SRI MEENAKSHI GOVERNMENT ARTS COLLEGE FOR WOMEN

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

Re-Accredited with **B^{++}** Grade by NAAC (**4th Cycle**)

Madurai 625002.

SYLLABUS

Programme:	Postgraduate
Programme Code:	**PPHE1**
Name of the Programme:	**M.Sc., PHYSICS**
Duration of the Programme:	**2 years** (4 semesters)
Year	**2024-2026**
Eligibility for Admission	As per **DCE** norms: (i) Pass in **B.Sc. Physics** exam with **55 %** (ii)**Age Limit** under Government Order

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SRI MEENAKSHI GOVERNMENT ARTS COLLEGE FOR WOMEN(AUTONOMOUS)

MADURAI – 625 002.

DEPARTMENT OF PHYSICS

1. PROFILE OF THE DEPARTMENT

2024 - 2026

Physics plays vital role to enrich the science in Nature. It is fact behind every action occurring in our surroundings. The Department of Physics is one of the oldest department in our college, established in the year **1970 – 1971** and is functioning from the prestigious science block. It extending and rendering countless academic support to the downtrodden, rural students, around Madurai district. M.Sc PHYSICS is started in **2013** with affiliated strength of **20** students in our college. It offers PG Physics course with full strength. A physics major is a science degree path helps to explain how the world works and how the universe is structured. Majors, study matter and energy and gain exposure to both classical modern theories in the field. Students also spend time in completing experiments in a lab setting. The main objective of the department is to equip the students with knowledge and skills and to inculcate the deep understanding in physics. The department strives to provide quality Education to make the students competent in all aspects with the help of the well qualified, committed and experienced faculty members. The main aims to provide students with good opportunities to learn about Core ideas and practices of Physics, which can help them to understand and solve a broad range of problems beyond physics problems, including societal problems.

S.NO	NAME	DESIGNATION
1.	Dr. N. NAGARANI	Head & Associate Professor
2.	Dr. G. KRISHNA BAMA	Associate Professor
3.	Dr. J.S.P.CHITRA	Assistant Professor
4.	Dr. M.SANTHI	Associate Professor
5.	Dr. M.MAHALAKSHMI	Associate Professor
6.	Dr. R.VIJAYALAKSHMI	Associate Professor
7.	Dr. G.SELVARANI	Associate Professor
8.	Dr. S.V.MEENAKSHI	Assistant Professor
9.	Dr. K. LILLY MARY EUCHARISTA	Associate Professor
10.	Dr. U. KARUNANEETHI	Assistant Professor
11.	Dr. R. VIJAYA KUMAR	Assistant Professor
12.	Dr. A. BEULAH MARY	Assistant Professor
13.	Dr. P. INDRA DEVI	Assistant Professor
14.	Dr. P.N. NIRMALA	Assistant Professor
15.	Mrs. V.SATHYA BAMA	Guest Lecturer
16.	Mrs. VINOLIA	Lecturer (PTA)

2. SCOPE OF THE PROGRAMME

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.

3. PROGRAMME OUTCOMES

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 endeavours 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.

4. PROGRAMME SPECIFIC OUTCOMES

PSO1 – Placement

To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours and 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 start-ups 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

5. ABSTRACT OF PROGRAMME STRUCTURE

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**

6. CURRICULAR FRAMEWORK

Programme : M.Sc. Physics

SEMESTER–I

Course Type	SUB CODE	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
						Int	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	4	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	4	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
CC9(P)	P23CP9P	Practical – III	6	4	4	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	4	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 / Professional competency skill paper	P23SEP3	Crystal Growth And Thin Films	3	2	3	25	75	100
	P23EAP	Extension Activity	-	1	-	--	--	100
Total			**30**	**23**				**600**

PG COURSE - 2024 -2026

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 - 40 marks

Participation - 40 marks

Report - 20 marks

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

Attendance (mandatory) - 40 marks

Field work and performance - 40 marks

Report writing - 20 marks

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

ATTENDANCE CERTIFICATE FOR INTERNSHIP

Ms. ______________________________________ Reg. No. _________________________ studying __________________ programme at Sri Meenakshi Government Arts College for Women(A), Madurai in semester III at the Department of _________________________________ has attended the Internship from _________ to ________ for _____ hours. It is certified that she has completed the Internship at ___________________________________ (Organization/ Institution).

Signature with date:

Name and Designation of the Officer:

Seal of the Organization:

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	II	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	GEC 2	Physics of Nano Science and Technology	6	3
III	II	P23DP16	GEC 3	Advanced Optics	5	3
III	II	P23DP19	GEC 4	Microprocessor 8085 and Microcontroller 8051	5	3
III	III	P23DP09	GEC 5	Numerical Methods and Computer Programming	5	3
III	IV	P23DP10	GEC 6	Spectroscopy	5	3

7. SYLLABUS WITH LESSON PLAN

PROGRAMME: **M. Sc., Physics**				
SEMESTER: **I**	**Part: III Core Course 1**	COURSE CODE:**P23CP1**		
TITLE OF THE COURSE: **MATHEMATICAL PHYSICS**				
HOURS OF INSTRUCTION PER WEEK: **6 Hrs./W (90Hrs /S)**	CREDITS: **6**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program.
- To extend their manipulative skills to apply mathematical techniques in their fields.
- To help students apply Mathematics in solving problems of Physics.

✓ **MATHEMATICAL PHYSICS**

UNIT	CONTENT	HRS
I LINEAR VECTOR SPACE	Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalisation procedure – linear operators – Dual space- Ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation.	**18**

II COMPLEX ANALYSIS	Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders.	**18**
III MATRICES	Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices - Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem –Diagonalization.	**18**
IV FOURIER TRANSFORMS & LAPLACE TRANSFORMS	Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions - Application - Laplace equation: Potential problem in a semi - infinite strip.	**18**
V DIFFERENTIAL EQUATIONS	Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and Reciprocity theorem - Sturm- Liouville's type equation in one dimension & their Green's function.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	

COURSE OUTCOMES:

At the endofthe course thestudentwillbeableto:

CO1	Understand use ofbra-ketvector notation and explain the meaning of complete ortho -normal set of basis vectors, and transformations and be able to apply them.
CO2	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.
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.
CO4	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
CO5	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

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

TEXTBOOKS:

1. P.K. Chattopadhyay, 2013, *Mathematical Physics* (2nd edition), New Age, New Delhi
2. SathyaPrakash,(2007) *Mathematical Physics* (5th edition), S. Chand & Company Pvt. Ltd., New Delhi

REFERENCES:

1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated EastWest, New Delhi.
5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York
6. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
7. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt.Ltd., India
8. B. D. Gupta, 2009, *Mathematical Physics* (4th edition), VikasPublishing House, New Delhi.
9. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

E-LEARNING RESOURCES:

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_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/

MAPPING WITH PROGRAMME 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)**.**

CO / PO	**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
Weightage	14	14	15	14	12	15	15	10	12	`11
Weighted % of Course Contribution to PO's	2.8	2.8	3	2.8	2.4	3	3	2	2.4	2.2

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**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

Weightage	14	14	15	14	12	15	15	10	12	11
Weighted % of Course Contribution to PSO's	2.8	2.8	3.0	2.8	2.2	3.0	3.0	2.0	2.2	2.1

LESSON PLAN

COURSE CODE:**P23CP1**	TITLE OF THE COURSE: **MATHEMATICAL PHYSICS**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	**TOPIC**	**LECTURE HOURS**	**MODE OF TEACHING**
I LINEAR VECTOR SPACE	Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product.	3	Lecture, ICT
	Orthogonality – Gram-Schmidt orthogonalisation procedure –linear operators.	3	Lecture, ICT
	Dual space- Ket and bra notation – orthogonal basis – change of basis.	4	Lecture, Seminar
	Isomorphism of vector space – projection operator –Eigen values and Eigen functions.	4	Lecture, ICT
	Direct sum and invariant subspace – orthogonal transformations and rotation.	4	Lecture, ICT
II **COMPLEX ANALYSIS**	Review of Complex Numbers -de Moivre's theorem- Functions of a Complex Variable- Differentiability.	4	Lecture, ICT
	Analytic functions- Harmonic Functions- Complex Integration- Contour Integration,	3	Lecture, ICT
	Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula.	3	Lecture, ICT
	Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1).	4	Lecture, ICT
	Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) - Heat problems - Parallel plates and coaxial cylinders.	4	Lecture, Seminar
III	Types of Matrices and their properties, Rank of a Matrix - Conjugate of a matrix.	4	Lecture, ICT

MATRICES	Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices	4	Lecture, ICT
	Trace of a matrix- Transformation of matrices - Characteristic equation.	4	Lecture, ICT
	Eigen values and Eigen vectors	3	Lecture, Seminar
	- Cayley–Hamilton theorem –Diagonalization	3	Lecture, ICT
IV **FOURIER TRANSFORMS & LAPLACE TRANSFORMS**	Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function.	3	Lecture, ICT
	Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium.	4	Lecture, ICT
	Wave equation: Vibration of an infinite string and of a semi - infinite string.	3	Lecture, Seminar
	Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms.	4	Lecture, ICT
	Dirac delta functions - Application - Laplace equation: Potential problem in a semi - infinite strip.	4	Lecture, ICT
V **DIFFERENTIAL EQUATIONS**	Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples.	4	Lecture, ICT
	Hermite polynomials - Generating function - Orthogonality properties	3	Lecture, Seminar
	Recurrence relations – Legendre polynomials - Generating function	3	Lecture, ICT
	Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and Reciprocity theorem	4	Lecture, ICT
	Sturm-Liouville's type equation in one dimension & their Green's function	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23CP1	MATHEMATICAL PHYSICS	Understand use ofbra-ketvector notation and explain the meaning of complete ortho -normal set of basis vectors, and transformations and be able to apply them.
		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.
		Analyze characteristics of matrices and its different types, and the process of diagonalization.
		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
		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

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SEMESTER: **I**	**Part: III CoreCourse 2**	COURSE CODE: **P23CP2**

TITLE OF THE COURSE: **CLASSICAL MECHANICS AND RELATIVITY**

HOURS OF INSTRUCTION PER WEEK: **6 Hrs./W (90Hrs /S)**	CREDITS: **6**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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.

CLASSICAL MECHANICS AND RELATIVITY

UNIT	CONTENT	HRS
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.	**18**
II LAGRANGIAN FORMALATION	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.	**18**

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.	**18**
IV SMALL OSCILLATIONS	Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	**18**
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.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	

COURSE OUTCOMES:
At the endofthe course thestudentwillbeableto:

CO1	Understand the fundamentals of Classical Mechanics.
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.

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

TEXTBOOK:

- H. Goldstein, 2002, *Classical Mechanics,* 3rd Edition, Pearson Edu.
- J. C. Upadhyaya, *Classical Mechanics,* HimalayaPublshing. Co.New Delhi.

REFERENCE :

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.

