SRI MEENAKSHI GOVT.ARTS COLLEGE FOR WOMEN (A), MADURAI - 625 002

DEPARTMENT OF PHYSICS

SYLLABUS

M.Sc. PHYSICS

FOR STUDENTS WHO ARE ADMITTED IN THE ACADEMIC YEAR 2023 - 2024

M.Sc. DEGREE COURSE IN PHYSICS
COURSE STRUCTURE

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Preamble

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

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M. Sc., Physics**
Programme Code	**PPHE1**

Duration	PG – 2YEARS
Programme Outcomes (POs)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/ reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit. **PSO 6** Students will utilize e-resources, digital tools and techniques for widening their knowledge base. **PSO 7** Students gain exposure to programming language and skills. **PSO 8** Student will appreciate the interplay of mathematics, physics and technology. **PSO 9** Students will develop adequate knowledge and skills for employment and entrepreneurship. **PSO 10** An awareness of civic and ecological duties as good citizens and importance of human values will be inculcated in students

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METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test	**25 Marks**
	Assignments / Snap Test / Quiz	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**

METHODS OF ASSESSMENT	
Remembering (K1)	• The lowest level of questions require student store call information from the course content • Knowledge questions usually require students to identify information in the textbook.

Understanding (K2)	• Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. • The questions go beyond simple recall and require Students to combined at a together
Application (K3)	• Students have to solve problems by using / applying a concept learned in the classroom. • Students must use their knowledge to determine a exact response.
Analyze (K4)	• Analyzing the question is one that asks the students to breakdown something into its component parts. • Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations.
Evaluate (K5)	• Evaluation requires an individual to make judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. Students are engaged in decision- making and problem–solving. • Evaluation questions do not have single right answers.
Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem solving skills

PG COURSE - 2023 -2025

QUESTION PAPER PATTERN

Section – A	**Section-B**
Internal choice questions (5 * 5 = 25)	**Internal choice questions (5 * 10 = 50)**
I to V units equal distribution	

Evaluation pattern for **Extension Activity** shall be as follows: Attendance - 50 marks

Participation - 25 marks

Report - 25 marks

Evaluation pattern for **Internship** shall be as follows:

Attendance (mandatory) - 40 marks

Field work and performance - 40 marks

Report writing - 20 marks

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Evaluation Pattern for Project shall be as follows:

The **60 marks for internals** can be given for **three** reviews of 20 marks each. **Review- I**

Problem Selection/ Choice of the Topic	Methodology/ Technology used	Effective content delivery	Interaction/ Answering questions	Total
5	5	5	5	20

Review- II

Work Progress	Development of ideas	Effective content delivery	Interaction/ Answering questions	Total
5	5	5	5	20

Review- III

Final outcome of the project	Implementation & execution	Effective content delivery	Interaction/ Answering questions	Total
5	5	5	5	20

Evaluation criteria for External (40 marks):

Organisation of ideas	Effective content delivery	Report	Total
10	10	20	40

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First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	5	7
	Core – II	5	7
	Core – III	4	6
	Elective – I	3	5
	Elective – II	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	5	6
	Core – V	5	6
	Core – VI	4	6
	Elective – III	3	4
	Elective – IV	3	4
	Skill Enhancement Course - I	2	4
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	5	6
	Core (Industry Module) – X	4	6

	Elective – V	3	3
	Skill Enhancement Course – II	2	3
	Internship / Industrial Activity	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with VIVA VOCE	7	10
	Elective – VI (Industry Entrepreneurship)	3	4
	Skill Enhancement Course – III / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**

Total 91 Credits for PG Courses

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SRI MEENAKSHI GOVT. ARTS COLLEGE FOR WOMEN (AUTONOMOUS) MADURAI – 625 002

Programme : M.Sc. Physics

SEMESTER–I

Course Type	SUB CODE	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
							Ext	Total
CC1	P23CP1	Mathematical Physics	6	6	3	25	75	100
CC 2	P23CP2	Classical Mechanics and Relativity	6	6	3	25	75	100
CC 3 (P)	P23CP3P	Practical I	6	4	3	25	75	100
GEC/ DSEC1	P23DP08	Linear and Digital ICs and Applications	6	3	3	25	75	100

GEC/ DSEC2	P23DP04	Physics of Nano Science and Technology	6	3	3	25	75	100
Total			**30**	**22**				**500**
SEMESTER–II								
CC4	P23CP4	Statistical Mechanics	6	5	3	25	75	100
CC5	P23CP5	Quantum Mechanics –I	6	5	3	25	75	100
CC6 (P)	P23CP6P	Practical – II	6	4	3	25	75	100
GEC/ DSEC3	P23DP16	Advanced Optics	5	3	3	25	75	100
GEC/ DSEC4	P23DP19	Microprocessor 8085 and Microcontroller 8051	5	3	3	25	75	100
SEC1	P23SEP1	Solar Energy Utilization	2	2	3	25	75	100
Total			**30**	**22**				**600**

SUMMER INTERNSHIP/INDUSTRIAL TRAINING

SEMESTER–III								
CC7	P23CP7	Quantum Mechanics –II	6	5	3	25	75	100
CC8	P23CP8	Condensed Matter Physics	6	5	3	25	75	100
	) P23CP9P	Practical – III	6	4	3	25	75	100
CC10	P23CP10	Electromagnetic Theory	5	3	3	25	75	100
GEC/ DSEC5	P23DP09	Numerical Methods and Computer Programming	5	3	3	25	75	100
SEC2	P23SEP2	Solid Waste Management	2	2	3	25	75	100
	P23SIP1	Internship/Industrial Activity	-	2		--	--	100

Total			**30**	**24**				**700**
SEMESTER–IV								
CC11	P23CP11	Nuclear and Particle Physics	6	5	3	25	75	100
CC12(P)	P23CP12P	Practical – IV	6	5	3	25	75	100
CC13	P23PPW	Project with Viva voce	10	7	-	60	40	100
GEC/ DSEC6	P23DP10	Spectroscopy	5	3	3	25	75	100
SEC3 / Professio nal competen cy skill paper	P23SEP3	Crystal Growth And Thin Films	3	2	3	25	75	100
P23EAP		Extension Activity	-	1	-	--	--	100
Total			**30**	**23**				**600**

ELECTIVE PAPER : **LIST 1.**

S.NO	SUBJECT CODE	TITLE OF THE PAPER
1.	P23DP01	Energy Physics
2.	P23DP02	Analysis of Crystal Structures
3.	P23DP03	Materials Science
4.	P23DP04	Physics of Nano Science and Technology
5.	P23DP05	Digital Communication
6.	P23DP06	Communication Electronics
7.	P23DP07	Astrophysics.
8.	P23DP08	Linear and Digital ICs and Applications
9.	P23DP09	Numerical Methods and Computer Programming
10.	P23DP10	Spectroscopy

ELECTIVE PAPER : **LIST 2.**

S.NO	SUBJECT CODE	TITLE OF THE PAPER
11.	P23DP11	Plasma Physics
12.	P23DP12	Bio Physics
13.	P23DP13	Non – Linear Dynamics
14.	P23DP14	Quantum Field Theory
15.	P23DP15	General Relativity and Cosmology
16.	P23DP16	Advanced Optics
17.	P23DP17	Advanced Mathematical Physics

