT
<Font Size 18><1.5 line spacing>**

**A PROJECT REPORT
<Font Size 14>**

**Submitted by
<Font Size 14><Italic>**

**NAME OF THE CANDIDATE(S)
<Font Size 16>**

**in partial fulfilment for the award of the
degree of
<Font Size 14><1.5 line spacing><Italic>**

**NAME OF THE DEGREE
<Font Size**

16> IN

**BRANCH OF STUDY
<Font Size 14>**

**NAME OF THE COLLEGE
<Font Size 14>**

**MANONMANIAM SUNDARARANAR UNIVERSITY
TIRUNELVELI- 627 012
<Font Size 16><1.5 line spacing>**

**MONTH & YEAR
<Font Size 14>**