E-LEARNING RESOURCES:

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5. https://www.britannica.com/science/relativistic-mechanics

MAPPING WITH PROGRAMME 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)**.**

CO / PO	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
Weightage	10	15	15	15	10	10	10	15	10	10
Weighted % of Course Contribution to PO'S	2.0	3.0	3.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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	2
Weightage	14	14	15	14	12	15	15	10	12	10
Weighted % of Course Contribution to PSO'S	2.8	2.8	3.0	2.8	2.2	3.0	3.0	2.0	2.4	2.0

LESSON PLAN

COURSE CODE:**P23CP2**	TITLE OF THE COURSE:**CLASSICAL MECHANICS AND RELATIVITY**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I PRINCIPLES OF CLASSICAL MECHANICS	Introduction - Mechanics of a single particle – Mechanics of a system of particles	3	Lecture, ICT
	Conservation laws for a system of particles	3	Lecture, ICT
	constraints – holonomic & non-holonomic constraints	4	Lecture, Seminar
	generalized coordinates – configuration space	4	Lecture, ICT
	transformation equations – principle of virtual work.	4	Lecture, ICT
II **LAGRANGIAN FORMALATION**	Introduction -D'Alembert's principle	4	Lecture, ICT
	Lagrangian equations of motion for conservative systems	3	Lecture, ICT
	Applications: (i) simple pendulum	3	Lecture, ICT
	(ii)Atwood's machine	4	Lecture, ICT
	(iii)projectile motion.	4	Lecture, Seminar
III **HAMILTONIAN FORMULATION**	Introduction -Phase space – cyclic coordinates – conjugate momentum	4	Lecture, ICT
	Hamiltonian function – Hamilton's canonical equations of motion	5	Lecture, ICT
	Applications: (i) simple pendulum	3	Lecture, ICT
	(ii) one dimensional simple harmonic oscillator	3	Lecture, Seminar
	(iii) motion of particle in a central force field.	3	Lecture, ICT
IV **SMALL OSCILLATIONS**	Introduction -Formulation of the problem	5	Lecture, ICT
	transformation to normal coordinates	5	Lecture, Seminar
	frequencies of normal modes	4	Lecture, ICT
	linear triatomic molecule.	4	Lecture, ICT
V **RELATIVITY**	Introduction -Inertial and non-inertial frames – Lorentz transformation equations	4	Lecture, ICT
	length contraction and time dilation – relativistic addition of velocities	4	Lecture, Seminar
	Einstein's mass-energy relation	3	Lecture, ICT

Minkowski's space	2	Lecture, ICT
four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations.	5	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes**: At the endofthe course thestudentwillbeableto:
P23CP2	CLASSICAL MECHANICS AND RELATIVITY	Understand the fundamentals of Classical Mechanics.
		Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.
		Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.
		Analyze the small oscillations in systems and determine their normal modes of oscillations.
		Understand and apply the principles of relativistic kinematics to the mechanical systems.

<table>
<tr><td colspan="2">SEMESTER : I</td><td colspan="2">Part: III Core Course 3 – Practical 1</td><td colspan="4">COURSE CODE:P23CP3P</td></tr>
<tr><td colspan="8">TITLE OF THE COURSE: PRACTICAL I</td></tr>
<tr><td colspan="3">HOURS OF INSTRUCTION PER WEEK:
6 Hrs./W (90Hrs /S)</td><td>CREDITS: 4</td><td>CIA: 25</td><td colspan="2">EXTERNAL MARKS: 75</td><td>TOTAL: 100</td></tr>
<tr><td colspan="8">NATURE OF THE COURSE</td></tr>
<tr><td>Relevant to Global need</td><td>✓</td><td colspan="2">Employability Oriented</td><td>✓</td><td colspan="2">Addresses Professional Ethics</td><td>✓</td></tr>
<tr><td>Relevant to National need</td><td>✓</td><td colspan="2">Entrepreneurship Oriented</td><td></td><td colspan="2">Addresses Gender Sensitization</td><td></td></tr>
<tr><td>Relevant to Regional need</td><td>✓</td><td colspan="2" rowspan="2">Skill Development Oriented</td><td rowspan="2">✓</td><td colspan="2">Environment and Sustainability</td><td>✓</td></tr>
<tr><td>Relevant to Local need</td><td>✓</td><td colspan="2">Addresses Human Values</td><td>✓</td></tr>
</table>

LEARNING OBJECTIVES: To enable the students to:

- 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.

PRACTICAL I

CONTENT

(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.

COURSE OUTCOMES:

At the endofthe course thestudentwillbeableto:

CO1	Understand the strength of material using Young's modulus.
CO2	Acquire knowledge of thermal behaviour of the materials.
CO3	Understand theoretical principles of magnetism through the experiments.
CO4	Acquire knowledge about arc spectrum and applications of laser
CO5	Improve the analytical and observation ability in Physics Experiments
CO6	Conduct experiments on applications of FET and UJT
CO7	Analyze various parameters related to operational amplifiers.
CO8	Understand the concepts involved in Arithmatic and logical circuits using IC's
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits
CO10	Analyze the applications of counters and registers

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

TEXTBOOKS:

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

REFERENCES:

1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
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.

MAPPING WITH PROGRAMME 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)**.**

CO / PO	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
Weightage	27	25	28	30	30	25	19	18	24	25
Weighted % of Course Contribution to PO'S	2.7	2.5	2.8	3.0	3.0	2.5	1.9	1.8	2.4	2.5

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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
Weightage	27	25	28	30	30	25	19	18	24	25
Weighted % of Course Contribution to PSO'S	2.7	2.5	2.8	3.0	3.0	2.5	1.9	1.8	2.4	2.5

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes**: At the endofthe course thestudentwillbeableto:
P23CP3P	**PRACTICAL – I**	Understand the strength of material using Young's modulus.
		Acquire knowledge of thermal behaviour of the materials.
		Understand theoretical principles of magnetism through the experiments.
		Acquire knowledge about arc spectrum and applications of laser
		Improve the analytical and observation ability in Physics Experiments
		Conduct experiments on applications of FET and UJT
		Analyze various parameters related to operational amplifiers.
		Understand the concepts involved in Arithmatic and logical circuits using IC's
		Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits
		Analyze the applications of counters and registers

PROGRAMME: **M. Sc., Physics**

SEMESTER: **I**	**Part: III ELECTIVE PAPER – 1**	COURSE CODE: **P23DP08**		
TITLE OF THE COURSE: **LINEAR AND DIGITAL ICs & APPLICATIONS**				
HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**	CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need				Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- 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

LINEAR AND DIGITAL ICs & APPLICATIONS

UNIT	CONTENT	HRS
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.	**18**
II APPLCATIONS 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.	**18**

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	**18**
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.	**18**
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).	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES: At the end of the course the student will be able to:	
CO1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems
CO2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.

CO3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.
CO4	Learn about various techniques to develop A/D and D/A converters.
CO5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits

TEXTBOOKS:

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 Gautamsaha(2011), Digital Principles and Applications 7th Edition, Tata McGraw Hill, New Delhi

REFERENCES:

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)
6. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi.
7. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
8. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
9. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S.Viswanathan Printers & Publishers Private Ltd, Reprint. V.

E-LEARNING RESOURCES:

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/chpt-7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

MAPPING WITH PROGRAMME 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).

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	3	3	3
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
Weightage	15	15	15	14	7	12	14	15	11	7
Weighted % of Course Contribution to PO'S	3.0	3.0	3.0	2.8	1.4	2.4	2.8	3.0	2.2	1.4

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	3	3	3	3
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
Weightage	15	15	15	14	7	12	14	15	11	7
Weighted % of Course Contribution to PSO'S	3.0	3.0	3.0	2.8	1.4	2.4	2.8	3.0	2.2	1.4

LESSON PLAN

<table>
<tr><td>COURSE CODE:P23DP08</td><td colspan="8">TITLE OF THE COURSE:LINEAR AND DIGITAL ICs & APPLICATIONS</td></tr>
<tr><td rowspan="2">Pedagogy</td><td>Total Hours</td><td>Lecture</td><td>Practical Experience</td><td>Peer Group Learning</td><td>Demo/ OER /Tutorial</td><td>GD / Seminar</td><td>ICT / Blended Learning</td><td>Field work / Internship</td></tr>
<tr><td>6</td><td>4</td><td>-</td><td>-</td><td>-</td><td>1</td><td>1</td><td>-</td></tr>
<tr><td>UNIT</td><td colspan="6">TOPIC</td><td>LECTURE HOURS</td><td>MODE OF TEACHING</td></tr>
<tr><td rowspan="4">I
INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER</td><td colspan="6">Introduction, Classification of IC‘s.,</td><td>4</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Basic information of Op-Amp 741 and its features</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">the ideal Operational amplifier</td><td>4</td><td>Lecture, Seminar</td></tr>
<tr><td colspan="6">Op-Amp internal circuit and Op-AmpCharacteristics.</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td rowspan="5">II
APPLICATIONS OF OP-AMP</td><td colspan="6">LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Instrumentation amplifiers, V to I and I to V converters.</td><td>4</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">NON-LINEAR APPLICATIONS OF OP-AMP: Sample and Hold circuit, Log and Antilog amplifier</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">multiplier and divider, Comparators, Schmitt trigger, Multivibrators</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Triangular and Square waveform generators</td><td>3</td><td>Lecture, Seminar</td></tr>
<tr><td rowspan="4">III
ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS</td><td colspan="6">ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters.</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">band pass, band reject and all pass filters</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL</td><td>5</td><td>Lecture, Seminar</td></tr>
<tr><td colspan="6">introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td rowspan="3">IV
VOLTAGE REGULATOR & D to A AND A to D CONVERTERS</td><td colspan="6">VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator</td><td>4</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC</td><td>5</td><td>Lecture, Seminar</td></tr>
</table>

	A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC	3	Lecture, ICT
	dual slope ADC, DAC and ADC Specifications	3	Lecture, ICT
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	4	Lecture, ICT
	CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic	3	Lecture, Seminar
	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)	3	Lecture, ICT
	BCDto7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154)	4	Lecture, ICT
	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)	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes**: At the endofthe course thestudentwillbeableto:
P23DP08	**LINEAR AND DIGITAL ICs & APPLICATIONS**	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems
		Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.
		Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.
		Learn about various techniques to develop A/D and D/A converters.
		Acquire the knowledge about the CMOS logic, combinational and sequential circuits

PROGRAMME: **M. Sc., Physics**				
SEMESTER: **I**	**Part: III ELECTIVE PAPER-2**	COURSE CODE:**P23DP04**		
TITLE OF THE COURSE: **PHYSICS OF NANO SCIENCE AND TECHNOLOGY**				
HOURS OF INSTRUCTION PER WEEK: **6 Hrs./W (90Hrs /S)**	CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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.

PHYSICS OF NANO SCIENCE AND TECHNOLOGY

UNIT	CONTENT	HRS
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.	**18**

II PROPERTIES OF NANOMETERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant – Mechanical behaviour: Elastic properties – strength - ductility – super plastic behaviour- Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).	**18**
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.	**18**
IV CHARATERIZATI ON 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 tunnelling microscopy (STM) – Vibrating sample Magnetometer.	**18**
V APPLICATIONS OF NANOMATERIALS	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.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES: At the end of the course the student will be able to:	
CO1	Understand the basic of nanoscience and explore the different types of nano materials and should comprehend the surface effects of the nano materials.
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.

CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.

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

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)

REFERENCES:

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).