ELECTIVE PAPER : **LIST 3.**

S.NO	SUBJECT CODE	TITLE OF THE PAPER
18.	P23DP18	Advanced Spectroscopy
19.	P23DP19	Microprocessor 8085 and Microcontroller 8051
20.	P23DP20	Characterization of Materials
21.	P23DP21	Medical Physics
22.	P23DP22	Sewage and Waste Water Treatment and Reuse

List of **CORE** paper:

S.NO	SUBJECT CODE	TITLE OF THE PAPER
1.	P23CP1	Mathematical Physics
2.	P23CP2	Classical Mechanics and Relativity
3.	P23CP3P	Practical I
4.	P23CP4	Statistical Mechanics
5.	P23CP5	Quantum Mechanics –I
6.	P23CP6P	Practical – II
7.	P23CP7	Quantum Mechanics –II
8.	P23CP8	Condensed Matter Physics
9.	P23CP9P	Practical – III

10.	P23CP10	Electromagnetic Theory
11.	P23CP11	Nuclear and Particle Physics
12.	P23CP12P	Practical – IV
13.	P23PPW	Project with Viva voce

LIST OF SKILL ENHANCEMENT COURSE **(SEC)**

PART	SEMESTER	SUB CODE	COURSE TYPE	TITLE OF THE PAPER	HRS/ WEEK	CREDITS
III	I	P23SEP1	SEC-1	Solar Energy Utilization	2	2
III	III	P23SEP2	SEC-2	Solid Waste Management	2	2
III	IV	P23SEP3	SEC-3	Crystal Growth And Thin Films	3	2

LIST OF ELECTIVE PAPERS **(GEC/DSEC)**

PART	SEMESTER	SUB CODE	COURSE TYPE	TITLE OF THE PAPER	HRS/ WEEK	CREDITS
III	I	P23DP08	GEC 1	Linear and Digital ICs and Applications	6	3
III	I	P23DP04		Physics of Nano Science and Technology	6	3
III	II	P23DP16		Advanced Optics	5	3
III	II	P23DP19		Microprocessor 8085 and Microcontroller 8051	5	3
III	III	P23DP09		Numerical Methods and Computer Programming	5	3
III	IV	P23DP10		Spectroscopy	5	3

COURSE STRUCTURE ABSTRACT

For all PG Programmes

COURSES	TOTAL NO OF PAPERS	HOURS	CREDITS	MARKS
Core Courses	12	71	57	1200
Core Project with Viva voce	1	10	7	100
Discipline Specific Elective Courses	6	32	18	600
Skill Enhancement Courses	3	7	6	300
Internship/Industrial Activity	1	--	2	100
Extension Activity	1	--	1	100
Total	**24**	**120**	**91**	**2400**

Consolidation:

Part	Subject	Credits Distribution	Total
A	Core	12x4	48
A	Core Practical	4x3	12
A	Elective	4x3	12
B1	Skill Enhancement Course(SEC)	4x2	08
B2	Soft Skill& Internship	5x2	10

C	Extension Activity	1x1	01
	TOTAL		**91**

ELECTIVE PAPERS

List 1

1. Energy Physics
2. Crystal Growth and Thin films
3. Analysis of Crystal Structures
4. Materials Science
5. Physics of Nano Science and Technology
6. Digital Communication
7. Communication Electronics
8. Astrophysics

LIST 2

9. Plasma Physics
10. Bio Physics
11. Non-linear Dynamics
12. Quantum Field Theory
13. General Relativity and Cosmology
14. Advanced Optics
15. Advanced Mathematical Physics

LIST 3

INDUSTRY ORIENTED ELECTIVE (IOE)

16. Advanced Spectroscopy
17. Microprocessor 8086 and Microcontroller 8051
18. Characterization of Materials
19. Medical Physics
20. Solid Waste Management
21. Sewage and Waste Water Treatment and Reuse
22. Solar Energy Utilization.

(**Note:** Institutions can also frame such IOE courses more suitable for their locality.)

Relevant to National need		Entrepreneurship Oriented
Relevant to Regional need		Skill Development Oriented
Relevant to Local need		

Pre-Req
Knowledge of Matrices, vectors, differentiation, i
Learning C
➢ To equip students with the mathematical tec treatment in different courses taught in thei ➢ To extend their manipulative skills to apply fields ➢ To help students apply Mathematics i

UNITS	
UNITI: **LINEAR VECTOR SPACE**	Basic concepts – Definitions - Scalar product- Orthogonal – linear operators – Dual spa change of basis – Isomorphis values and Eigen functions – transformations and rotation
UNITII: **COMPLEX ANALYSIS**	Review of Complex Numbe Variable- Differentiability -A Integration- Contour Integr points – Cauchy's Integral T Laurent's Expansion- Zeros Potential theory - (1) Elec plates, coaxial cylinders an plates and coaxial cylinders

Programme : M.Sc Physics Part III: Core
Semester : I Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP1 Credits: 6

TITLE OF THE PAPER: MATHEMATICAL PHYSICS

Nature of the Course

Relevant to Global need	(✓)	Employability O

UNITIV: **FOURIER TRANSFORMS & LAPLACE TRANSFORMS**	Definitions -Fourier transf function and Dirac delta fu and sine transforms - Conv Flow of heat in an infinite Vibration of an infinite string Laplace transform and its in Differentiation and integra -Application - Laplace equat

UNITV: **DIFFERENTIAL EQUATIONS**	Second order differential e solution with simple exam -Orthogonality properties -Generating function - Ro delta function- One dimen -Sturm- Liouville's type e
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Onl Interactions/Visits, Co Communication Skill Enh
TEXT BOOKS	1. P.K. Chattopadhyay Age, New Delhi 2. SathyaPrakash,(200 Company Pvt. Ltd.

REFERENCE BOOKS	1. E. Kreyszig, 1983, Eastern, New Delh 2. D. G. Zill and M. R Mathematics, 3rd 3. S. Lipschutz, 1987, New York 3. E. Bu -Wesley, Reading, 4. P. R. Halmos, 1965, Affiliated EastWes 5. C. R. Wylie and Mathematics, 6 th York 3. George Arfken and Physicists – A Compre W Joshi, 2017, Matric (Paperback), New Age

UNITIII: **MATRICES**	Types of Matrices and matrix - Adjoint of a Matrices - Trace of a equation - Eigen value –Diagonalization

	5. B. D. Gupta, 2009, *Mathematical Physics* (4th edition),VikasPublishing House, New Delhi. 6. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi
WEB SOURCES	1. www.khanacademy.org 2. https://youtu.be/LZnRIOA1_2I 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath 4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSE OUTCOMES:

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

CO 1	Understand use of bra-ket vector notation and explain the meaning of complete ortho -normal set of basis vectors, and transformations and be able to apply them	K1, K2
CO 2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	**K2, K3**
CO 3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	**K4**
CO 4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	**K4, K5**
CO 5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	**K2, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

Programme : M.Sc Physics Part III : Core
Semester : I Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP2 Credits : 6

TITLE OF THE PAPER: CLASSICAL MECHANICS AND RELATIVITY

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to				Addresses Human	

Local need				Values	

Pre-Requisites
Knowledge offundamentals of mechanics, Foundation in mathematical methods.
Learning Objectives
➢ To understand fundamentals of Classical Mechanics. ➢ To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. ➢ To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. ➢ To discuss the theory of Small Oscillations of a system. ➢ To learn the relativistic formulation of mechanics of a system.

UNITS	Course Details
UNIT I: PRINCIPLES OF CLASSICAL MECHANICS	Mechanics of a single particle – Mechanics of a system of particles – Conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.
UNIT II: LAGRANGIAN FORMULATION	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.
UNIT III: HAMILTONIAN FORMULATION	Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.
UNIT IV: SMALL OSCILLATIONS	Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.