E-LEARNING RESOURCES:

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

MAPPING WITH PROGRAMME 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)**.**

CO / PO	**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
Weightage	15	15	13	10	5	5	15	15	15	15
Weighted % of Course Contribution to PO'S	3	3	2.6	2	1.0	1.0	3	3	3	3

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**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
Weightage	15	15	13	10	5	5	15	15	15	15
Weighted % of Course Contribution to PSO'S	3	3	2.6	2	1.0	1.0	3	3	3	3

LESSON PLAN

COURSE CODE: **P23DP04**	TITLE OF THE COURSE: **PHYSICS OF NANO SCIENCE AND TECHNOLOGY**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology	6	Lecture, ICT, Seminar
	-– Classification of Nanomaterials – Metal and Semiconductor - Nanomaterials - 2D, 1D, 0D nanostructured materials -	6	Lecture, ICT, Seminar
	Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.	6	Lecture, ICT, Seminar
UNIT II: PROPERTIES OF NANOMATERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice	3	Lecture, ICT
	constant – Mechanical behaviour:Elastic properties – strength - ductility – super plastic behaviour -	4	Lecture, ICT
	Optical properties: - Surface Plasmon Resonance – Quantum size effects -	3	Lecture, ICT, Seminar
	Electrical properties - Conductivity, Ferroelectrics and dielectrics -	4	Lecture, ICT, Seminar
	Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).	4	Lecture, Seminar
UNIT III: SYNTHESIS AND FABRICATION	Physical vapour deposition - Chemical vapour deposition - sol-gel –	5	Lecture, ICT
	Wet deposition techniques - electrochemical deposition method – Plasma arching.	4	Lecture, ICT, Seminar
	- Electrospinning method - ball milling technique - pulsed laser deposition -	5	Lecture, ICT, Seminar
	Nanolithography: photolithography – Nanomanipulator	4	Lecture, Seminar
UNIT IV: CHARACTERIZATION TECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS).	4	Lecture, ICT
	UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM)	6	Lecture, ICT, Seminar

	- Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) -	4	Lecture, Seminar
	Scanning tunnelling microscopy (STM) – Vibrating sample Magnetometer	4	Lecture, ICT, Seminar
UNIT V: APPLICATIONS OF NANOMATERIALS	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors.	4	Lecture, ICT, Seminar
	Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters –	3	Lecture, Seminar
	Photocatalytic application: Air purification, water purification -	3	Lecture, Seminar
	Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy -	4	Lecture, ICT
	Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes**: At the end of the course the student will be able to:
P23DP04	**PHYSICS OF NANO SCIENCE AND TECHNOLOGY**	Understand the basic of nanoscience and explore the different types of nano materials and should comprehend the surface effects of the nano materials.
		Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.
		Understand the process and mechanism of synthesis and fabrication of nanomaterials.
		Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.
		Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.

PROGRAMME: **M. Sc., Physics**					
SEMESTER: **II**	**Part: III Core Course 4**	COURSE CODE:**P23CP4**			
TITLE OF THE COURSE: **STATISTICAL MECHANICS**					
HOURS OF INSTRUCTION PER WEEK: **6 Hrs./W (90Hrs /S)**		CREDITS: **5**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- To acquire the knowledge of thermodynamic potentials and to understand phase transition inthermodynamics
- 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 ofstatistics
- To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

STATISTICAL MECHANICS

UNIT	CONTENT	HRS
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.	**18**

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.	**18**
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.	**18**
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.	**18**
V REAL GAS, ISING MODEL AND FLUCTUATIONS	Cluster expansion for a classical gas - Virial equation of state – Calculation of thefirst Virial coefficient in the cluster expansion - Ising model - Mean-field theories ofthe Ising model in three, two and one dimensions - Exact solutions in onedimension.Correlation of space-time dependent fluctuations - Fluctuations and transportphenomena - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem- The Fokker-Planck equation.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits,Competitive Examinations, Employable and Communication Skill Enhancement,Social Accountability and Patriotism	

COURSE OUTCOMES: At the end of the course, the student will be able to:	
CO1	To examine and elaborate the effect of changes in thermodynamic quantities onthe states of matter during phase transition
CO2	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

CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermo dynamical quantities and partition function
CO4	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.
CO5	To discuss and examine the thermo dynamical behaviour of gases under fluctuation and also using Ising model

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

TEXTBOOKS:

1. B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second EditionNew Age International, New Delhi.
2. K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London .

REFERENCES:

1. R. K. Pathria, 1996, *Statistical Mechanics*, 2nd edition, Butter WorthHeinemann, New Delhi.
2. L. D. Landau and E. M. Lifshitz, 1969, *Statistical Physics*, PergamonPress,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, AlliedPublication, 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..

E-LEARNING RESOURCES:

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

MAPPING WITH PROGRAMME 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).

CO / PO	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
Weightage	15	15	15	5	5	10	15	7	5	15
Weighted % of Course Contribution to PO'S	3.0	3.0	3.0	1.0	1.0	2	3	1.4	1.0	3

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
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
Weightage	15	15	15	5	5	10	15	7	5	15
Weighted % of Course Contribution to PSO'S	3.0	3.0	3.0	1.0	1.0	2	3	1.4	1.0	3

LESSON PLAN

COURSE CODE:**P23CP4**	TITLE OF THE COURSE:**STATISTICAL MECHANICS**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I PHASE TRANSITIONS	Introduction - Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule -Phase transitions and Ehrenfest's classifications	6	Lecture, ICT, Seminar
	Third law ofThermodynamics. Order parameters – Landau's theory of phase	6	Lecture, ICT, Seminar
	Transition - Critical indices - Scale transformations and dimensionalanalysis.	6	Lecture, ICT, Seminar
II STATISTICAL MECHANICS AND THERMODYNAMICS	Introduction -Foundations of statistical mechanics - Specification of states of asystem	5	Lecture, ICT
	Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics	6	Lecture, ICT, Seminar
	Entropy of anideal gas using the micro canonical ensemble - Entropy of mixing andGibb's paradox.	7	Lecture, ICT, Seminar
III CANONICAL AND GRAND CANONICAL ENSEMBLES	Introduction - Trajectories and density of states - Liouville's theorem	6	Lecture, ICT
	Canonicaland grand canonical ensembles - Partition function	6	Lecture, ICT, Seminar
	Calculation ofstatistical quantities - Energy and density fluctuations.	6	Lecture, ICT, Seminar
IV CLASSICAL AND QUANTUM STATISTICS	Introduction -Density matrix - Statistics of ensembles	3	Lecture, ICT
	Statistics of indistinguishableparticles - Maxwell-Boltzmann statistics	5	Lecture, ICT, Seminar
	Fermi-Dirac statistics – IdealFermi gas	4	Lecture, Seminar
	Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.	6	Lecture, ICT, Seminar
V REAL GAS, ISING MODEL AND FLUCTUATIONS	Introduction - Cluster expansion for a classical gas - Virial equation of state	3	Lecture, ICT, Seminar
	Calculation of thefirst Virial coefficient in the cluster expansion - Ising model	4	Lecture, Seminar

Mean-field theories ofthe Ising model in three, two and one dimensions	3	Lecture, Seminar
Exact solutions in onedimension.Correlation of space-time dependent fluctuations - Fluctuations and transportphenomena	4	Lecture, ICT
Brownian motion - Langevin's theory - Fluctuation-dissipation theorem- The Fokker-Planck equation.	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes**: At the endofthe course thestudentwillbeableto:
P23CP4	STATISTICAL MECHANICS	To examine and elaborate the effect of changes in thermodynamic quantities onthe states of matter during phase transition
		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
		Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermo dynamical quantities and partition function
		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.
		To discuss and examine the thermo dynamical behaviour of gases under fluctuation and also using Ising model

PROGRAMME: **M. Sc., Physics**				
SEMESTER: **II**	**Part: III Core Course 5**	COURSE CODE: **P23CP5**		
TITLE OF THE COURSE: **QUANTUM MECHANICS I**				
HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**	CREDITS: **5**	CI A: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need				Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- To develop the physical principles and the mathematical background important to quantummechanical 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 forparticle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and seetheir relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational and WKBmethods for solving the Schrödinger equation.

QUANTUM MECHANICS I

UNIT	CONTENT	HRS
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 EigenValues – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation.	**18**

II ONE DIMENSIONAL AND THREE DIMENSIONAL ENERGY ELGRN VALUES 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.	**18**
III GENERAL FORMALISM	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinaterepresentation – Momentum representation – Symmetries and conservationlaws – Unitary transformation – Parity and time reversal.	**18**
IV APPROXIMATION METHODS	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground andexcited state – Variation method – Helium atom – WKB approximation –Connection formulae (no derivation) – WKB quantization – Application tosimple harmonic oscillator.	**18**
V ANGULAR MOMENTUM	Eigenvalue spectrum of general angular momentum – Ladder operators andtheir algebra – Matrix representation – Spin angular momentum – Additionof angular momenta – CG Coefficients – Symmetry and anti – symmetry functions – Construction of wave-functions and Pauli's exclusionprinciple.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on IndustrialInteractions/Visits, Competitive Examinations, Employable andCommunication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Demonstrates a clear understanding of the basic postulates of quantummechanics which serve to formalize the rules of quantum mechanics
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensionalproblems and three dimensional problems
CO3	Can discuss the various representations, space time symmetries andformulations of time evolution

CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems
CO5	To apply non-commutative algebra for topics such as angular and spin angularmomentum and hence explain spectral line splitting.

TEXTBOOK:

1. G. Aruldhas, *Quantum Mechanics*, 2nd Edition, Prentice-Hall of India, New Delhi,2009.

REFERENCES:

1. E. Merzbacher, *Quantum Mechanics*, 2nd Edition, John Wiley and Sons, New York, 1970.
2. 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*, 4th Edition, Macmillan, India, 1984.

E-LEARNING RESOURCES:

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.pdf4.
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

MAPPING WITH PROGRAMME 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)**.**

CO / PO	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	3	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	3	3	3	2	3
Weightage	14	15	15	13	15	12	15	12	10	15
Weighted % of Course Contribution to PO'S	2.8	3.0	3.0	2.6	3.0	2.4	3.0	2.4	2.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	3	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	3	3	3	2	3
Weightage	14	15	15	13	15	12	15	12	10	15
Weighted % of Course Contribution to PSO'S	2.8	3.0	3.0	2.6	3.0	2.4	3.0	2.4	2.0	3.0

LESSON PLAN

COURSE CODE: **P23CP5**	TITLE OF THE COURSE: **QUANTUM MECHANICS I**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I BASIC FORMALISM	Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states	6	Lecture, ICT, Seminar
	Ehrenfest'stheorem – Linear vector space – Linear operator – Eigen functions and EigenValues – Hermitian Operator	6	Lecture, ICT, Seminar
	Postulates of Quantum Mechanics –Simultaneous measurability of observables – General Uncertainty relation.	6	Lecture, ICT, Seminar
UNIT II ONE DIMENSIONAL AND THREE DIMENSIONAL ENERGY ELGRN VALUES PROBLEMS	Square – well potential with rigid walls	3	Lecture, ICT
	Square well potential with finite walls	3	Lecture, ICT
	Square potential barrier – Alpha emission – Bloch waves in a periodic potential	4	Lecture, ICT, Seminar
	Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method	4	Lecture, ICT, Seminar
	Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator.	4	Lecture, Seminar
UNIT III GENERAL FORMALISM	Dirac notation – Equations of motions – Schrodinger representation	5	Lecture, ICT
	Heisenberg representation – Interaction representation	4	Lecture, ICT, Seminar
	Coordinaterepresentation – Momentum representation	5	Lecture, ICT, Seminar
	Symmetries and conservationlaws – Unitary transformation – Parity and time reversal.	4	Lecture, Seminar
UNIT IV APPROXIMATION METHODS	Time independent perturbation theory for non-degenerate energy levels	5	Lecture, ICT
	Degenerate energy levels – Stark effect in Hydrogen atom	4	Lecture, ICT, Seminar

	Ground andexcited state – Variation method – Helium atom	4	Lecture, Seminar
	WKB approximation –Connection formulae (no derivation) – WKB quantization – Application tosimple harmonic oscillator.	5	Lecture, ICT, Seminar
UNIT V ANGULAR MOMENTUM	Eigenvalue spectrum of general angular momentum	3	Lecture, ICT, Seminar
	Ladder operators andtheir algebra – Matrix representation	3	Lecture, Seminar
	Spin angular momentum – Additionof angular momenta	4	Lecture, Seminar
	CG Coefficients – Symmetry and anti – symmetry functions	4	Lecture, ICT
	Construction of wave-functions and Pauli's exclusionprinciple.	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:**At the endofthe course thestudentwillbeableto:
P23CP5	**QUANTUM MECHANICS I**	Demonstrates a clear understanding of the basic postulates of quantummechanics which serve to formalize the rules of quantum mechanics
		Is able to apply and analyze the Schrodinger equation to solve one dimensionalproblems and three dimensional problems
		Can discuss the various representations, space time symmetries andformulations of time evolution
		Can formulate and analyze the approximation methods for various quantum mechanical problems
		To apply non-commutative algebra for topics such as angular and spin angularmomentum and hence explain spectral line splitting.

<table>
<tr><td colspan="6">PROGRAMME: M. Sc., Physics</td></tr>
<tr><td>SEMESTER : II</td><td colspan="2">Part: III Core Course 6 - Practical -2</td><td colspan="3">COURSE CODE: P23CP6P</td></tr>
<tr><td colspan="6">TITLE OF THE COURSE: PRACTICAL II</td></tr>
<tr><td colspan="2">HOURS OF INSTRUCTION PER WEEK:
6 Hrs/W (90Hrs /S)</td><td>CREDITS: 4</td><td>CIA: 25</td><td>EXTERNAL MARKS: 75</td><td>TOTAL: 100</td></tr>
</table>

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- To understand the concept of mechanical behaviour 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

PRACTICAL II

CONTENT

(Minimum of Twelve Experiments from the list)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Determination of Stefan's constant of radiation from a hot body
3. Measurement of Susceptibility of liquid - Quincke's method
4. B-H curve using CRO
5. Thickness of LG Plate
6. Arc spectrum: Copper
7. Determination of e/m - Millikan's method
8. Miscibility measurements using ultrasonic diffraction method
9. Determination of Thickness of thin film. - Michelson Interferometer
10. Iodine absorption spectra
11. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
12. Measurement of Dielectricity - Microwave test bench
13. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility
14. Interpretation of vibrational spectra of a given material
15. Determination of I-V Characteristics and efficiency of solar cell
16. GM counter – Absorption coefficient – Maximum range of β rays
17. IC 7490 as scalar and seven segment display using IC7447
18. Solving simultaneous equations – IC 741 / IC LM324
19. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Butterworth filter
20. Construction of Current to Voltage and Voltage to Current Conversion using IC 741
21. Construction of second order butterworth multiple feedback narrow band pass filter
22. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counterIC74193
23. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application assquarer
24. Construction of pulse generator using the IC 555 – Application as frequency divider
25. BCD to Excess- 3 and Excess 3 to BCD code conversion
26. Study of binary up / down counters - IC 7476 / IC7473
27. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474.
28. Determination of the width of the single slit and double silt of a laser source using Diffraction Grating.
29. Determination of Planck's Constant and Verification of Planck's inverse square law using Photosensitive device.

COURSE OUTCOMES:	
CO1	Understand the strength of material using Young's modulus
CO2	Acquire knowledge of thermal behaviour of the materials

CO3	Understand theoretical principles of magnetism through the experiments.
CO4	Acquire knowledge about arc spectrum and applications of laser
CO5	Improve the analytical and observation ability in Physics Experiments
CO6	Conduct experiments on applications of FET and UJT
CO7	Analyze various parameters related to operational amplifiers
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits
CO10	Analyze the applications of counters and registers.

TEXTBOOKS:

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. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. Electronic lab manual Vol I, K A Navas, Rajath Publishing
5. Electronic lab manual Vol II, K A Navas, PHI eastern Economy Edition

REFERENCES:

1. 1. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, 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. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi

MAPPING WITH PROGRAMME 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)**.**										
CO / PO	**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	3	3	3
CO7	2	2	3	3	3	2	2	2	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
Weightage	26	25	28	30	30	26	25	28	30	30
Weighted % of Course Contribution to PO 'S	2.6	2.5	2.8	3.0	3.0	2.6	2.5	2.8	3.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES										
CO / PSO	**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	3	3	3
CO7	2	2	3	3	3	2	2	2	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
Weightage	26	25	28	30	30	26	25	28	30	30
Weighted % of Course Contribution to PSO'S	2.6	2.5	2.8	3.0	3.0	2.6	2.5	2.8	3.0	3.0

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes** : At the endofthe course thestudentwillbeableto:
P23CP6P	**PRACTICAL II**	Understand the strength of material using Young’s modulus
		Acquire knowledge of thermal behaviour of the materials
		Understand theoretical principles of magnetism through the experiments.
		Acquire knowledge about arc spectrum and applications of laser
		Improve the analytical and observation ability in Physics Experiments
		Conduct experiments on applications of FET and UJT
		Analyze various parameters related to operational amplifiers
		Understand the concepts involved in arithmetic and logical circuits using IC’s
		Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits
		Analyze the applications of counters and registers.

PROGRAMME: **M. Sc., Physics**		
SEMESTER: **II**	**Part: III ELECTIVE PAPER - 3**	COURSE CODE: **P23DP16**
TITLE OF THE COURSE: **ADVANCED OPTICS**		

HOURS OF INSTRUCTION PER WEEK: **5 Hrs/W (75Hrs /S)**	CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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.

ADVANCED OPTICS

UNIT	CONTENT	HRS
I POLARIZATION AND DOUPLE 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 – Thephenomenon of double refraction – Normal and oblique incidence –Interference of polarized light: Quarter and half wave plates –Analysis of polarized light – Optical activity	**15**

II LASERS	Basic principles – Spontaneous and stimulated emissions –Components of the laser – Resonator and lasing action – Types oflasers 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	**15**
III FIBEROPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibersThe 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 .	**15**
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	**15**
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	**15**
VI PROFESSIONAL COMPONNENTS	Expert Lectures, Online Seminars - Webinars on IndustrialInteractions/Visits, Competitive Examinations, Employable andCommunication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Discuss the transverse character of light waves and different polarization Phenomenon
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices
CO3	Demonstrate the basic configuration of a fiber optic – communication system andadvantages
CO4	Identify the properties of nonlinear interactions of light and matter
CO5	Interpret the group of experiments which depend for their action on an appliedmagnetic and electric field

TEXTBOOK:

1. B. B. Laud, 2017, *Lasers and Non – Linear Optics*, 3rd Edition, NewAge International (P) Ltd.
2. AjoyGhatak, 2017, *Optics*, 6th Edition, McGraw – Hill Education Pvt.Ltd.

REFERENCES:

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*, 4thEdition, 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-Inter science.

E-LEARNING RESOURCES:

- 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

6. http://optics.byu.edu/textbook.aspx

MAPPING WITH PROGRAMME 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)**.**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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
Weightage	15	15	15	13	15	15	15	15	15	15
Weighted % of Course Contribution to PO'S	3.0	3.0	3.0	2.6	3.0	3.0	3.0	3.0	3.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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
Weightage	15	15	15	13	15	15	15	15	15	15
Weighted % of Course Contribution to PSO'S	3.0	3.0	3.0	2.6	3.0	3.0	3.0	3.0	3.0	3.0

LESSON PLAN

COURSE CODE: **P23DP16**	TITLE OF THE COURSE : **ADVANCED OPTICS**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	5	3		1			1	

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I POLARIZATION AND DOUBLE REFRACTION	Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light	4	Lecture, Peer
	Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction	4	Lecture, ICT
	Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence –	4	Lecture, ICT
	Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity	3	Lecture, ICT
II LASERS	Basic principles – Spontaneous and stimulated emissions – Components of the laser	4	Lecture, ICT
	Resonator and lasing action – Types of lasers and its applications – Solid state lasers	3	Lecture, Peer
	Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser –	4	Lecture, ICT
	CO2 laser – Chemical lasers – HCl laser – Semiconductor laser	4	Lecture, ICT
III FIBER OPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle	4	Lecture, ICT
	The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers –	3	Lecture, Peer
	Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers –	4	Lecture, ICT
	Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor	4	Lecture, ICT

IV NON-LINEAR OPTICS	Basic principles – Harmonic generation	4	Lecture, ICT
	Second harmonic generation – Phase matching	3	Lecture, Peer
	Third harmonic generation – Optical mixing	4	Lecture, ICT
	Parametric generation of light – Self-focusing of light	4	Lecture, ICT
V MAGNETO-OPTICS AND ELECTRO-OPTICS	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect	4	Lecture, ICT
	Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect –	4	Lecture, ICT
	Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction –	3	Lecture, Peer
	Kerr electro-optic effect – Pockels electro-optic effect	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23DP16	**ADVANCED OPTICS**	Discuss the transverse character of light waves and different polarization Phenomenon
		Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices
		Demonstrate the basic configuration of a fiber optic – communication system andadvantages
		Identify the properties of nonlinear interactions of light and matter
		Interpret the group of experiments which depend for their action on an appliedmagnetic and electric field

PROGRAMME: **M. Sc., Physics**						
SEMESTER: **II**	**Part: III ELECTIVE PAPER -4**	COURSE CODE: **P23DP19**				
TITLE OF THE COURSE: **MICROPROCESSOR 8085AND MICROCONTROLLER 8051**						
HOURS OF INSTRUCTION PER WEEK: **5 Hrs./W (75Hrs /S)**		CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**	

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- To provide an understanding of the architecture and functioning of microprocessor 8085Aand to the methods of interfacing I/O devices and memory to microprocessor
- To introduce 8085A programming and applications and the architecture and instructionsets of microcontroller 8051

MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

UNIT	CONTENT	HRS
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 – Interruptsof 8085 - Programmable peripheral interface (PPI) – Controlgroup and control word- Programmable DMA controller -Programmable interrupt controller – Programmablecommunication interface - Programmable counter /intervaltimer.	**15**

II **8085 INTERFACING APPLICATIONS**	Seven segment display interface - Interfacing of Digital toAnalog converter and Analog to Digital converter – Steppermotor interface - Measurement of electrical quantities –Voltageand current) Measurement of physical quantities (Temperatureand strain).	**15**
III **8051 MICROCONTROLLER HARDWARE**	Introduction – Features of 8051 – 8051 MicrocontrollerHardware: Pin-out 8051, Central Processing Unit (CPU),internal RAM, Internal ROM, Register set of 8051 – Memoryorganization of 8051 – Input/Output pins, Ports and Circuits –External data memory and program memory: External program memory, External data memory.	**15**
IV **8051 INSTRUCTION SET AND ASSEMLY LANGUAGE PROGRAMMING**	Addressing modes – Data moving (Data transfer) instructions:Instructions to Access external data memory, external ROM /program memory, PUSH and POP instructions, Data exchangeinstructions – Logical instructions: byte and bit level logicaloperations, Rotate and swap operations – Arithmeticinstructions: Flags, Incrementing and decrementing, Addition,, Multiplication and division, Decimal arithmetic –Jump and CALL instructions: Jump and Call program range,Jump, Call and subroutines – Programming.	**15**
V **INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD**	8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts– Serial communication interrupts and programming – Interrupt priority in the8051 : Nested interrupts , Software triggering of interrupt. LED Interface Sevensegment display interface- Interfacing of Digital to Analog converter andAnalog to Digital converter - Stepper motor interface - Measurement ofelectrical quantities – Voltage and current) Measurement of physicalquantities(Temperature and strain).	**15**
VI	Expert Lectures, Online Seminars - Webinars on IndustrialInteractions/Visits, Competitive Examinations, Employable andCommunication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Gain knowledge of architecture and working of 8085 microprocessor.
CO2	Get knowledge of architecture and working of 8051 Microcontroller.
CO3	Be able to write simple assembly language programs for 8085A microprocessor.
CO4	Able to write simple assembly language programs for 8051 Microcontroller.

CO5	Understand the different applications of microprocessor and microcontroller.