UNIT V: RELATIVITY	Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. H. Goldstein, 2002, *Classical Mechanics*, 3rd Edition, Pearson Edu. 2. J. C. Upadhyaya, *Classical Mechanics*, HimalayaPublshing. Co.New Delhi.
REFERENCE BOOKS	1. K. R. Symon,1971, *Mechanics,* Addison Wesley, London. 2. S. N. Biswas, 1999, *Classical Mechanics*, Books & Allied, Kolkata. 3. Gupta and Kumar, *Classical Mechanics*, KedarNath. 4. T.W.B. Kibble, *Classical Mechanics*, ELBS. 5. Greenwood, *Classical Dynamics*, PHI, New Delhi. 6. R. Resnick, 1968, *Introduction to Special Theory of Relativity,* Wiley Eastern, New Delhi. 7. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 1980. 8. N. C. Rana and P.S. Joag, Classical Mechanics - Tata McGraw Hill, 2001
WEB SOURCES	(i) http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldst ein_Classical_Mechanics_optimized.pdf (ii) https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014- editionpdf-pdf-free.html (iii)https://nptel.ac.in/courses/122/106/122106027/ (iv)https://ocw.mit.edu/courses/physics/8-09-classical-mechanics iii-fall-2014/lecture-notes/ (v) https://www.britannica.com/science/relativistic-mechanics

COURSE OUTCOMES:

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

CO 1	Understand the fundamentals of Classical Mechanics.	**K2**
CO 2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3**
CO 3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3, K5**
CO 4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	**K4, K5**
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO 1	3	3	3	3	3	3	3	2	3	2
CO 2	2	3	3	3	3	3	3	2	2	2
CO 3	3	3	3	2	2	3	3	2	3	2
CO 4	3	3	3	3	2	3	3	2	2	2
CO 5	3	2	3	3	2	3	3	2	2	2

Programme : M.Sc Physics Part III: Core Practical Semester : I Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP3P Credits: 4

TITLE OF THE PAPER: PRACTICAL I

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites

Knowledge and hands on experience of basic general and electronics experiments of Physics

Learning Objectives

➢ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.

➢ To calculate the thermodynamic quantities and physical properties of materials. ➢ To analyze the optical and electrical properties of materials.

Course Details

(Minimum of Twelve Experiments from the list)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Viscosity of the given liquid – Meyer's disc
3. Measurement of Coefficient of linear expansion- Air wedge Method
4. B-H loop using Anchor ring.
5. Determination of Thickness of the enamel coating on a wire by diffraction 6. Determination of Rydberg's Constant - Hydrogen Spectrum
7. Thickness of air film - FP Etalon
8. Measurement of Band gap energy- Thermistor
9. Determination of Specific charge of an electron – Thomson's method.
10. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer 11. GM counter – Characteristics and inverse square law.
12. Measurement of Conductivity - Four probe method.
13. Molecular spectra – AlO band.
14. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating. 15. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
16. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
17. Construction of relaxation oscillator using UJT
18. FET CS amplifier- Frequency response, input impedance, output impedance 19. Study of important electrical characteristics of IC741.

20. V- I Characteristics of different colours of LED.
21. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
22. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.

23. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer.
24. Construction of square wave Triangular wave generator using IC 741
25. Construction of a quadrature wave using IC 324
26. Construction of pulse generator using the IC 741 – application as frequency divider 27. Study of R-S, clocked R-S and D-Flip flop using NAND gates
28. Study of J-K, D and T flip flops using IC 7476/7473
29. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction. 30. Study of Arithmetic logic unit using IC 74181.

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

COURSE OUTCOMES:

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

CO 1	Understand the strength of material using Young's modulus.	**K2**
CO 2	Acquire knowledge of thermal behavior of the materials.	**K1**

CO 3	Understand theoretical principles of magnetism through the experiments.	**K2**
CO 4	Acquire knowledge about arc spectrum and applications of laser	**K1, K3**
CO 5	Improve the analytical and observation ability in Physics Experiments	**K3, K5**
CO 6	Conduct experiments on applications of FET and UJT	**K4**
CO 7	Analyze various parameters related to operational amplifiers.	**K4**
CO 8	Understand the concepts involved in Arithmatic and logical circuits using IC's	**K2**
CO 9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K1**
CO 10	Analyze the applications of counters and registers	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	**100**	

Programme : M.Sc Physics Part III: ELECTIVE PAPER- 1 Semester : I Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23DP08 Credits: 3

TITLE OF THE PAPER: LINEAR AND DIGITAL ICs & APPLICATIONS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Knowledge of semiconductor devices, basic concepts of digital and analog electronics
Learning Objectives
➢ To introduce the basic building blocks of linear integrated circuits. ➢ To teach the linear and non-linear applications of operational amplifiers. ➢ To introduce the theory and applications of PLL. ➢ To introduce the concepts of waveform generation and introduce one special function ICs. ➢ Exposure to digital IC‘s

UNITS	Course Details
UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER	Introduction, Classification of IC‘s, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp Characteristics.
UNIT II: APPLICATIONS OF OP-AMP	LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. NON-LINEAR APPLICATIONS OF OP-AMP: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.
UNIT III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS	ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS	VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. D to A AND A to D CONVERTERS: Introduction, basic DAC techniques - weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs	CMOS LOGIC:CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India 2. Albert Pad Malvino, Donald P Leach and Gautam saha(2011), Digital Principles and Applications 7th Edition, Tata McGraw Hill, New Delhi

REFERENCE BOOKS	1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi. 2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi. 3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi 4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi. 5. Integrated Electronics, Millman & Halkias, Tata McGraw Hill, 17th Reprint (2000) 3. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi. 4. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co. 5. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition. 6. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S.Viswanathan Printers & Publishers Private Ltd, Reprint. V.

WEB SOURCES	1. https://nptel.ac.in/course.html/digital circuits/ 2. https://nptel.ac.in/course.html/electronics/operational amplifier/ 3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt7/field-effect-controlled-thyristors/ 4. https://www.electrical4u.com/applications-of-op-amp/ 5. https://www.geeksforgeeks.org/digital-electronics-logic-design tutorials/

COURSE OUTCOMES:

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

CO 1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	**K1, K5**
CO 2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	**K3**

CO 3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	**K1, K3**
CO 4	Learn about various techniques to develop A/D and D/A converters.	**K2**
CO 5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)**for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Programme : M.Sc Physics Part III: ELECTIVE -2 Semester : I Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23DP04 Credits: 3

TITLE OF THE PAPER: PHYSICS OF NANO SCIENCE AND TECHNOLOGY

Nature of the Course

Relevant to	(✓)	Employability Oriented		Addresses	

Global need				Professional Ethics	
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Basic knowledge in Solid State Physics
Learning Objectives
➢ Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale. ➢ To provide the basic knowledge about nanoscience and technology. ➢ To learn the structures and properties of nanomaterials. ➢ To acquire the knowledge about synthesis methods and characterization techniques and its applications. ➢

UNITS	Course Details
UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.
UNIT II: PROPERTIES OF NANOMATERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior:Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
UNIT III: SYNTHESIS AND FABRICATION	Physical vapour deposition - Chemical vapour deposition - sol gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nano manipulator.