TEXTBOOKS:

1. A. NagoorKani, *Microprocessors & Microcontrollers*, RBA Publications(2009).
2. A. P. Godse and D. A. Godse, *Microprocessors*, Technical Publications,Pune (2009).
3. Ramesh Gaonkar, *Microprocessor Architecture, Programming and Applications with 8085*, Penram International Publishing (2013).
4. B. Ram, *Fundamentals of Microprocessors & Microcontrollers*, DhanpatRai publications New Delhi (2016).
5. V.Vijayendran, 2005, *Fundamentals of Microprocessor-8085,* 3rd EditionS.Visvanathan Pvt, Ltd.

REFERENCES:

1. Douglas V. Hall, *Microprocessors and Interfacing programming and Hardware,* Tata Mc Graw Hill Publications (2008)
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. Mckinlay, *The 8051 Microcontroller and Embedded Systems*, Pearson Education (2008).
3. Barry B. Brey, 1995, *The Intel Microprocessors 8086/8088, 80186, 80286,80386 and 80486*, 3rd Edition, Prentice- Hall of India, New Delhi.
4. J. Uffrenbeck, *"The 8086/8088 Family-Design, Programming and*
5.
6. *Interfacing, Software, Hardware and Applications"*, Prentice-Hall of India,New Delhi.
7. W. A. Tribel, Avtar Singh, *"The 8086/8088 Microprocessors:Programming, Interfacing, Software, Hardware and Applications"*, Prentice-Hall of India, New Delhi.

E-LEARNING RESOURCES:

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/

MAPPING WITH PROGRAMME 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).										
CO / PO	**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
Weightage	13	13	13	13	13	5	5	5	5	5
Weighted % of Course Contribution to PO'S	2.6	2.6	2.6	2.6	2.6	1.0	1.0	1.0	1.0	1.0
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES										
CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**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
Weightage	13	13	13	13	13	5	5	5	5	5
Weighted % of Course Contribution to PSO'S	2.6	2.6	2.6	2.6	2.6	1.0	1.0	1.0	1.0	1.0

LESSON PLAN

COURSE CODE:**P23DP19**	TITLE OF THE COURSE:**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	5	3	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I 8085 PROGRAMMING , PERIPHERAL DEVICES AND THEIR INTERFACING	Instruction set - Addressing modes - Programming techniques	3	Lecture, ICT
	Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing	3	Lecture, ICT
	Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word	3	Lecture, Seminar
	Programmable DMA controller - Programmable interrupt controller	3	Lecture, ICT
	Programmable communication interface - Programmable counter /interval timer.	3	Lecture, ICT
II 8085 INTERFACING APPLICATIONS	Seven segment display interface	3	Lecture, ICT
	Stepper motor interface	3	Lecture, Seminar
	Interfacing of Digital to Analog converter and Analog to Digital converter	3	Lecture, ICT
	Measurement of electrical quantities –Voltage and current)	3	Lecture, ICT
	Measurement of physical quantities (Temperature an strain)	3	Lecture, ICT
III 8051 MICRO CONTROLLER HARDWARE	Introduction – Features of 8051	3	Lecture, ICT
	8051 Microcontroller Hardware: Pin-out 8051	3	Lecture, ICT
	Central Processing Unit (CPU), internal RAM, Internal ROM	3	Lecture, ICT
	Register set of 8051 – Memory organization of 8051 – Input/Output pins, Ports and Circuits	3	Lecture, Seminar
	External data memory and program memory: External program memory, External data memory	3	Lecture, ICT
IV 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE	Addressing modes – Data moving (Data transfer) instructions.	3	Lecture, ICT
	Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions,	3	Lecture, ICT
	Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations	3	Lecture, Seminar

PROGRAMMING	Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic	3	Lecture, ICT
	Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.	3	Lecture, ICT
V INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD	8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt	3	Lecture, ICT
	Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming	3	Lecture, Seminar
	Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface	3	Lecture, ICT
	Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface	3	Lecture, ICT
	Measurement of electrical quantities (Voltage and current) Measurement of physical quantities(Temperature an strain)	3	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23DP19	**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**	Gain knowledge of architecture and working of 8085 microprocessor.
		Get knowledge of architecture and working of 8051 Microcontroller.
		Be able to write simple assembly language programs for 8085A microprocessor.
		Able to write simple assembly language programs for 8051 Microcontroller.
		Understand the different applications of microprocessor and microcontroller.

PROGRAMME: **M. Sc., Physics**					
SEMESTER: **II**	**Part: IV SKILL ENCHANCEMENT PAPER-1**	COURSE CODE: **P23SEP1**			
TITLE OF THE COURSE: **SOLAR ENERGY UTILIZATION**					
HOURS OF INSTRUCTION PER WEEK: **2 Hrs/W (30 Hrs /S)**		CREDITS: **2**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- To impart fundamental aspects of solar energy utilization.
- To give adequate exposure to solar energy related industries
- To harness entrepreneurship skills
- To understand the different types of solar cells and channelizing them to the differentsectors of society
- To develop an industrialist mindset by utilizing renewable source of energy

SOLAR ENERGY UTILIZATION

UNIT	CONTENT	HRS
I HEAT TRANSFER &RADIATION ANALYSIS	Conduction, Convection and Radiation – Solar Radiation at theearth's surface - Determination of solar time – Solar energymeasuring instruments.	**6**
II SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flatplate collectors – Generalcharacteristics – Focusing collector systems – Thermal performanceevaluation of optical loss.	**6**

III SOLAR HEATERS	Types of solar water heater - Solar heating system – Collectors andstorage tanks – Solar ponds – Solar cooling systems.	**6**
IV SOLAR ENERGY CONVERSIO N	Photo Voltaic principles – Types of solar cells – Crystallinesilicon/amorphous silicon and Thermo - electric conversion – processflow of silicon solar cells-different approaches on the process-texturisation, diffusion, Antireflective coatings, metallization.	**6**
V NANOMETE RIALS IN FUEL CELL APPLICATI ONS	Use of nanostructures and nanomaterials in fuel cell technology -high and low temperature fuel cells, cathode and anode reactions,fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nanotechnology in hydrogen production and storage.Industrial visit – data collection and analysis – presentation.	**6**
VI PROFESSIO NAL COMPONEN TS	Expert Lectures, Online Seminars - Webinars on IndustrialInteractions/Visits, Competitive Examinations, Employable andCommunication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Gained knowledge in fundamental aspects of solar energy utilization
CO2	Equipped to take up related job by gaining industry exposure
CO3	Develop entrepreneurial skills
CO4	Skilled to approach the needy society with different types of solar cells
CO5	Gained industrialist mindset by utilizing renewable source of energy

TEXTBOOKS:

1. *Solar energy utilization* -G.D. Rai –Khanna publishers – Delhi 5thedn, 4thprint, 2001.
2. MaheshwarSharon, 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.

REFERENCES:

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*,4^{th} Edition, John Wiley and Sons, 2013.
5. Duffie, J.A., Beckman, W.A. *"Solar Energy Thermal Process"*, John Wileyand Sons, 2007.
6. *Energy Technology* – S.Rao, Dr. B.B. Parukkar, Khanna Publisher, 3^{rd}edn, 4^{th}reprint, 2005, Delhi.
7. *Solar Energy*, S.P.Sukhatna, Tata Mc Grawall, Hill Publishing Company Ltd, Delhi, 2^{nd}edn, 14^{th}Reprint, 2006.
8. *Solar Energy* – M.P. Agarwal, 1^{st}edn, Reprint 1985, S.ChandPublications,Delhi.

E-LEARNING RESOURCES:

- https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb
- https://books.google.vg/books?id=lXHcwZo9XwC&sitesec=buy&source=gbs_vpt_read
- www.nptel.ac.in/courses/112105051
- www.freevideolectures.com

7. http://www.e-booksdirectory.com

MAPPING WITH PROGRAMME 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)**.**

CO / PO	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
Weightage	11	12	12	12	13	13	12	14	14	11
Weighted % of Course Contribution to PO'S	2.2	2.4	2.4	2.4	2.6	2.6	2.4	2.8	2.8	2.2

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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
Weightage	11	12	12	12	13	13	12	14	14	11
Weighted % of Course Contribution to PSO'S	2.2	2.4	2.4	2.4	2.6	2.6	2.4	2.8	2.8	2.2

LESSON PLAN

COURSE CODE : **P23SEP1**	TITLE OF THE COURSE : **SOLAR ENERGY UTILIZATION**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	2	1					1	

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I HEAT TRANSFER &RADIATION ANALYSIS	Conduction, Convection and Radiation	2	Lecture, ICT
	Solar Radiation at theearth's surface - Determination of solar time	2	Lecture, ICT
	Solar energymeasuring instruments.	2	Lecture, ICT
II SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flatplate collectors	2	Lecture, ICT
	Generalcharacteristics – Focusing collector systems	2	Lecture, Peer
	Thermal performanceevaluation of optical loss.	2	Lecture, ICT
III SOLAR HEATERS	Types of solar water heater - Solar heating system –	2	Lecture, ICT
	Collectors andstorage tanks	2	Lecture, Peer
	Solar ponds – Solar cooling systems.	2	Lecture, ICT
IV SOLAR ENERGY CONVERSION	Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion	2	Lecture, ICT
	processflow of silicon solar cells- different approaches on the process-	2	Lecture, ICT
	texturisation, diffusion, Antireflective coatings, metallization.	2	Lecture, Peer
V NANOMETERIALS IN FUEL CELL APPLICATIONS	Use of nanostructures and nanomaterials in fuel cell technology -high and low temperature fuel cells,	2	Lecture, ICT
	cathode and anode reactions,fuel cell catalysts, electrolytes, ceramic catalysts.	2	Lecture, ICT
	Use of Nanotechnology in hydrogen production and storage.Industrial visit – data collection and analysis – presentation.	2	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23SEP1	**SOLAR ENERGY UTILIZATION**	Gained knowledge in fundamental aspects of solar energy utilization
		Equipped to take up related job by gaining industry exposure
		Develop entrepreneurial skills
		Skilled to approach the needy society with different types of solar cells
		Gained industrialist mindset by utilizing renewable source of energy

PROGRAMME: **M. Sc., Physics**		
SEMESTER: **III**	**Part: III Core Course 7**	COURSE CODE: **P23CP7**
TITLE OF THE COURSE: **QUANTUM MECHANICS – II**		

HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**	CREDITS: **5**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- 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

QUANTUM MECHANICS – II

UNIT	CONTENT	HRS
I 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.	**18**

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.	**18**
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.	**18**
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).	**18**
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.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	

COURSE OUTCOMES:	
CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions.

CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.

TEXTBOOKS:

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2ndedition(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).

REFERENCES:

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,1stedition,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.