UNIT IV: CHARACTERIZATIO N TECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT V: APPLICATIONS OF NANOMATERIAL S	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010). 2. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012). 3. Nanotechnology and Nanoelectronics, D.P. Kothari, V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt.Ltd, New Delhi. (2018)
REFERENCE BOOKS	1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press (2004). 2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J.H.Fendler John Wiley and Sons. (2007) 4. Textbook of Nanoscience and Nanotechnology, B.S.Murty, et al., Universities Press. (2012) 5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi. 6. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012). 7. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).

WEB SOURCES	1. www.its.caltec.edu/feyman/plenty.html 2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm 3. http://www.understandingnano.com 4. http://www.nano.gov 5. http://www.nanotechnology.com

COURSE OUTCOMES:

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

CO 1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	**K1, K2**
CO 2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	**K1**
CO 3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	**K2, K3**
CO 4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	**K4**
CO 5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3

CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

Programme : M.Sc Physics Part III: Core
Semester : II Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP4 Credits: 5

TITLE OF THE PAPER : STATISTICAL MECHANICS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Knowledge of Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium, Brownian motion
Learning Objectives
➢ To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics ➢ To identify the relationship between statistic and thermodynamic quantities ➢ To comprehend the concept of partition function, canonical and grand canonical ensembles ➢ To grasp the fundamental knowledge about the three types of statistics ➢ To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

UNITS	**Course Details**

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

UNIT IV: CLASSICAL AND QUANTUM STATISTICS	Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.
UNIT V: REAL GAS, ISING MODEL AND FLUCTUATIONS	Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in onedimension. Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. B. K. Agarwal and M. Eisner, 1998, *Statistical Mechanics,* Second Edition New Age International, New Delhi. 2. K. Huang, 2002, *Statistical Mechanics,* Taylor and Francis, London .

REFERENCE BOOKS	1. R. K. Pathria, 1996, *Statistical Mechanics,* 2nd edition, Butter Worth Heinemann, New Delhi. 2. L. D. Landau and E. M. Lifshitz, 1969, *Statistical Physics,* Pergamon Press, Oxford. 3. K. Huang, 2002, *Statistical Mechanics,* Taylor and Francis, London 4. W. Greiner, L. Neise and H.Stoecker, *Thermodynamics and Statistical Mechanics,* Springer Verlang, New York. 5. A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata 6. S. K. Sinha, 1990, Statistical *Mechanics*, Tata McGraw Hill, New Delhi. 7. J. K. Bhattacharjee, 1996, *Statistical Mechanics*: An Introductory Text, Allied Publication, New Delhi. 8. F. Reif, 1965, *Fundamentals of Statistical and Thermal Physics,* McGraw - Hill, New York. 9. M. K. Zemansky, 1968, *Heat and Thermodynamics,* 5th edition, McGraw-Hill New York..
WEB SOURCES	➢ https://byjus.com/chemistry/third-law-of-thermodynamics/ ➢ https://web.stanford.edu/~peastman/statmech/thermodynamics.html ➢ https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics ➢ https://en.wikipedia.org/wiki/Grand_canonical_ensemble ➢ https://en.wikipedia.org/wiki/Ising_model

COURSE OUTCOMES:

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

CO 1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K5**
CO 2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	**K4**
CO 3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermo dynamical quantities and partition function	**K1**
CO 4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	**K4, K5**
CO 5	To discuss and examine the thermo dynamical behaviour of gases under fluctuation and also using Ising model	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO1 0**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

Programme : M.Sc Physics Part III: Core
Semester : II Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP5 Credits: 5

TITLE OF THE PAPER : **QUANTUM MECHANICS I**

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites

Knowledge of Newton's laws of motion, Schrodinger's equation, integration, differentiation.

Learning Objectives

➢ To develop the physical principles and the mathematical background important to quantum mechanical descriptions.

➢ To describe the propagation of a particle in a simple, one-dimensional potential. ➢ To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.

➢ To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature

➢ To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

UNITS	Course Details
UNIT I: BASIC FORMALISM	Interpretation of the wave function – Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation
UNIT II:ONE DIMENSIONAL AND THREE DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS	Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator
UNIT III: GENERAL FORMALISM	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

UNIT IV: APPROXIMATIO N METHODS	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.
UNIT V: ANGULAR MOMENTUM	Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.
UNIT VI: PROFESSIONAL	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

COMPONENTS	
TEXT BOOKS	1. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
REFERENCE BOOKS	1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970. 2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985. 3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976. 4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999. 5. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011. 6. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982. 7. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.
WEB SOURCES	1. http://research.chem.psu.edu/lxjgroup/download_files/chem565- c7.pdf 2. http://www.feynmanlectures.caltech.edu/III_20.html 3. http://web.mit.edu/8.05/handouts/jaffe1.pdf 4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/ Lecture_ 1.pdf 5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSE OUTCOMES:

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

CO 1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	**K1, K5**
CO 2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	**K3, K4**
CO 3	Can discuss the various representations, space time symmetries and formulations of time evolution	**K1**
CO 4	Can formulate and analyze the approximation methods for various quantum mechanical problems	**K4, K5**
CO 5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

Programme : M.Sc Physics Part III: Core Practical - 2 Semester : II Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP6P Credits: 4

TITLE OF THE PAPER: PRACTICAL II

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites

Knowledge and handling of basic general and electronics experiments of Physics

Learning Objectives

➢ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
➢ To calculate the thermodynamic quantities and physical properties of materials. ➢ To analyze the optical and electrical properties of materials.
➢ To observe the applications of FET and UJT.
➢ To study the different applications of operational amplifier circuits.
➢ To learn about Combinational Logic Circuits and Sequential Logic Circuits

Course Details

(Minimum of Twelve Experiments from the list)

➢ Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
➢ Determination of Stefan's constant of radiation from a hot body
➢ Measurement of Susceptibility of liquid - Quincke's method
➢ B-H curve using CRO
➢ Thickness of LG Plate
➢ Arc spectrum: Copper
➢ Determination of e/m - Millikan's method
➢ Miscibility measurements using ultrasonic diffraction method
➢ Determination of Thickness of thin film. - Michelson Interferometer
➢ Iodine absorption spectra
➢ Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
➢ Measurement of Dielectricity - Microwave test bench
➢ Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility
➢ Interpretation of vibrational spectra of a given material

➢ Determination of I-V Characteristics and efficiency of solar cell
➢ GM counter – Absorption coefficient – Maximum range of β rays
➢ IC 7490 as scalar and seven segment display using IC7447
➢ Solving simultaneous equations – IC 741 / IC LM324
➢ Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter

➢ Construction of Current to Voltage and Voltage to Current Conversion using IC 741. ➢ Construction of second order butterworth multiple feedback narrow band pass filter ➢ Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193 ➢ Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer ➢ Construction of pulse generator using the IC 555 – Application as frequency divider ➢ BCD to Excess- 3 and Excess 3 to BCD code conversion ➢ Study of binary up / down counters - IC 7476 / IC7473 ➢ Shift register and Ring counter and Johnson counter- IC 7476/IC 7474	
TEXT BOOKS	1. Practical Physics, Gupta and Kumar, PragatiPrakasan 2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences 3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
REFERENCE BOOKS	1. An advanced course in Practical Physics, D.Chattopadhayay, C.RRakshit, New Central Book Agency Pvt. Ltd 2. Advanced Practical Physics, S.P Singh, Pragati Prakasan 3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt.ltd 4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing 5. Electronic Laboratory Primer a design approach, S. Poorna chandra, B.Sasikala, Wheeler Publishing, New Delhi

COURSE OUTCOMES:

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

CO 1	Understand the strength of material using Young's modulus	**K 2**
CO 2	Acquire knowledge of thermal behaviour of the materials	**K 1**
CO 3	Understand theoretical principles of magnetism through the experiments.	**K 2**
CO 4	Acquire knowledge about arc spectrum and applications of laser	**K 1**
CO 5	Improve the analytical and observation ability in Physics Experiments	**K 4**
CO6	Conduct experiments on applications of FET and UJT	**K 5**
CO7	Analyze various parameters related to operational amplifiers	**K 4**
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	**K 2**

CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K 3**
CO10	Analyze the applications of counters and registers	**K 4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3

CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	S	S	2	2	2	3	3
CO7	2	2	S	S	S	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

METHOD OF EVALUATION:

Continuous Internal Assessment	**End Semester Examination**	**Total**	**Grade**
25	75	**100**	

Programme : M.Sc Physics Part III: ELECTIVE PAPER - 3 Semester : II Hours : 5 Hrs/W (75Hrs P/S) Sub. Code : P23DP16 Credits: 3

TITLE OF THE PAPER: ADVANCED OPTICS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional		Skill Development Oriented		Addresses Environment and	

need				Sustainability	
Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites
Knowledge of ray properties and wave nature of light
Learning Objectives
➢ To know the concepts behind polarization and could pursue research work on application aspects of laser ➢ To impart an extensive understanding of fiber and non-linear optics ➢ To study the working of different types of LASERS ➢ To differentiate first and second harmonic generation ➢ Learn the principles of magneto-optic and electro-optic effects and its applications

UNITS	Course Details
UNIT 1: POLARIZATION AND DOUBLE REFRACTION	Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity
UNIT II: LASERS	Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Chemical lasers – HCl laser – Semiconductor laser
UNIT III: FIBER OPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor .

UNIT IV: NON-LINEAR OPTICS	Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light

UNIT V: MAGNETO OPTICS AND ELECTRO-OPTICS	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro optic effect
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd. 2. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
REFERENCE BOOKS	**1.** F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4thEdition), McGraw – Hill International Edition. 2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH. 3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011. 4. Y. B. Band, Light and Matter, Wiley and Sons (2006) 5. R. Guenther, Modern Optics, Wiley and Sons (1990) 6. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York 7. J. Peatros, Physics of Light and Optics, a good (and free!) electronic book 8. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley Interscience,
WEB SOURCES	➢ https://www.youtube.com/watch?v=WgzynezPiyc ➢ https://www.youtube.com/watch?v=ShQWwobpW60 ➢ https://www.ukessays.com/essays/physics/fiber–optics–and–it applications.php ➢ https://www.youtube.com/watch?v=0kEvr4DKGRI ➢ http://optics.byu.edu/textbook.aspx

COURSE OUTCOMES:

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

CO 1	Discuss the transverse character of light waves and different polarization phenomenon	**K1**
CO 2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**

CO 3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	**K3, K4**
CO 4	Identify the properties of nonlinear interactions of light and matter	**K4**
CO 5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	3
C02	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Programme : M.Sc Physics Part III: ELECTIVE PAPER - 4 Semester : II Hours : 5 Hrs/W (75Hrs P/S) Sub. Code : P23DP19 Credits: 3

TITLE OF THE PAPER: MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)

Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Knowledge of number systems and binary operations
Learning Objectives
1. To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor 2. To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

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

UNIT IV: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING	Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.

UNIT V: INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD	8051 Interrupts – Inter – Timer interrupts ai interrupts – Serial cc priority in the 8051 : N Interface Seven segm converter and Analc Measurement of elect physical quantities(Ter
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Onlir Competitive Examir Enhancement, Social A

TEXT BOOKS	1. A. Nagoor Kani, Micropro (2009). 2. A. P. Godse and D. A. God Pune (2009). 3. Ramesh Gaonkar, Micropr Applications with 8085, Penra Fundamentals of Microproces publications New Delhi (2016 5. V. Vijayendran, 2005, Func S.Visvanathan Pvt, Ltd.
REFERENCE BOOKS	1. Douglas V. Hall, Micropr Hardware, Tata Mc Graw 2. Muhammad Ali Mazidi, 8051 Microcontroller and E Barry B. Brey, 1995, The In 80386 and 80486, 3rd Edi Uffrenbeck, "The 8086/8088 Software, Hardware and App 5. W. A. Tribel, Avtar Singh, Programming, Interfacing Prentice Hall of India, Ne

WEB SOURCES	1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html 2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/ 3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/ 4. http://www.circuitstoday.com/8051-microcontroller 5. https://www.elprocus.com/8051-assembly-language-programming/

COURSE OUTCOMES:

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

CO 1	Gain knowledge of architecture and working of 8085 microprocessor.	**K1**
CO 2	Get knowledge of architecture and working of 8051 Microcontroller.	**K1**
CO 3	Be able to write simple assembly language programs for 8085A microprocessor.	**K2, K3**
CO 4	Able to write simple assembly language programs for 8051 Microcontroller.	**K3, K4**
CO	Understand the different applications of microprocessor and microcontroller.	**K3,K**

5		**5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

Programme : M.Sc., Physics Part IV: SKILL ENCHANCEMENT PAPER-1 Semester : II
Hours : 2 Hrs/W (30Hrs P/S)
Sub. Code : P23SEP1 Credits: 2

TITLE OF THE PAPER: SOLAR ENERGY UTILIZATION

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	S

Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites
Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types
Learning Objectives
1. To impart fundamental aspects of solar energy utilization. 2. To give adequate exposure to solar energy related industries 3. To harness entrepreneurship skills 4. To understand the different types of solar cells and channelizing them to the different sectors of society 5. To develop an industrialist mindset by utilizing renewable source of energy

UNITS	Course Details
UNIT I: HEAT TRANSFER & RADIATION ANALYSIS	Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.
UNIT II: SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.
UNIT III: SOLAR HEATERS	Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.
UNIT IV: SOLAR ENERGY CONVERSION	Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process texturisation, diffusion, Antireflective coatings, metallization.
UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS	Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage. Industrial visit – data collection and analysis – presentation.

UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.

TEXT BOOKS	1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 5th edn, 4 th print, 2001. 2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", Mc Graw-Hill, 2010. 3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems", Academic Press, London, 2009. 4. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002. 5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
REFERENCE BOOKS	1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976). 2. Solar energy thermal processes – John A.Drife and William. (1974). 3. John W. Twidell & Anthony D.Weir, 'Renewable Energy Resources, 2005. 4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013. 5. Duffie, J.A., Beckman, W.A."Solar Energy Thermal Process", John Wiley and Sons, 2007. 6. Energy Technology – S.Rao, Dr. B.B. Parukkar, Khanna Publisher, 3 rdedn, 4 th reprint, 2005, Delhi. 7. Solar Energy, S.P.Sukhatna, Tata Mc Grawall, Hill Publishing Company Ltd, Delhi, 2 nd edn, 14th Reprint, 2006. 8. Solar Energy – M.P. Agarwal, 1 st edn, Reprint 1985, S.Chand Publications, Delhi.
WEB SOURCES	1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556 f9a4fb 2. https://books.google.vg/books?id=l XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read 3. www.nptel.ac.in/courses/112105051 4. www.freevideolectures.com 5. http://www.e-booksdirectory.com

COURSE OUTCOMES:

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

CO 1	Gained knowledge in fundamental aspects of solar energy utilization	**K1**
CO 2	Equipped to take up related job by gaining industry exposure	**K3**
CO 3	Develop entrepreneurial skills	**K5**
CO 4	Skilled to approach the needy society with different types of solar cells	**K4**

CO 5	Gained industrialist mindset by utilizing renewable source of energy	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

Programme : M.Sc Physics Part III: CORE PAPER Semester : III Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP7 Credits: 5

TITLE OF THE PAPER: QUANTUM MECHANICS – II

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional		Skill Development Oriented		Addresses Environment and	

need				Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Knowledge of postulates of Quantum mechanics, properties of Hermitian operators, ladder operators, degeneracy, angular momentum techniques and commutation rules
Learning Objectives
➢ Formal development of the theory and the properties of angular momenta, both orbital and spin ➢ To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation. ➢ Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field ➢ To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts ➢ To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNITS	Course Details
UNIT 1: SCATTERING THEORY	Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for s wave – Optical theorem – Transformation from centre of mass to laboratory frame.
UNIT II: PERTURBATION THEORY	Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation

UNIT III: RELATIVISTIC QUANTUM MECHANICS	Klein – Gordon Equation – Charge And Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation Of Negative Energy States – Antiparticles – Spin of Electron – Magnetic Moment Of An Electron Due To Spin

UNIT IV: DIRAC EQUATION	Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman's theory of positron (Elementary ideas only without propagation formalism).

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION	Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.
TEXT BOOKS	1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw-Hill, New Delhi, 2010. (UNIT – II) 2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2016.(UNIT – I, III, IV, V) 3. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011. (UNIT – IV) 4. S.L.Kakani, H.M. Chandalia, Quantum Mechanics, 4 th Edition, S.Chand& Sons. (UNIT IV, V).

REFERENCE BOOKS	1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition,Oxford University Press, London, 1973. 2. B.K.Agarwal& HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009. 3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics,1st edition,I.K.International Publishing house Pvt.Ltd., 2006 4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi. 5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970 6. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition,Tata McGraw-Hill, New Delhi, 2010. 7. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968 8. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005. 9. NouredineZettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

WEB SOURCES	1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics -ii fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf 2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf 3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf 4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-q m notes-gk.pdf 5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

COURSE OUTCOMES:

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

CO 1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	**K1**
CO 2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	**K2**
CO 3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	**K1, K4**
CO 4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	**K1, K3**

CO 5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

Programme : M.Sc Physics Part III: CORE PAPER Semester : III Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP8 Credits: 5

TITLE OF THE PAPER: CONDENSED MATTER PHYSICS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to		Skill Development		Addresses	

Regional need		Oriented		Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.
Learning Objectives
➢ To describe various crystal structures, symmetry and to differentiate different types of bonding. ➢ To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. ➢ To critically assess various theories of electrons in solids and their impact in distinguishing solids. ➢ Outline different types of magnetic materials and explain the underlying phenomena. ➢ Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNITS	Course Details
UNIT I: CRYSTAL PHYSICS	Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).
UNIT II: LATTICE DYNAMICS	Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.
UNIT III: THEORY OF METALS AND SEMICONDUCTORS	Free electron gas in three dimensions - Electronic heat capacity - Wiedemann Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

UNIT IV: MAGNETISM	Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.

UNIT V: Superconductivity	**Experimental facts:** Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors. **Theoretical Explanation:** Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime- Nature of paring and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. C. Kittel, 1996, *Introduction to Solid State Physics,* 7th Edition, Wiley, New York. 2. Rita John, Solid State Physics,Tata Mc-GrawHill Publication,2014.
REFERENCE BOOKS	1. J. S. Blakemore, 1974, *Solid state Physics,* 2nd Edition, W.B. Saunder, Philadelphia 2. H. M. Rosenburg, 1993, *The Solid State,* 3rd Edition, Oxford University Press, Oxford. 3. J. M. Ziman, 1971, Principles *of the Theory of Solids*, Cambridge University Press, London. 4. C. Ross-Innes and E. H. Rhoderick, 1976, *Introduction to Superconductivity,* Pergamon, Oxford. 5. J. P. Srivastava, 2001, *Elements of Solid State Physics,* Prentice-Hall of India, New Delhi. 6. A. J. Dekker, *Solid State Physics*, Macmillan India, New Delhi. 7. M. Ali Omar, 1974, *Elementary Solid State Physics – Principles and Applications,* Addison - Wesley 8. H. P. Myers, 1998, *Introductory Solid State Physics,* 2nd Edition, Viva Book, New Delhi.

WEB SOURCES	➢ http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html ➢ http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html ➢ https://www.britannica.com/science/crystal ➢ https://www.nationalgeographic.org/encyclopedia/magnetism/ ➢ https://www.brainkart.com/article/Super-Conductors_6824/

COURSE OUTCOMES:

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

CO 1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	**K1**
CO 2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	**K1, K2**
CO 3	Student will be able to comprehend the heat conduction in solids	**K3**

CO 4	Student will be able to generalize the electronic nature of solids from band theories.	**K3, K4**
CO 5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO1 0**
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

Programme : M.Sc Physics Part III: Core Practical - 3 Semester : III Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP9P Credits: 4

TITLE OF THE PAPER: Practical – III -NUMERICAL METHODS AND COMPUTER PROGRAMMING (FORTRAN/C) Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	

Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Basic knowledge in differential equation and linear algebra Basic knowledge of operating system and computer fundamentals.
Learning Objectives
➢ The aim and objective of the course on Computational Practical is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as C/FORTRAN ➢ To equip the computational skill using various mathematical tools. ➢ To apply the software tools to explore the concepts of physical science. ➢ To approach the real time activities using physics and mathematical formulations.

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

18. Boole's rule
19. Gaussian quadrature method (2 point and 3 point formula)
20. Giraffe's root square method for solving algebraic equation.

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

COURSE OUTCOMES:

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

CO 1	Program with the C Program/ FORTRAN with the C or any other high level language	**K1**
CO 2	Use various numerical methods in describing/solving physics problems.	**K4**
CO 3	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.	**K5**
CO 4	To enhance the problem-solving aptitudes of students using various numerical methods.	**K5**

CO 5	To apply various mathematical entities, facilitate to visualise any complicate tasks.	**K3**
CO6	Process, analyze and plot data from various physical phenomena and interpret their meaning	**K4**
CO7	Identify modern programming methods and describe the extent and limitations of computational methods in physics	**K1**
CO8	Work out numerical differentiation and integration whenever routine are not applicable.	**K5**
CO9	Apply various interpolation methods and finite difference concepts.	**K4**
CO10	Understand and apply numerical methods to find out solution of algebraic equation using different methods under different conditions, and numerical solution of system of algebraic equation.	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3

CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	**100**	

Programme : M.Sc Physics Part III: CORE PAPER Semester : III Hours : 5Hrs/W (75Hrs P/S) Sub. Code : P23CP10 Credits: 3

TITLE OF THE PAPER: ELECTROMAGNETIC THEORY

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Knowledge of different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma
Learning Objectives

- ➢ To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables
- ➢ To understand Biot – Savart's law and Ampere's circuital law
- ➢ To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws
- ➢ To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves
- ➢ To grasp the concept of plasma as the fourth state of matter

UNITS	Course Details
UNIT I: ELECTROSTATICS	Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.
UNIT II: MAGNETOSTATICS	Biot - Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

UNIT III: MAXWELL EQUATIONS	Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

UNIT IV: WAVE PROPAGATION	Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole
UNIT V: ELEMENTARY PLASMA PHYSICS	The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magneto sonic waves.

UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. D. J. Griffiths, 2002, *Introduction to Electrodynamics,* 3rd Edition, Prentice-Hall of India, New Delhi. 2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, *Foundations of Electromagnetic Theory,* 3rd edition, Narosa Publishing House, New Delhi. 3. J. D. Jackson, 1975, *Classical Electrodynamics,* Wiley Eastern Ltd. New Delhi. 4. J. A. Bitten court, 1988, *Fundamentals of Plasma Physics,* Pergamon Press, Oxford. 5. Gupta, Kumar and Singh, Electrodynamics, S.Chand & Co., New Delhi
REFERENCE BOOKS	➢ W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism,* Addison Wesley, London. ➢ J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications,* 5th Edition, WCB McGraw-Hill, New York. ➢ B. Chakraborty, 2002, *Principles of Electrodynamics,* Books and Allied, Kolkata. ➢ P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi. ➢ Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA.
WEB SOURCES	1. http://www.plasma.uu.se/CED/Book/index.html 2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html 3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html 4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tut

	orials/ **5.** https://www.cliffsnotes.com/study-guides/physics/electricity-and magnetism/electrostatics

COURSE OUTCOMES:

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

CO 1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	**K1, K5**
CO	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction &	**K2,**

2	magnetic vector potential for various physical problems	**K3**
CO 3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	**K3**
CO 4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	**K3, K4**
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Programme : M.Sc Physics Part III: ELECTIVE PAPER-5 Semester : III Hours : 5Hrs/W (75Hrs P/S) Sub. Code : P23DP09 Credits: 3

TITLE OF THE PAPER: NUMERICAL METHODS AND COMPUTER PROGRAMMING

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented		Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Prior knowledge on computer and basic mathematics
Learning Objectives
➢ To make students to understand different numerical approaches to solve a problem. ➢ To understand the basics of programming

UNITS	Course Details
UNIT I: SOLUTIONS OF EQUATIONS	Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - Zeros of polynomials –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton- Raphson methods – Convergence of solutions in Bisection and Newton- Raphson methods – Limitations of Bisection and Newton- Raphson methods.
UNIT II: LINEAR SYSTEM OF EQUATIONS	Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.
UNIT III: INTERPOLATION AND CURVE FITTING	Interpolation with equally spaced points - Newton forward and backward interpolation - Interpolation with unevenly spaced points - Lagrange interpolation – Curve fitting – Method of least squares – Fitting a polynomial.
UNIT IV: DIFFERENTIATIO N, INTEGRATION AND SOLUTION OF	Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss-Legendre, Gauss Laguerre, Gauss-Hermite and Gauss- Chebyshev quadrature – solution of ordinary differential equations – Euler and Runga Kutta methods.

DIFFERENTIAL EQUATIONS	

UNIT V: PROGRAMMING WITH C	Flow-charts – Integer and floating point arithmetic expressions – Built-in functions – Executable and non-executable statements – Subroutines and functions – Programs for the following computational methods: (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.

UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. V. Rajaraman, 1993, Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi 2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Edition, New Age Intl., New Delhi 3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, New Delhi 4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York 5. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, 1992, Numerical Recipes in FORTRAN, 2nd Edition, Cambridge Univ. Press
REFERENCE BOOKS	1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,) 2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley, MA. 3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, New York. 4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley. 5. V. Rajaraman, Programming in FORTRAN / Programming in C, PHI, New Delhi

WEB SOURCES	1. https://www.scribd.com/doc/202122350/Computer Oriented-Numerical-Methods-by-V-RajaRaman 2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874 3. https://nptel.ac.in/course/122106033/ 4. https://nptel.ac.in/course/103106074/ 5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

COURSE OUTCOMES:

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

CO 1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1, K2**
CO 2	Relate Simultaneous linear equations and their matrix representation Distinguishbetween various methods in solving simultaneous linear equations.	**K5**
CO 3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	**K2, K3**
CO 4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.	**K3, K4**
CO 5	Understand the basics of C-programming and conditional statements.	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO10**

CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

Programme : M.Sc Physics Part III: SKILLED PAPER-2 Semester : III Hours : 2Hrs/W (30Hrs P/S) Sub. Code : P23SEP2 Credits: 2

TITLE OF THE PAPER: SOLID WASTE MANAGEMENT

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented	(✓)	Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to Local need	(✓)			Addresses Human Values	(✓)

Pre-Requisites
Basic knowledge of solid waste and its type
Learning Objectives
1. To gain basic knowledge in solid waste management procedures 2. To gain industry exposure and be equipped to take up a job. 3. To harness entrepreneurial skills. 4. To analyze the status of solid waste management in the nearby areas. 5. To sensitize the importance of healthy practices in waste managements

UNITS	**Course Details**
UNIT I: SOLID WASTE MANAGEMENT	Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and

	non-municipal solid waste.
UNIT II: SOLID WASTE CHARACTERISTICS	Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation
UNIT III: TOOLS AND EQUIPMENT	Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique
UNIT IV: ECONOMIC DEVELOPMENT	SWM for economic development and environmental protection Linking SWM and climate change and marine litter.
UNIT V: INDUSTRIAL VISIT	SWM Industrial visit – data collection and analysis - presentation
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Handbook of Solid Waste Management /Second Edition, George Tcho banoglous, McGraw Hill (2002). 2. Prospects and Perspectives of Solid Waste Management, Prof. B B Hosett, New Age International (P) Ltd (2006). 3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS Publications / BSPBooks (.)2020 4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014). 5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016
REFERENCE BOOKS	1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012 2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2 3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237 4. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 20061SBN-I3: 978-8131709122 5. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693

WEB SOURCES	1. https://www.meripustak.com/Integrated-Solid-Waste Management-Engineering-Principles-And-Management-Issues 125648 2. https://testbook.com/learn/environmental-engineering-solid waste-management/ 3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCR ARIsA gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3Q XjJ1iACq30KofoaAmFsEALw_wcB 4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28 5. https://amzn.eu/d/5VUSTDI

COURSE OUTCOMES:

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

CO 1	Gained knowledge in solid waste management	**K 1**
CO 2	Equipped to take up related job by gaining industry exposure	**K 5**
CO 3	Develop entrepreneurial skills	**K 3**
CO 4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	**K 4**
CO 5	Adequately sensitized in managing solid wastes in and around his/her locality	**K 5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

Programme : M.Sc Physics Part III: CORE PAPER Semester : IV Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP11 Credits: 5

TITLE OF THE PAPER: NUCLEAR AND PARTICLE PHYSICS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites
Knowledge of basic structure of atom and nucleus.
Learning Objectives
➢ Introduces students to the different models of the nucleus in a chronological order ➢ Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles ➢ Provides students with details of nuclear decay with relevant theories ➢ Exposes students to the Standard Model of Elementary Particles and Higgs boson

UNITS	Course Details

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

UNIT IV: **NUCLEAR DECAY**	Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.