E-LEARNING RESOURCES:

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-qm-notes-gk.pdf
5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

MAPPING WITH PROGRAMME 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)**.**

CO / PO	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
Weightage	13	10	9	15	15	11	13	13	15	15
Weighted % of Course Contribution to PO'S	2.6	2.0	1.9	3.0	3.0	2.1	2.6	2,6	3.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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
Weightage	13	10	9	15	15	11	13	13	15	15
Weighted % of Course Contribution to PSO'S	2.6	2.0	1.9	3.0	3.0	2.1	2.6	2,6	3.0	3.0

LESSON PLAN

COURSE CODE: **P23CP7**	TITLE OF THE COURSE: **QUANTUM MECHANICS II**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I SCATTERING THEORY	Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential	6	Lecture, ICT, Seminar
	Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for s wave	6	Lecture, ICT, Seminar
	Optical theorem – Transformation from centre of mass to laboratory frame.	6	Lecture, ICT, Seminar
UNIT II PERTURBATION THEORY	Time dependent perturbation theory – Constant and harmonic perturbations	3	Lecture, ICT
	Fermi Golden rule	2	Lecture, ICT
	Transition probability Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation	5	Lecture, ICT, Seminar
	Semi – classical treatment of an atom with electromagnetic radiation	4	Lecture, ICT, Seminar
	Selection rules for dipole radiation.	4	Lecture, Seminar
UNIT III RWLATIVISTIC 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.	5	Lecture, ICT
	Dirac Matrices – Dirac Equation – Plane Wave Solutions	5	Lecture, ICT, Seminar
	Interpretation Of Negative Energy States – Antiparticles – Spin of Electron	6	Lecture, ICT, Seminar
	Magnetic Moment Of An Electron Due To Spin.	2	Lecture, Seminar
UNIT IV DIRAC EQUATION	Covariant form of Dirac Equation – Properties of the gamma matrices	5	Lecture, ICT
	Traces – Relativistic invariance of Dirac equation – Probability Density	4	Lecture, ICT, Seminar

	Current four vector – Bilinear covariant	4	Lecture, Seminar
	Feynman's theory of positron (Elementary ideas only without propagation formalism).	5	Lecture, ICT, Seminar
UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION	Classical fields – Euler Lagrange equation	3	Lecture, ICT, Seminar
	Hamiltonian formulation – Noether's theorem	3	Lecture, Seminar
	Quantization of real and complex scalar fields	4	Lecture, Seminar
	Creation, Annihilation and Number operators – Fock states	4	Lecture, ICT
	Second Quantization of K-G field.	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23CP7	**QUANTUM MECHANICS – II**	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation
		Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
		Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment
		Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions.
		Demonstrate an understanding of field quantization and the explanation of the scattering matrix.

PROGRAMME: **M. Sc., Physics**						
SEMESTER: **III**	**Part: III Core Course 8**	COURSE CODE : **P23CP8**				
TITLE OF THE COURSE: **CONDENSED MATTER PHYSICS**						
HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**		CREDITS: **5**	CI A: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**	

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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

CONDENSED MATTER PHYSICS

UNIT	CONTENT	HRS
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).	**18**

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.	**18**
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	**18**
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 anti ferro magnetism - Neel temperature	**18**
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.	**18**
VI **PROFESSIONAL COMPONENTS**	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:

CO1	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
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.
CO3	Student will be able to comprehend the heat conduction in solids
CO4	Student will be able to generalize the electronic nature of solids from band theories.
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.

TEXTBOOKS:

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

REFERENCES:

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.

E-LEARNING RESOURCES:

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

MAPPING WITH PROGRAMME 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).

CO / PO	**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
Weightage	13	11	13	10	12	10	12	12	10	14
Weighted % of Course Contribution to PO'S	2.6	2.5	2.6	2.0	2.2	2.0	2.4	2.4	2.0	2.8

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
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
Weightage	13	11	13	10	12	10	12	12	10	14
Weighted % of Course Contribution to PSO'S	2.6	2.5	2.6	2.0	2.2	2.0	2.4	2.4	2.0	2.8

LESSON PLAN

COURSE CODE: **P23CP8**	TITLE OF THE COURSE: **CONDENSED MATTER PHYSICS**

Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6	4	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: CRYSTAL PHYSICS	Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures.	3	Lecture, ICT
	Atomic Packing Factor- Crystal diffraction - Bragg's law	3	Lecture, ICT
	Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals.	4	Lecture, Seminar
	Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor.	4	Lecture, ICT
	Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).	4	Lecture, ICT
UNIT II: LATTICE DYNAMICS	Lattice with two atoms per primitive cell - First Brillouin zone.	4	Lecture, ICT
	Group and phase velocities - Quantization of lattice vibrations.	4	Lecture, ICT
	Phonon momentum - Inelastic scattering by phonons.	3	Lecture, ICT
	Debye’s theory of lattice heat capacity	3	Lecture, Seminar
	Thermal Conductivity - Umkalapp processes.	4	Lecture, ICT
UNIT III: THEORY OF METALS AND SEMICONDUCTORS	Free electron gas in three dimensions - Electronic heat capacity.	4	Lecture, ICT
	Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem.	4	Lecture, ICT
	Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence.	4	Lecture, ICT
	Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction.	3	Lecture, Seminar
	Experimental methods in Fermi surface studies - de Hass-van Alphen effect.	3	Lecture, ICT
UNIT IV: MAGNETISM	Diamagnetism - Quantum theory of paramagnetism - Rare earth ion.	3	Lecture, ICT
	Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization.	4	Lecture, ICT

	Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field.	3	Lecture, Seminar
	Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons.	4	Lecture, ICT
	Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.	4	Lecture, ICT
UNIT V: Superconductivity	**Experimental facts:** Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current.	4	Lecture, ICT
	Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors.	3	Lecture, Seminar
	Theoretical Explanation: Thermodynamics of super conducting transition - London equation - Coherence length	3	Lecture, ICT
	Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime-	4	Lecture, ICT
	Nature of paring and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.	4	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:**At the endofthe course thestudentwillbeableto:
P23CP8	**CONDENSED MATTER PHYSICS**	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
		Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.
		Student will be able to comprehend the heat conduction in solids
		Student will be able to generalize the electronic nature of solids from band theories.
		Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.

PROGRAMME: **M. Sc., Physics**				
SEMESTER : **III**	**Part: III Core Practical 3**	COURSE CODE : **P23CP9P**		
TITLE OF THE COURSE: **Practical – III -NUMERICAL METHODS AND COMPUTER PROGRAMMING(FORTRAN/C)**				
HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**	CREDITS: **4**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- 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.

Practical – III -NUMERICAL METHODS AND COMPUTER PROGRAMMING(FORTRAN/C)

CONTENT

(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. Runge Kutta 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.

COURSE OUTCOMES:	
CO1	Program with the C Program/ FORTRAN with the C or any other high level language
CO2	Use various numerical methods in describing/solving physics problems.
CO3	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.
CO4	To enhance the problem-solving aptitudes of students using various numerical methods.
CO5	To apply various mathematical entities, facilitate to visualise any complicate tasks.
CO6	Process, analyze and plot data from various physical phenomena and interpret their meaning

CO7	Identify modern programming methods and describe the extent and limitations of computational methods in physics
CO8	Work out numerical differentiation and integration whenever routine are not applicable.
CO9	Apply various interpolation methods and finite difference concepts.
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.

TEXTBOOKS:

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

REFERENCES:

1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw-Hill).
2. B.F. Gerald and P.O. Wheately, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.
3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York.
4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison - Wesley, London.
5. V. Rajaraman,Programming in FORTRAN/ Programming in C, PHI, New Delhi.

MAPPING WITH PROGRAMME 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)**.**

CO / PO	**PO 1**	**PO 2**	**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
Weightage	26	25	28	30	30	27	25	28	30	30
Weighted % of Course Contribution to PO 'S	2.6	2.5	2.8	3.0	3.0	2.7	2.5	2.8	3.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	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
Weightage	26	25	28	30	30	27	25	28	30	30
Weighted % of Course Contribution to PSO'S	2.6	2.5	2.8	3.0	3.0	2.7	2.5	2.8	3.0	3.0

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23CP9P	**PRACTICAL - III**	Program with the C Program/ FORTRAN with the C or any other high level language
		Use various numerical methods in describing/solving physics problems.
		Solve problem, critical thinking and analytical reasoning as applied to scientific problems.
		To enhance the problem-solving aptitudes of students using various numerical methods.
		To apply various mathematical entities, facilitate to visualise any complicate tasks.
		Process, analyze and plot data from various physical phenomena and interpret their meaning
		Identify modern programming methods and describe the extent and limitations of computational methods in physics
		Work out numerical differentiation and integration whenever routine are not applicable.
		Apply various interpolation methods and finite difference concepts.
		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.

SEMESTER: **III**	**Part: III Core Course 10**	COURSE CODE : **P23CP10**		
TITLE OF THE COURSE: **ELECTROMAGNETIC THEORY**				
HOURS OF INSTRUCTION PER WEEK: **5 Hrs/W (75Hrs /S)**	CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- 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

ELECTROMAGNETIC THEORY

UNIT	CONTENT	HRS
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.	**15**
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.	**15**

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.	**15**
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	**15**
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.	**15**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems
CO2	Use Biot-Savart’s law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems
CO3	Apply Maxwell’s equations to describe how electromagnetic field behaves in different media
CO4	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
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields.

TEXTBOOKS:

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

REFERENCES:

1. W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism*, Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications*, 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, *Principles of Electrodynamics*, Books and Allied, Kolkata.
4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA

E-LEARNING RESOURCES:

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

MAPPING WITH PROGRAMME 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).

CO / PO	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

Weightage	15	15	15	5	10	10	15	15	5	15
Weighted % of Course Contribution to PO'S	3.0	3.0	3.0	1.0	2.0	2.0	3.0	3.0	1.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	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
Weightage	15	15	15	5	10	10	15	15	5	15
Weighted % of Course Contribution to PSO'S	3.0	3.0	3.0	1.0	2.0	2.0	3.0	3.0	1.0	3.0

LESSON PLAN

COURSE CODE **P23CP10**	TITLE OF THE COURSE: **ELECTROMAGNETIC THEORY**						
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning
	5	3	1			1	

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I ELECTROSTATICS	Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension –	4	Lecture, ICT
	Solution in Cartesian and spherical polar coordinates –	4	Lecture, ICT
	Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions -	4	Lecture, ICT
	Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.	3	Lecture, Peer
IIMAGNETOSTATICS	Biot-Savart's Law - Ampere's law - Magnetic vector	4	Lecture, ICT
	potential and magnetic field of a localized current distribution	4	Lecture, ICT
	Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy	4	Lecture, ICT
	Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.	3	Lecture, Peer
III MAXWELL	Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations -	4	Lecture, ICT

EQUATIONS	Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution-	4	Lecture, ICT
	Coulomb and Lorentz gauges - Energy and momentum of the field -	4	Lecture, ICT
	Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.	3	Lecture, Peer
IV WAVE PROPAGATION	Plane waves in non-conducting media - Linear and circular polarization,	4	Lecture, ICT
	reflection and refraction at a plane interface -	4	Lecture, ICT
	Waves in a conducting medium - Propagation of waves in a rectangular wave guide.	4	Lecture, ICT
	Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole	3	Lecture, Peer
V ELEMENTARY PLASMA PHYSICS	The Boltzmann Equation - Simplified magneto-hydrodynamic equations -	4	Lecture, ICT
	Electron plasma oscillations -	4	Lecture, ICT
	The Debye shielding problem - Plasma confinement in a magnetic field - -	4	Lecture, ICT
	Magneto hydrodynamic waves - Alfven waves and magnetosonic waves.	3	Lecture, Peer

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23CP10	**ELECTRO MAGNETIC THEORY**	Solve the differential equations using Laplace equation and to find solutions for boundary value problems
		Use Biot-Savart’s law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems
		Apply Maxwell’s equations to describe how electromagnetic field behaves in different media
		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
		Investigate the interaction of ionized gases with self-consistent electric and magnetic fields.

PROGRAMME**: M. Sc., Physics**						
SEMESTER: **III**	**Part: III ELECTIVE PAPER -5**	COURSE CODE : **P23DP09**				
TITLE OF THE COURSE: **NUMERICAL METHODS AND COMPUTER PROGRAMMING**						
HOURS OF INSTRUCTION PER WEEK: **5 Hrs/W (75 Hrs /S)**		CREDITS: **3**	CI A: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**	

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- To make students to understand different numerical approaches to solve a problem.
- To understand the basics of programming

NUMERICAL METHODS AND COMPUTER PROGRAMMING

UNIT	CONTENT	HRS
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.	**15**
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.	**15**

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.	**15**
IV DIFFERENTIATION, INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS	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 RungaKutta methods.	**15**
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.	**15**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	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.
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.