UNIT V: **ELEMENTARY PARTICLES**	Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011) 2. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)

REFERENCE BOOKS	1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973) 2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974). 3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002) 4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001) 5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi. 6. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008) 7. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996) 8. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968)
WEB SOURCES	1. http://bubl.ac.uk/link/n/nuclearphysics.html 2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp: //www.scholarpedia.org/article/Nuclear_Forces 3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/ 4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html 5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/r adioactivedecay.html

COURSE OUTCOMES:

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

CO 1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	**K1, K5**
CO 2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	**K2, K3**
CO 3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	**K3**
CO 4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	**K3, K4**
CO 5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW

(1).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO1 0
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

Programme : M.Sc Physics Part III: Core Practical - 4 Semester : IV Hours : 6 Hrs/W (90Hrs P/S) Sub. Code : P23CP12P Credits: 5

TITLE OF THE PAPER: PRACTICAL IV

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites
Knowledge and handling of general and experiments of Physics, as well as fundamentals of digital principles,

Learning Objectives
➢ To understand the theory and working of Microprocessor, Microcontroller and their applications ➢ To use microprocessor and Microcontroller in different applications

Course Details
(Minimum of Twelve Experiments from the list) 1. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes. 2. Determination of Solar constant 3. Determination of velocity and compressibility of a liquid using Ultrasonics Interferometer 4. Arc spectrum – Iron. 5. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser. 6. Measurement of Magnetic Susceptibility - Guoy's method 7. GM counter – Feather's analysis: Range of Beta rays 8. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser. 9. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser 10. Molecular spectra – CN bands 11. Determination of Planck Constant – LED Method 12. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type) 13. Construction of square wave generator using IC 555 – Study of VCO 14. Study of Binary to Gray and Gray to Binary code conversion. 15. Construction of Encoder and Decoder circuits using ICs. 16. Study of synchronous parallel 4-bit binary up/down counter using IC 74193 17. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493 18. Study of Modulus Counter

19. Construction of Multiplexer and Demultiplexer using ICs. 20. 8-bit addition and subtraction, multiplication and division using microprocessor 8085 21. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array. Sorting in ascending and descending order using microprocessor 8085 22. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary using microprocessor 8085 23. Addition of multi byte numbers, Factorial using microprocessor 8085

24. Clock program- 12/24 hours-Real time application – Six Digits Hexa Decimal and Decimal Counters using microprocessor 8085
25. Interfacing of LED – Binary up/down counter, BCD up/down counter and N/2N up/down counter using microprocessor 8085
26. Interfacing of seven segment display using microprocessor 8085
27. Interfacing of 8-bit R / 2R ladder DAC (IC 741) – Wave form generation – Square, Rectangular, Triangular, Saw tooth and Sine waves using microprocessor 8085 28. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action using microprocessor 8085
29. Interfacing of Temperature Controller and Measurementusing microprocessor 8085 30. Interfacing of Traffic light controller using microprocessor 8085

TEXT BOOKS	1. Practical Physics, Gupta and Kumar, PragatiPrakasan 2. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 3. Electronic lab manual Vol I, K ANavas, Rajath Publishing 4. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008) 5. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085", 3rd Edition S.VisvanathanPvt, Ltd.
REFERENCE BOOKS	1. Advanced Practical Physics, S.P Singh, PragatiPrakasan 2. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. ltd 3. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing 4. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi 5. Microprocessor and Its Application - S. Malarvizhi, Anuradha Agencies Publications

COURSE OUTCOMES:

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

CO 1	Develop the programming skills of Microprocessor	**K5**
CO 2	Appreciate the applications of Microprocessor programming	**K3**
CO 3	Understand the structure and working of 8085 microprocessor and apply it.	**K1, K3**
CO 4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.	**K1, K4**

CO 5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.	**K1,K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

METHOD OF EVALUATION:

Continuous Internal Assessment	**End Semester Examination**	**Total**	**Grade**
25	**75**	**100**	

Programme : M.Sc Physics Part III: ELECTIVE PAPER 6 Semester : IV Hours : 5Hrs/W (75Hrs P/S) Sub. Code : P23DP10 Credits: 3

TITLE OF THE PAPER: SPECTROSCOPY

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	
Relevant to Local need				Addresses Human Values	(✓)

Pre-Requisites
Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour
Learning Objectives
➢ To comprehend the theory behind different spectroscopic methods ➢ To know the working principles along with an overview of construction of different types of spectrometers involved ➢ To explore various applications of these techniques in R &D. ➢ Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds. ➢ Understand this important analytical tool

UNITS	Course Details
UNITI: **MICROWAVE SPECTROSCOPY**	Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)- reduced mass – rotational constant - - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra- Stark effect Problems.

UNITII: **INFRA-RED SPECTROSCOPY**	Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications.

UNITIII: **RAMAN SPECTROSCOPY**	Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle determination of N_2O structure -Instrumentation technique and block diagram - structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS.

UNITIV: **RESONANCE SPECTROSCOPY**	Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin - Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR.
UNITV: **UV SPECTROSCOPY**	Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV Spectrophotometer -Simple applications.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.
TEXT BOOKS	1. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi. 2. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers.

REFERENCE BOOKS	1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi. 2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge. 3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York. 4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi. 5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.

	6. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi. 7. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication. 8. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
WEB SOURCES	1. https://www.youtube.com/watch?v=0iQhirTf2PI 2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5 3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy 8jEee 4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy introduction-XCWRu

COURSE OUTCOMES:

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

CO 1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	**K2**
CO 2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	**K2, K3**
CO 3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	**K5**
CO 4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	**K4**

CO 5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	**K1, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO1 0**
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Programme : M.Sc Physics Part III: SKILLED PAPER - 3 Semester : IV Hours : 3 Hrs/W (45Hrs P/S) Sub. Code : P23SEP3 Credits: 2

TITLE OF THE PAPER: CRYSTAL GROWTH AND THIN FILMS

Nature of the Course

Relevant to Global need	(✓)	Employability Oriented	(✓)	Addresses Professional Ethics	(✓)
Relevant to National need		Entrepreneurship Oriented		Addresses Gender Sensitization	

Relevant to Regional need		Skill Development Oriented	(✓)	Addresses Environment and Sustainability	(✓)
Relevant to Local need				Addresses Human Values	

Pre-Requisites
Fundamentals of Crystal Physics
Learning Objectives
➢ To acquire the knowledge on Nucleation and Kinetics of crystal growth ➢ To understand the Crystallization Principles and Growth techniques ➢ To study various methods of Crystal growth techniques ➢ To understand the thin film deposition methods ➢ To apply the techniques of Thin Film Formation and thickness Measurement

UNITS	Course Details
UNIT I: CRYSTAL GROWTH KINETICS	Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films
UNIT II: CRYSTALLIZATION PRINCIPLES	Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.
UNIT III: GEL, MELT AND VAPOUR GROWTH	Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

UNIT IV: THIN FILM DEPOSITION METHODS	Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.

UNIT V: THIN FILM FORMATION	Thin Film Formation and thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes",KRU Publications 2001. 2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008) 3. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition
REFERENCE BOOKS	1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986) 2. P. Ramasamy and F. D. Gnanam, 1983, "UGC Summer School Notes". 3. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York 4. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution" 5. D. Elwell and H. J. Scheel, "Crystal Growth from High Temperature Solution"Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.
WEB SOURCES	(i)https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrI O8kZl1D1Jp (ii) https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF (iii) https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m (iv) https://www.youtube.com/playlist?list=PLXHedIxbyr8xIl_KQFs_R_oky3Yd1Emw **(v)**https://www.electrical4u.com/thermal-conductivity-of-metals/

COURSE OUTCOMES:

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

CO 1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	**K1**
CO 2	Understand the Crystallization Principles and Growth techniques	**K2, K4**
CO 3	Study various methods of Crystal growth techniques	**K3**
CO 4	Understand the Thin film deposition methods	**K2**
CO 5	Apply the techniques of Thin Film Formation and thickness Measurement	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

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	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO1 0**
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

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