CO5	Understand the basics of C-programming and conditional statements.
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;	

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

E-LEARNING RESOURCES:

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/**REFERENCES**papers.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

MAPPING WITH PROGRAMME 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)**.**

CO / PO	**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
Weightage	15	10	15	5	5	10	15	10	10	15
Weighted % of Course Contribution to PO'S	3.0	2.0	3.0	1.0	1.0	2.0	3.0	2.0	2.0	3.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**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
Weightage	15	10	15	5	5	10	15	10	10	15
Weighted % of Course Contribution to PSO'S	3.0	2.0	3.0	1.0	1.0	2.0	3.0	2.0	2.0	3.0

LESSON PLAN

<table>
<tr><td>COURSE CODE: P23DP09</td><td colspan="8">TITLE OF THE COURSE:NUMERICAL METHODS AND COMPUTER PROGRAMMING</td></tr>
<tr><td rowspan="2">Pedagogy</td><td>Total Hours</td><td>Lecture</td><td>Practical Experience</td><td>Peer Group Learning</td><td>Demo/ OER /Tutorial</td><td>GD / Seminar</td><td>ICT / Blended Learning</td><td>Field work / Internship</td></tr>
<tr><td>5</td><td>4</td><td></td><td></td><td></td><td></td><td>1</td><td></td></tr>
<tr><td>UNIT</td><td colspan="6">TOPIC</td><td>LECTURE HOURS</td><td>MODE OF TEACHING</td></tr>
<tr><td rowspan="3">UNIT I: Solutions of equations</td><td colspan="6">Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Zeros of polynomials –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Convergence of solutions in Bisection and Newton-Raphson methods – Limitations of Bisection and Newton-Raphson methods.</td><td>7</td><td>Lecture, ICT</td></tr>
<tr><td rowspan="3">UNIT II: Linear system of equations</td><td colspan="6">Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations</td><td>4</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.</td><td>6</td><td>Lecture, ICT</td></tr>
<tr><td rowspan="3">UNIT III:
Interpolation and curve fitting</td><td colspan="6">Interpolation with equally spaced points - Newton forward and backward interpolation</td><td>4</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Interpolation with unevenly spaced points - Lagrange interpolation</td><td>3</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Curve fitting – Method of least squares – Fitting a polynomial.</td><td>5</td><td>Lecture, ICT</td></tr>
<tr><td rowspan="3">UNIT IV Differentiation integration and solution of differential equations</td><td colspan="6">Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson’s rule – Error estimates</td><td>6</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite and Gauss-Chebyshev quadrature</td><td>6</td><td>Lecture, ICT</td></tr>
<tr><td colspan="6">solution of ordinary differential equations – Euler and RungaKutta methods.</td><td>6</td><td>Lecture, ICT</td></tr>
<tr><td>UNIT V: Programming with C</td><td colspan="6">Flow-charts – Integer and floating point arithmetic expressions – Built-in functions – Executable and non-executable statements – Subroutines and functions</td><td>5</td><td>Lecture, ICT</td></tr>
</table>

	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,	5	Lecture, ICT
	(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.	5	Lecture, ICT

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23DP09	**NUMERICA**	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.
		Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.
		Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation
		Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.

	PROGRAM	Understand the basics of C-programming and conditional statements.

<table>
<tr><td colspan="10">PROGRAMME: M. Sc., Physics</td></tr>
<tr><td colspan="2">SEMESTER: III</td><td colspan="2">Part: III SKILLED PAPER-2</td><td colspan="6">COURSE CODE : P23SEP2</td></tr>
<tr><td colspan="10">TITLE OF THE COURSE: : SOLID WASTE MANAGEMENT</td></tr>
<tr><td colspan="3">HOURS OF INSTRUCTION PER WEEK:
2 Hrs/W (30Hrs /S)</td><td colspan="2">CREDITS: 2</td><td>CIA: 25</td><td colspan="2">EXTERNAL MARKS: 75</td><td colspan="2">TOTAL: 100</td></tr>
<tr><td colspan="10">NATURE OF THE COURSE</td></tr>
<tr><td>Relevant to Global need</td><td>✓</td><td colspan="2">Employability Oriented</td><td colspan="2">✓</td><td colspan="3">Addresses Professional Ethics</td><td>✓</td></tr>
<tr><td>Relevant to National need</td><td></td><td colspan="2">Entrepreneurship Oriented</td><td colspan="2">✓</td><td colspan="3">Addresses Gender Sensitization</td><td></td></tr>
<tr><td>Relevant to Regional need</td><td></td><td colspan="2" rowspan="2">Skill Development Oriented</td><td colspan="2" rowspan="2">✓</td><td colspan="3">Environment and Sustainability</td><td>✓</td></tr>
<tr><td>Relevant to Local need</td><td>✓</td><td colspan="3">Addresses Human Values</td><td>✓</td></tr>
<tr><td colspan="10">LEARNING OBJECTIVES: To enable the students to:
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</td></tr>
</table>

SOLID WASTE MANAGEMENT

UNIT	CONTENT	HRS
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.	**6**
II SOLID WASTE CHARACTERISTICS	Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation	**6**

III TOOLS AND EQUIPMENT	Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique	**6**
IV ECONOMIC DEVELOPMENT	SWM for economic development and environmental protection Linking SWM and climate change and marine litter.	**6**
V INDUSTRIAL VISIT	SWM Industrial visit – data collection and analysis - presentation	**6**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:

CO1	Gained knowledge in solid waste management
CO2	Equipped to take up related job by gaining industry exposure
CO3	Develop entrepreneurial skills
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas
CO5	Adequately sensitized in managing solid wastes in and around his/her locality

TEXTBOOKS:

1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).
2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, 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), VasudevanRajaram, PHI learning private limited, 2016

REFERENCES:

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

E-LEARNING RESOURCES:

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=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28
5. https://amzn.eu/d/5VUSTDI

MAPPING WITH PROGRAMME 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).										
CO / PO	**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
Weightage	11	14	13	11	10	11	14	14	13	12
Weighted % of Course Contribution to PO'S	2.2	2.8	2.6	2.2	2.0	2.2	2.8	2.8	2.6	2.4
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES										
CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**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
Weightage	11	14	13	11	10	11	14	14	13	12
Weighted % of Course Contribution to PSO'S	2.2	2.8	2.6	2.2	2.0	2.2	2.8	2.8	2.6	2.4

LESSON PLAN

COURSE CODE : **P23SEP2**	TITLE OF THE COURSE : **SOLID WASTE MANAGEMENT**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	2	1					1	

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I SOLID WASTE MANAGEMENT	Introduction - Definition of solid waste	2	Lecture, ICT
	Types – Hazardous Waste: Resource conservation and Renewal act	2	Lecture, ICT
	Hazardous Waste: Municipal Solid waste and non-municipal solid waste.	2	Lecture, ICT
II SOLID WASTE CHARACTERITICS	Solid Waste Characteristics: Physical and chemical characteristics	2	Lecture, ICT
	SWM hierarchy	2	Lecture, Peer
	factors affecting SW generation	2	Lecture, ICT
III TOOLS AND EQUIPMENT	Tools and equipment - Transportation	2	Lecture, ICT
	Disposal techniques	2	Lecture, Peer
	Composting and land filling technique	2	Lecture, ICT
IV ECONOMIC DEVELOPMENT	SWM for economic development and environmental protection	4	Lecture, ICT
	Linking SWM and climate change and marine litter.	2	Lecture, Peer
V INDUSTRIAL VISIT	SWM Industrial visit	2	Lecture, ICT
	data collection and analysis	2	Lecture, ICT
	data collection and analysis - presentation	2	Lecture, ICT

Course Outcomes (COs)

Course Code	**Course Name**	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23SEP2	**SOLID WASTE MANAGEMENT**	Gained knowledge in solid waste management
		Equipped to take up related job by gaining industry exposure
		Develop entrepreneurial skills

		Will be able to analyze and manage the status of the solid wastes in the nearby areas
		Adequately sensitized in managing solid wastes in and around his/her locality

<table>
<tr><td colspan="6">PROGRAMME: M. Sc., Physics</td></tr>
<tr><td>SEMESTER : III</td><td colspan="2">Part: III Core Course 1</td><td colspan="3">COURSE CODE : P23SIP1</td></tr>
<tr><td colspan="6">TITLE OF THE COURSE: INTERNSHIP / INDUSTRIAL ACTIVITY</td></tr>
<tr><td colspan="2">HOURS OF INSTRUCTION PER WEEK:</td><td>CREDITS: 2</td><td>CI A:</td><td>EXTERNAL MARKS:</td><td>TOTAL: 100</td></tr>
</table>

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	✓	Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

UNIT	CONTENT	HRS

I		**15**
II		**15**
III		**15**
IV		**15**
V		**15**

COURSE OUTCOMES:	
CO1	
CO2	
CO3	
CO4	
CO5	
TEXTBOOK:	
REFERENCES:	

E-LEARNING RESOURCES:

MAPPING WITH PROGRAMME OUTCOMES

CO / PO	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0
CO1										
CO2										
CO3										
CO4										
CO5										
Weightage										
Weighted % of Course Contribution to Pos										

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
Total Weightage					
Weighted % of Course Contribution to PSOs					

LESSON PLAN

COURSE CODE:	TITLE OF THE COURSE:							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	75							

UNIT	**TOPIC**	**LECTURE HOURS**	**MODE OF TEACHING**

Course Outcomes (COs)

Course Code	Course Name	Course Outcomes: At the endofthe course thestudentwillbeableto:

<table>
<tr><td colspan="6">PROGRAMME: M. Sc., Physics</td></tr>
<tr><td>SEMESTER: IV</td><td colspan="2">Part: III Core Course 11</td><td colspan="3">COURSE CODE : P23CP11</td></tr>
<tr><td colspan="6">TITLE OF THE COURSE: NUCLEAR AND PARTICLE PHYSICS</td></tr>
<tr><td colspan="2">HOURS OF INSTRUCTION PER WEEK: 6 Hrs/W (90Hrs /S)</td><td>CREDITS: 5</td><td>CIA: 25</td><td>EXTERNAL MARKS: 75</td><td>TOTAL: 100</td></tr>
<tr><td colspan="6">NATURE OF THE COURSE</td></tr>
</table>

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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

NUCLEAR AND PARTICLE PHYSICS

UNIT	CONTENT	HRS
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.	**18**

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.	**18**
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.	**18**
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.	**18**
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.	**18**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula

CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.

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)

REFERENCES:

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)

E-LEARNING RESOURCES:

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/radioactivedecay.html

MAPPING WITH PROGRAMME 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)**.**										
CO / PO	**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
Weightage	15	15	9	12	8	12	8	10	12	12
Weighted % of Course Contribution to PO'S	3.0	3.0	1.8	2.4	1.6	2.4	1.6	2.0	2.4	2.4
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES										
CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
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
Weightage	15	15	9	12	8	12	8	10	12	12
Weighted % of Course Contribution to PSO'S	3.0	3.0	1.8	2.4	1.6	2.4	1.6	2.0	2.4	2.4

LESSON PLAN

COURSE CODE: **P23CP11**	TITLE OF THE COURSE**: NUCLEAR AND PARTICLE PHYSICS**

Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	6hrs/week	3	--	---	---	1	2	---

UNIT	**TOPIC**	**LECTURE HOURS**	**MODE OF TEACHING**
I **NUCLEAR MODELS**	Liquid drop model – Weizacker mass formula – Isobaric mass parabola –	4	Lecture/ICT/Seminar
	- Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states –	5	Lecture/ICT/Seminar
	Mirror Pair magnetic moment – Schmidt model – electric Quadrapole moment -	5	Lecture/ICT/Seminar
	Bohr and Mottelson collective model – rotational and vibrational bands	4	Lecture/ICT/Seminar
II **NUCLEAR FORCES**	Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron –	6	Lecture/ICT/Seminar
	Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces -	8	Lecture/ICT/Seminar
	charge independence and charge symmetry – isospin formalism.	4	Lecture/ICT/Seminar
III **NUCLEAR REACTIONS**	Kinds of nuclear reactions – Reaction kinematics – Q-value –	4	Lecture/ICT/Seminar
	Partial wave analysis of scattering and reaction cross section – scattering length –	5	Lecture/ICT/Seminar
	Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula –	5	Lecture/ICT/Seminar
	Direct reactions - Nuclear Chain reaction – four factor formula.	4	Lecture/ICT/Seminar
IV **NUCLEAR DECAY**	Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot ––	5	Lecture/ICT/Seminar
	mass of neutrino – allowed and forbidden decay –– neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion	8	Lecture/ICT/Seminar
	nuclear isomerism – angular momentum and parity selection rules.	5	Lecture/ICT/Seminar
V **ELEMENTARY PLASMA PHYSICS**	Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles –	5	Lecture/ICT/Seminar
	Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-	5	Lecture/ICT/Seminar
	Gell-Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.	8	Lecture/ICT/Seminar

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23CP11	**NUCLEAR AND PARTICLE PHYSICS**	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.
		Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.
		Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula
		Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.
		Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.

PROGRAMME: **M. Sc., Physics**		
SEMESTER : **IV**	**Part: III Core Practical – 4**	COURSE CODE : **P23CP12P**
TITLE OF THE COURSE: **PRACTICAL IV**		

HOURS OF INSTRUCTION PER WEEK: **6 Hrs/W (90Hrs /S)**	CREDITS: **5**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

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

PRACTICAL IV

CONTENT

(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

COURSE OUTCOMES:

CO1	Develop the programming skills of Microprocessor
CO2	Appreciate the applications of Microprocessor programming
CO3	Understand the structure and working of 8085 microprocessor and apply it.
CO4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.
CO5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.

TEXT BOOKS:

1. Practical Physics, Gupta and Kumar, Pragati Prakasan
2. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
3. Electronic lab manual Vol I, K A Navas, 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.Visvanathan Pvt, Ltd.

REFERENCES:

1. Advanced Practical Physics, S.P Singh, Pragati Prakasan
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. Poorna chandra, B. Sasikala, Wheeler Publishing, New Delhi
5. Microprocessor and Its Application - S. Malarvizhi, Anuradha Agencies Publications

MAPPING WITH PROGRAMME 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).

CO / PO	PO 1	PO 2	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
Weightage	13	12	12	15	15	10	10	5	15	10
Weighted % of Course Contribution to PO'S	2.6	2.4	2.4	3.0	3.0	2.0	2.0	1.0	3.0	2.0

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	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
Weightage	13	12	12	15	15	10	10	5	15	10
Weighted % of Course Contribution to PSO'S	2.6	2.4	2.4	3.0	3.0	2.0	2.0	1.0	3.0	2.0

Course Outcomes (COs)

Course Code	Course Name	Course Outcomes: At the endofthe course thestudentwillbeableto:
P23CP12P	PRACTICAL IV	Develop the programming skills of Microprocessor
		Appreciate the applications of Microprocessor programming
		Understand the structure and working of 8085 microprocessor and apply it.
		Acquire knowledge about the interfacing peripherals with 8085 microprocessor.
		Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.

PROGRAMME: **M. Sc., Physics**		
SEMESTER: **IV**	**Part: III** **ELECTIVE** **PAPER 6**	COURSE CODE : **P23DP10**
TITLE OF THE COURSE: **SPECTROSCOPY**		

HOURS OF INSTRUCTION PER WEEK: **5 Hrs/W (75Hrs /S)**	CREDITS: **3**	CIA: **25**	EXTERNAL MARKS: **75**	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need	✓			Addresses Human Values	✓

LEARNING OBJECTIVES: To enable the students to:

- 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

SPECTROSCOPY

UNIT	CONTENT	HRS

I 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.	**15**
II INFRARED 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.	**15**
III 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.	**15**
IV 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.	**15**

V 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.	**15**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.	

COURSE OUTCOMES:	
CO1	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.
CO2	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.
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances
CO5	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.

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.

E-LEARNING RESOURCES:

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

MAPPING WITH PROGRAMME 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)**.**

CO / PO	**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
Weightage	14	12	14	14	15	15	15	15	15	13
Weighted % of Course Contribution to PO'S	2.8	2.4	2.8	2.8	3.0	3.0	3.0	3.0	3.0	2.6

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
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
Weightage	14	12	14	14	15	15	15	15	15	13
Weighted % of Course Contribution to PSO'S	2.8	2.4	2.8	2.8	3.0	3.0	3.0	3.0	3.0	2.6

LESSON PLAN

COURSE CODE:**P23DP10**	TITLE OF THE COURSE:**SPECTROSCOPY**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	5	3	-	-	-	1	1	-

UNIT	TOPIC	LECTURE HOURS	MODE OF TEACHING
I MICROWAVE SPECTROSCOPY	Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant.	3	Lecture, ICT
	Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines.	3	Lecture, ICT
	Polyatomic molecules – linear – symmetric asymmetric top molecules.	3	Lecture, Seminar
	Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram.	3	Lecture, ICT

	Information Derived from Rotational Spectra- Stark effect- Problems.	3	Lecture, ICT
II INFRA-RED SPECTRO SCOPY	Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator - fundamentals, overtones and combinations.	3	Lecture, ICT
	Diatomic Vibrating Rotator- PR branch – PQR branch - Fundamental modes of vibration of H_2O and CO_2.	3	Lecture, ICT
	Introduction to application of vibrational spectra - IR Spectrophotometer Instrumentation (Double Beam Spectrometer).	3	Lecture, ICT
	Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra.	3	Lecture, ICT
	Remote analysis of atmospheric gases like N2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications.	3	Lecture, Seminar
III RAMAN SPECTRO SCOPY	Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid.	3	Lecture, ICT
	Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule.	3	Lecture, ICT
	Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle.	3	Lecture, ICT
	Determination of N_2O structure-Instrumentation technique and block diagram -structure determination of planar	3	Lecture, Seminar
	Non-planar molecules using IR and Raman techniques. FT Raman spectroscopy- SERS.	3	Lecture, ICT
IV RESONANCE SPECTRO SCOPY	Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession.	3	Lecture, ICT
	Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei.	3	Lecture, ICT
	Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy.	3	Lecture, Seminar
	NMR in Chemical industries- MRI Scan Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction).	3	Lecture, ICT
	Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR.	3	Lecture, ICT
V	Origin of UV spectra - Laws of absorption – Lambert Bouguer law.	3	Lecture, ICT

UV SPECTRO SCOPY	Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds-	3	Lecture, Seminar
	Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores.	3	Lecture, ICT
	Choice of Solvent and Solvent effect - Absorption by inorganic systems.	3	Lecture, ICT
	Instrumentation - double beam UV-Spectrophotometer - Simple applications.	3	Lecture, ICT

Course Outcomes (COs)

Course Code	**Course Name**	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23DP10	**SPECTROSCOPY**	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.
		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.
		Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool
		Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances
		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.

<table>
<tr><td colspan="5">PROGRAMME: M. Sc., Physics</td></tr>
<tr><td>SEMESTER: IV</td><td>Part: III
SKILLED PAPER - 3</td><td colspan="3">COURSE CODE : P23SEP3</td></tr>
<tr><td colspan="5">TITLE OF THE COURSE: CRYSTAL GROWTH AND THIN FILMS</td></tr>
<tr><td>HOURS OF INSTRUCTION PER WEEK:
3 Hrs/W (45Hrs /S)</td><td>CREDITS: 2</td><td>CIA: 25</td><td>EXTERNAL MARKS: 75</td><td>TOTAL: 100</td></tr>
</table>

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	✓	Environment and Sustainability	✓
Relevant to Local need	✓			Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

- 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

CRYSTAL GROWTH AND THIN FILMS

UNIT	CONTENT	HRS
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	**9**

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.	**9**
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.	**9**
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.	**9**
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.	**9**
VI PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism	

COURSE OUTCOMES:	
CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth
CO2	Understand the Crystallization Principles and Growth techniques
CO3	Study various methods of Crystal growth techniques
CO4	Understand the Thin film deposition methods
CO5	Apply the techniques of Thin Film Formation and thickness Measurement

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

REFERENCES

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.
5. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution"
6. D. Elwell and H. J. Scheel, "Crystal Growth from HighTemperatureSolution"Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.

E-LEARNING RESOURCES

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

MAPPING WITH PROGRAMME 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).

CO / PO	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
Weightage	14	12	7	13	5	12	14	13	13	7
Weighted % of Course Contribution to PO'S	2.8	2.4	1.3	2.6	1.0	2.4	2.8	2.6	2.6	1.3

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
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
Weightage	14	12	7	13	5	12	14	13	13	7
Weighted % of Course Contribution to PSO'S	2.8	2.4	1.3	2.6	1.0	2.4	2.8	2.6	2.6	1.3

LESSON PLAN

COURSE CODE:**P23SEP3**	TITLE OF THE COURSE : **CRYSTAL GROWTH AND THIN FILMS**							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	3	1		1			1	
UNIT	TOPIC						LECTURE HOURS	MODE OF TEACHING
I CRYSTAL GROWTH KINETICS	Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson						3	Lecture, Peer
	Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation -						3	Lecture, ICT
	Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films						3	Lecture, ICT
II CRYSTALLIZATION PRINCIPLES	Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry -						3	Lecture, ICT
	Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram -						3	Lecture, Peer
	Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.						3	Lecture, ICT
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						3	Lecture, ICT

	Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth	3	Lecture, Peer
	Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.	3	Lecture, ICT
IV THIN FILM DEPOSITION METHODS	Thin film deposition methods of thin film preparation, Thermal evaporation	2	Lecture, ICT
	Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering,	3	Lecture, Peer
	RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition	4	Lecture, ICT
V THIN FILM FORMATION	Thin Film Formation and thickness Measurement Nucleation, Film growth and structure	2	Lecture, ICT
	Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison.	3	Lecture, ICT
	- Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.	4	Lecture, Peer

Course Outcomes (COs)

Course Code	Course Name	**Course Outcomes:** At the endofthe course thestudentwillbeableto:
P23SEP 3	**CRYSTAL GROWTH AND THIN FILMS**	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth
		Understand the Crystallization Principles and Growth techniques
		Study various methods of Crystal growth techniques
		Understand the Thin film deposition methods
		Apply the techniques of Thin Film Formation and thickness Measurement

PROGRAMME: **M. Sc., Physics**				
SEMESTER : **IV**	**Part: III- EXTENSION ACTIVITY**	COURSE CODE : **P23EAP**		
TITLE OF THE COURSE: **EXTENSION ACTIVITY**				
HOURS OF INSTRUCTION PER WEEK:	CREDITS: **1**	CIA:	EXTERNAL MARKS:	TOTAL: **100**

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	✓	Environment and Sustainability	
Relevant to Local need				Addresses Human Values	

LEARNING OBJECTIVES: To enable the students to:

UNIT	CONTENT	HRS
I		**15**
II		**15**

III		**15**
IV		**15**
V		**15**

COURSE OUTCOMES:	
CO1	
CO2	
CO3	
CO4	
CO5	
TEXTBOOK:	
REFERENCES:	
E-LEARNING RESOURCES:	

<table>
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</table>

TEMPLATE FOR LESSON PLAN

COURSE CODE:	TITLE OF THE COURSE:							
Pedagogy	Total Hours	Lecture	Practical Experience	Peer Group Learning	Demo/ OER /Tutorial	GD / Seminar	ICT / Blended Learning	Field work / Internship
	75							
UNIT	**TOPIC**						**LECTURE HOURS**	**MODE OF TEACHING**

Course Outcomes (COs)

Course Code	Course Name	Course Outcomes: At the endofthe course thestudentwillbeableto: