ETHIRAJ COLLEGE FOR WOMEN (AUTONOMOUS)

CHENNAI - 600 008

DEPARTMENT OF PHYSICS (SS)

M.Sc. SYLLABUS

CHOICE BASED CREDIT SYSTEM
OUTCOME BASED EDUCATION
(OFFERED FROM THE ACADEMIC YEAR 2021 - 2022)

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RULES AND REGULATIONS FOR THE PROGRAMME

Master of Science in Physics

(Revised syllabus effective from the academic year 2021 – 2022)

Department of Physics is revising regulations and syllabi with effect from 2021 - 2022, under 'CBCS' specified by the Government of Tamil Nadu.

Every academic year is divided into two semester sessions. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of hours a teacher teaches a particular subject. It is also related to the number of hours a student spends learning a subject or carrying out an activity.

Regulations

1. Eligibility for Admission:

Candidates for admission to the first year of the Degree of M.Sc. Physics course shall be required to have passed the B.Sc. Physics or equivalent degree of any Indian Universities.

2. Eligibility for the Award of Degree:

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study for a period of not less than two academic years, passed the examinations of all the four semesters prescribed.

3. Course of Study:

The main subject of study for Masters Degree shall consists of 15 core (10 theory, 4 practicals & 1 project), 5 major electives with internal choice, two inter disciplinary electives in the second and third semester, four soft skill papers in each semester and one internship at the end of the second semester is offered by the PG department.

4. Passing Minimum:

A candidate shall be declared to have passed in each paper & practical of the main subject of study wherever prescribed, if she secured not less than 50% of the marks prescribed for the examination.

5. Classification of Successful Candidates:

Successful candidates passing the examination and securing the marks (i) 60 percent and above and (ii) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the FIRST and SECOND class respectively.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

On obtaining a postgraduate degree the students will be able to:

PEO1. Display higher order thinking in the knowledge domain and demonstrate professional skills

PEO2. Contribute to the advancement and application of relevant knowledge by self-directed learning

PEO3. Extend and integrate knowledge and skills to design and develop novel products and explore innovative solutions to national and international goals of development.

PEO4. Exercise management skills and develop social interactions in a responsive, ethical and constructive way to meet global standards of excellence in all spheres of activity.

PEO5. Strive for social and economic equity based on the need for gender parity and ecological sustainability.

PROGRAMME OUTCOME (PO)

PO1 - To acquire advanced conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline.

PO2 - To apply knowledge and critically evaluate the concepts and scientific developments to take up any challenge.

PO3 - To visualize and work on laboratory multidisciplinary tasks related to current research in the fields of Mathematical, Physical and Life sciences

PO4 - To acquire research based knowledge and design methods to conduct investigations of complex problems in research/ Industrial field and achieve employability / self employment.

PO5 - To communicate effectively ideas verbally in English, leading to entrepreneurship ventures such as consultancy and training.

PO6 - Employ innovative and environment friendly methods, novel ideas to solve complex and challenging societal and environmental issues.

PROGRAMME SPECIFIC OUTCOME (PSO_S)

At the end of the program the student will be able to

PSO1. Organize and coherently communicate their knowledge in theoretical and experimental aspects of Physics which enables them to take up teaching Physics at college and school levels.

PSO2. Demonstrate critical analysis, logical reasoning and problem-solving skills required in the application of the principles of Physics. Display numerical and transferable skills to allow them to take up broad career choices in data analysis or computing.

PSO3. Plan and implement experimental work, analyse and interpret results, estimate errors involved to make recommendations for enhanced results ensuring their employability in academic and industrial establishments, research and development.

PSO4. Utilise their profound understanding of the core subjects for clearing CSIR, SLET, NET and other competitive examinations and the knowledge gained from the specialized elective papers for advanced research.

PSO5. Identify and assess current research areas of interest in physics making them proficient for research at a higher level as a consequence of the experience gained on completion of the supervised project as part of the course.

PSO6. Appreciate the role of physics in society, environment, safety and ethical issues while suggesting solutions.

PROGRAMME PROFILE – M.Sc. PHYSICS

SN	CORE/ELECTIVE/SS	TITLE OF THE PAPER	CODE	L	T	P	H/W	T H	C	CA	SE	MM
SEMESTER I												
1	CORE 1	Mathematical Physics	14SP21/1C/MMP	3	3	0	6	90	4	40	60	100
2	CORE 2	Classical Mechanics & Relativity	14SP21/1C/CMR	3	3	0	6	90	4	40	60	100
3	CORE 3	Electromagnetic Theory I	14SP21/1C/EM1	3	2	0	5	75	4	40	60	100
4	CORE 4	*General Experiments	14SP21/1C/PR1	0	3	3	6	90	*4	40	60	100
5	ELECTIVE 1	Electronics (or)	14SP21/1E1/ELS	3	2	0	5	75	3	40	60	100
		Communication Electronics	14SP21/1E1/CES	3	2	0	5	75	3	40	60	100
6	SOFT SKILL 1	Personality Enrichment for Women	PG21/1S/PEW	1	1	0	2	30	2	-	50	50
SEMESTER II												
7	CORE 5	Quantum Mechanics - I	14SP21/2C/QM1	3	2	0	5	75	4	40	60	100
8	CORE 6	Statistical Mechanics	14SP21/2C/STM	3	2	0	5	75	4	40	60	100
9	CORE 7	Electromagnetic Theory II	14SP21/2C/EM2	2	2	0	4	60	4	40	60	100
10	CORE 8	Electronics Experiments	14SP21/2C/PR2	0	3	3	6	90	4	40	60	100
11	ELECTIVE 2	Molecular Spectroscopy (or)	14SP21/2E2/MSY	2	2	0	4	60	3	40	60	100
		Characterization Techniques	14SP21/2E2/CRT	2	2	0	4	60	3	40	60	100
12	ELECTIVE 3	Medical Technology	14SP21/2E/MTG	2	2	0	4	60	3	40	60	100
13	SOFT SKILL 2	Communication Skills / Soft skills in French / German for beginners	PG21/2S/LCE PG21/2S/FRE PG21/2S/GER	1	1	0	2	30	2	-	50	50
14	INTERNSHIP	During summer vacation					Min. 21 days					
SEMESTER III												
15	CORE 9	Quantum Mechanics - II	14SP21/3C/QM2	3	2	0	5	75	4	40	60	100
16	CORE 10	Solid State Physics	14SP21/3C/SSP	3	2	0	5	75	4	40	60	100
17	CORE 11	Microprocessor 8085 and Microcontroller 8051	14SP21/3C/MPC	2	2	0	4	60	4	40	60	100
18	CORE 12	*Microprocessor 8085 & Microcontroller 8051 Experiments	14SP21/3C/PR3	0	3	3	6	90	*4	40	60	100
19	ELECTIVE 4	Computational Methods and C Programming (or)	14SP21/3E3/CMC	2	2	0	4	60	3	40	60	100
		Programming in MATLAB	14SP21/3E3/MAT	2	2	0	4	60	3	40	60	100
20	ELECTIVE 5	Digital Photography	14SP21/3E/PHO	2	2	0	4	60	3	40	60	100
21	SOFT SKILL 3	Computing Skills	14SP21/3S/CPS	0	1	1	2	30	2	-	50	50

SEMESTER IV												
22	CORE 13	Nuclear and Particle Physics	14SP21/4C/NPP	3	3	0	6	90	4	40	60	100
23	CORE 14	Project & Viva voce	14SP21/4C/PRO	0	3	3	6	90	4	40	60	100
24	CORE 15	Computational Methods & C Programming Experiments	14SP21/4C/PR4	0	3	3	6	90	4	40	60	100
25	ELECTIVE 6	NanoScience and Technology (or)	14SP21/4E4/NST	3	2	0	5	75	3	40	60	100
		Crystal Growth and Thin Film Technology	14SP21/4E4/TFT	3	2	0	5	75	3	40	60	100
26	ELECTIVE 7	X- Ray Crystallography (or)	14SP21/4E5/XRC	3	2	0	5	75	3	40	60	100
		Bio Physics	14SP21/4E5/BPY	3	2	0	5	75	3	40	60	100
27	SOFT SKILL 4	Spoken and Presentation Skills	PG21/3S/SPS	1	1	0	2	30	2	-	50	50
		OPTIONAL EXTRA CREDITS										
I	Extra Credits (OPTIONAL)	Self-Study (Semester III)		-	-	-	-	-	2	100	100	100

*****These credits will be given at the end of II and IV semesters after conduction of the practical examinations

L = Lecture Hours T = Tutorial Hours P=Practical Hours H = Hours per week

TH = Total Hours C= Credits CA=Continuous Assessment

SE=Semester Examinations MM=Maximum Marks

Note: Students can take up NPTEL/MOOC courses and earn extra credits

PROGRAMME PROFILE - M.SC PHYSICS

SELF STUDY PAPER

S.No.	TITLE OF THE PAPER
1	Energy Physics
2	An introduction to LATEX and MATHEMATICA
3	Carbon Nanostructures
4	Astro Physics

EVALUATION PATTERN FOR CONTINUOUS ASSESSMENT

10 theory core papers, 5 major elective papers & 2 interdisciplinary elective papers

INTERNAL VALUATION BY COURSE TEACHER/S

CORE / ELECTIVE – THEORY PAPERS

COMPONENT	**TIME**	**MAX. MARKS**	**CA MARKS**
1. TEST I	2 Hrs.	50 MARKS (TO BE CONVERTED)	10
2. TEST II	2 Hrs.	50 MARKS (TO BE CONVERTED)	10
3. ASSIGNMENT/ SEMINAR /FIELD VISIT			10
4. PARTICIPATORY LEARNING			10
TOTAL			40

CORE / ELECTIVE – PRACTICAL PAPERS

COMPONENT	**TIME**	**MAX. MARKS**	**CA MARKS**
1. TEST I	2 Hrs.	50 MARKS (TO BE CONVERTED)	10
2. TEST II	2 Hrs.	50 MARKS (TO BE CONVERTED)	10
3. RECORD			10
4. PARTICIPATORY LEARNING			10
TOTAL			40

PROJECT

COMPONENT	**MARKS**
1. SELECTION OF PROBLEM & REVIEW OF LITERATURE	10
2. PERIODICAL REPORTS & EVALUATION	10
3. SEMINAR	10
4. INTERNAL VIVA-VOCE	10
TOTAL	40

CA QUESTION PAPER PATTERN – PG

Knowledge Level	**Section**	**Word Limit**	**Marks**	**Total**
K3, K4	A – 4/6 X 8 marks	500	32	50
K5	B – 1/2 X 18 marks	1500	18	

RUBRICS FOR CONTINUOUS ASSESMENT

- FIRST FOUR RUBRICS SHOULD BE INCLUDED
- OTHERS ARE OPTIONAL BASED ON TEACHING-LEARNING METHODOLOGY ADOPTED FOR THE PROGRAMME OF STUDY

Assignment	Content/originality/Presentation/Schematic Representation and Diagram/Bibliography
Seminar	Organization/Subject Knowledge/Visual Aids/Confidence level/presentation-Communication and Language
Field Visit	Participation/Preparation/Attitude/Leadership
Participation	Answering Questions/Clearing Doubts/Participating in Group Discussions/Regular Attendance
Case Study	Finding the Problem/Analysis/Solution/Justification
Problem Solving	Understanding Concepts/Formula and Variable Identification/Logical Sequence/Answer
Group Discussion	Preparation/Situation Analysis/Relationship Management/Information Exchange/Delivery Skills
Flipped / Blended Learning	Preparation/Information Exchange/Group interaction/Clearing doubts

END SEMESTER EVALUATION PATTERN – PG

THEORY PAPERS

SEMESTER I/II/III/IV

DOUBLE VALUATION BY COURSE TEACHER AND EXTERNAL EXAMINER

MAXIMUM MARKS : 100 TO BE CONVERTED TO 60

PASSING MARKS : 50

PRACTICAL PAPERS

SEMESTER II/IV

DOUBLE VALUATION BY COURSE TEACHER AND EXTERNAL EXAMINER

MAXIMUM MARKS : 100 TO BE CONVERTED TO 60

PASSING MARKS : 50

SOFT SKILL PAPERS

SEMESTER I/II/III/IV

SINGLE VALUATION BY COURSE TEACHER

MAXIMUM MARKS : 50

PASSING MARKS : 25

PROJECT PAPER

SEMESTER : IV

DOUBLE VALUATION BY RESEARCH SUPERVISOR AND EXTERNAL EXAMINER

DISSERTATION : 60

VIVA : 40

MAXIMUM MARKS : 100 TO BE CONVERTED TO 60

PASSING MARKS : 50

INTERNSHIP

YEAR	SEMESTER
I	II

SELF STUDY

YEAR	SEMESTER
II	III

DOUBLE VALUATION BY COURSE TEACHER AND EXTERNAL EXAMINER

MAXIMUM MARKS : 100

PASSING MARKS : 50

SEMESTER I COURSE PROFILE – M.Sc.

Course Code	Course Title	Credits	Hrs/ Week	Total Hrs	L-T-P	CA Marks	End Sem. Marks	Total
14SP21/1C/MMP	Mathematical Physics	4	6	90	3 3 0	40	60	100
14SP21/1C/CMR	Classical Mechanics & Relativity	4	6	90	3 3 0	40	60	100
14SP21/1C/EM1	Electromagnetic Theory I	4	5	75	3 2 0	40	60	100
14SP21/1C/PR1	General Experiments	4	6	90	0 3 3	40	60	100
14SP21/1E1/ELS (or)	Electronics (or)	3	5	75	3 2 0	40	60	100
14SP21/1E1/CES	Communication Electronics	3	5	75	3 2 0	40	60	100
PG21/1S/PEW	Soft Skill 1 – Personality Enrichment for Women	2	2	30	1 1 0	-	50	50
	TOTAL CREDITS	21						

SEMESTER I

MATHEMATICAL PHYSICS

TOTAL HOURS: 90 **COURSE CODE: 14SP21/1C/MMP**
CREDITS: 4 **L-T-P: 3 3 0**

COURSE OBJECTIVES:

1. To acquire knowledge of linear vector space and Tensor analysis
2. To provide an in-depth knowledge of linear ordinary differential equations to solve problems in Theoretical Physics in a much simpler way
3. To solve complicated integrals of real functions with the help of functions of a complex variables
4. To enable the students to learn Laplace's and Fourier's integral transforms since they are specially useful in physical applications
5. Students will analyze the structure of 'small' finite groups and examine examples arising as groups of permutations of a set, symmetries of regular polygons and regular solids and group of matrices.

COURSE OUTLINE:

Unit I: Linear Vector Spaces and Tensors

Linear vector space – Linear independence of vectors and dimensions – Basis and Expansion theorem – Inner product and unitary spaces – Ortho-normal sets – Schwarz inequality – Schmidt's orthogonalisation method

Matrices -matrix representation of vectors - orthogonal, unitary, Hermitian and singular matrices-transpose,conjugate, Hermitian conjugate, adjoint and inverse of a matrix(using adjoint) – eigen values and eigenvectors -properties

Tensors – Introduction – N dimensional space – Superscripts and subscripts – Co-ordinate transformation – Indicial and summation conventions – Kronecker-delta and properties **18 Hrs**

Unit II: Linear Ordinary Differential Equations

Second order linear differential equations with variable, co-efficient, series and solution –Legendre, Hermite, Bessel and Laguerre differential equation – generating function – orthogonality of generating functions **18 Hrs**

Unit III: Complex Variables

Functions of a complex variable – single and multivalued functions – analytic functions – Cauchy Riemann conditions – Singular points – Cauchy's theorem and integral formulae – Taylor and Laurent expansions – Zeros and poles – Residue Theorem and evaluation of integrals **18 Hrs**

Unit IV: Laplace and Fourier Transforms

Fourier transforms – Sine and Cosine transforms – Theorems: similarity, shifting, modulation, convolution and Parseval - Fourier transforms of derivatives- solutions of heat conduction problems

Laplace and inverse Laplace transforms – shifting and convolution theorems - Transforms of derivatives and integrals - Transforms of Heaviside and Dirac-delta functions - inverse Laplace transforms using Partial Fraction methods - solution of differential equations – solution of wave equation and transmission line equations **18 Hrs**

Unit V: Group Theory

Basic definitions – Lagrange's theorem – Invariant subgroup – Homomorphism and isomorphism – representation of a group – Unitary representations – Schur's lemmas – Orthogonality theorem – Character table – Character table of C_{4v} – Irreducible representation of C_{4v} – Simple applications – SU(2) and O(3) Groups **18 Hrs**

RECOMMENDED TEXT BOOKS:

1. Satyaprakash, Mathematical Physics, 4th Edition, Sultan and Chand, 2002.
2. A.W.Joshi, Matrices and Tensors in Physics, 3rd Edition, Wiley Eastern, Madras, 1995.
3. F.A. Cotton, Chemical Application of Group Theory, 3rd Edition, Wiley Eastern Ltd, New York 1990.
4. H.K. Dass, Mathematical Physics, 4th Revised Edition, S.Chand &Company Ltd., New Delhi 2003.
5. A.W.Joshi, Elements of Group theory for Physics, Revised 4th Edition, New Age International Pub. New Delhi 2005.

REFERENCE BOOKS:

1. P.K.Chattopadhyay, Mathematical Physics, 1st Edition, New Age International Pub., 1990.
2. E.Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, NY, 2001.
3. P.K.Chakrabarti and S.N.Kundu, A Text Book of Mathematical Physics, 1st Edition, New Central Book Agency, Kolkata, 1996.
4. Ajay kumar Bhagi & Vinoth Kumar J, Group Theory and Symmetry in Chemistry, 2nd Edition, Krishnaprakashan Media Ltd., Meerut.
5. Goyal Gupta, Laplace and Fourier Transforms, 1st Edition, Pragathi Prakashan Meerut.
6. A.Singaravelu, MA131,MA132 Mathematics I,II,III, Revised Edition, Meenakshi Publications, 2003.

JOURNALS:

1. Journal of Physics A: Mathematical and Theoretical
2. Journal of Mathematical Physics
3. Communications in Mathematical Physics
4. Journal of the Ramanujan Mathematical Society

E-LEARNING RESOURCES:

1. http://www.math.pitt.edu/~sparling/14/20141540/20141540vectorspacesapril28.pdf
2. http://web.math.ucsb.edu/~jhateley/project/tensor.pdf
3. https://www.math.ust.hk/~machas/differential-equations.pdf
4. http://www.math.s.chiba-u.ac.jp/~yasuda/ippansug/CV-bookfi.pdf
5. http://people.uncw.edu/hermanr/mat367/fcabook/Transforms.pdf

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Able to demonstrate the application of tensor is in Theoretical Physics, Mechanics, and Electromagnetic Theory.	K3,K4
CO 2	Able to solve physically relevant linear differential equations using standard methods, evaluate the generating functions and their orthogonality.	K3, K5
CO 3	Invokes objective knowledge on the basic elements of complex analysis, including the important integral theorems.	K5
CO 4	Able to evaluate the Fourier and Laplace Transforms for given function and apply them to solve certain boundary value problems arising in physics and applied physics conveniently	K5
CO 5	Invokes objective knowledge on group theory and utilize the group representations for symmetry calculation	K5, K3

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	1	3	1	1
CO 2	3	3	2	3	2	1
CO 3	3	3	1	3	1	1
CO 4	3	3	2	3	2	1
CO 5	3	3	1	3	2	1
AVERAGE	**3**	**3**	**1.4**	**3**	**1.6**	**1**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either/or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER I

CLASSICAL MECHANICS AND RELATIVITY

TOTAL HOURS: 90 **COURSE CODE: 14SP21/1C/CMR**
CREDITS: 4 **L-T-P : 3 3 0**

COURSE OBJECTIVES:

1. Able to demonstrate the effectiveness of Newton's law of motion. To formulate and to solve equation of motion for a wide class of mechanical systems using Lagrangian and Hamilton's approach.
2. To interpret the characteristics of inertial and body systems of rigid body motion.
3. To be able to develop a new formulation for Lagrangian that provides a foundation for theoretical extensions both within and outside classical mechanics.
4. To acquire knowledge on oscillations for conservative systems. To understand the significance of classical model in making qualitative predictions and classifying the vibrational modes of the molecules.
5. To realize the inadequacy of Newtonian mechanics for the systems whose velocities approaches the velocity of light. Thus introducing the students to a concept based on the the fact that neither the space nor the time is absolute.

COURSE OUTLINE:

Unit I: Lagrangian and Hamiltonian Formulations

Mechanics of a Particle – Mechanics of a System of Particles – Lagrangian Dynamics: Coordinate System – Degrees of Freedom – Constraints – Generalized Coordinates – D'Alembert's Principle – Lagrange's Equation of Motion – Applications: Simple Pendulum, Atwood's Machine, Compound Pendulum – Conservative Force (Problems) - Hamilton's Principle – Lagrange's Equation from Hamilton's Principle – Superiority of Lagrangian Mechanics over Newtonian Approach – Hamiltonian Dynamics: Generalized Momentum and Cyclic Coordinates – Hamilton's Equations – Applications: Simple Pendulum, Compound Pendulum, Harmonic Oscillator – Reduction of Two Body Central Force Problem to the Equivalent One Body Problem (Problems) – Differential Equation for an Orbit – Kepler's Laws of Planetary Motion and their Deduction. **19 Hrs**

Unit II: Mechanics of Rigid Bodies

Generalized Co-ordinates for Rigid Body Motion - Euler's Theorem– Euler Angles – Components of Angular Velocity Vector along Body Set of Axes and Space Set of Axes —Angular Velocity and Angular Momentum of Rigid Body - Moments and Product of Inertia (Problems) - Rotational Kinetic Energy - Euler's Equations of Motion of a Rigid Body - Torque Free Motion of a Rigid Body – Equations of Motion – Force-Free Motion of a Symmetrical Top – Motion of a Heavy Symmetrical Top – First Integrals of Motion – Steady Precession. **18 Hrs**

Unit III: Canonical Transformation and Brackets

Hamilton's Principle of Least Action – Canonical Transformations and Generating Functions – First, Second, Third and Fourth Form – Advantage of Canonical Transformation – Condition for a Transformation to be Canonical (Problems) – Simple Examples – Hamilton-Jacobi Method - Kepler's Problem Solutions By H-J Method - Poisson Brackets (Problems) – Invariance of Poisson Brackets with respect to Canonical Transformation – Equation of Motion in Poisson Bracket Form – Lagrange's Brackets (Problems) - Relation Between Poisson and Lagrange Bracket. **19 Hrs**

Unit IV: Small Oscillations

Stable and Unstable Equilibrium -Two Coupled Oscillators-Formulation of the Problem: Lagrange's Equations of Motion for Small Oscillation – Properties of T,V and Ω – Normal Co-Ordinates and Normal Frequencies of Vibration –The Parallel Pendula - Linear Tri-Atomic Molecule. **17 Hrs**

Unit V: Relativity

Lorentz Transformations – Four Vectors – Lorentz Invariance of the Four Product of Two Four Vectors – Invariance of Maxwell's Equations – Relativistic Lagrangian and Hamiltonian for a Free Particle. **17 Hrs**

RECOMMENDED TEXTBOOKS:

1. J.C. Upadhayaya, Classical Mechanics, 1st Edition, Himalaya Publishing House 2009
2. Guptha Kumar Sharma, Classical Mechanics, 21st Edition, Pragrati Prakashan, Meerut 2012.

REFERENCE BOOKS:

1. C.R.Mondol, Classical Mechanics, 1st Edition, Prentice-Hall of India, New Delhi. 2008
2. R.Resnick, Introduction to Special Theory of Relativity, 1st Edition, Wiley Eastern Ltd., New Delhi, 1968
3. H.Goldstein, C.Poole and J.Safko, Classical Mechanics, 3rd Edition, Pearson Education Asia, New Delhi, 2011.
4. R. Douglas Gregory, Classical Mechanics, 1st Edition, Cambridge University Press, New Delhi, 2008.
5. G. Aruldhas, Classical Mechanics, 7th Edition, Eastern Economy Edition, New Delhi, 2016.

JOURNALS:

1. International Journal of Classical Physics
2. Journal of Modern Physics.
3. Indian Journal of Physics

E-LEARNING RESOURSES:

1. https://www.youtube.com/playlist?list=PLERGeJGfknBR3pXCPlV3bgb_qHCSNOdBf
2. https://www.khanacademy.org/science/physics
3. https://www.askiitians.com/iit-jee-physics/mechanics/keplers-laws-motion-of-satellite.aspx
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/MIT8_09F14_full.pdf.
5. http://www.ma.huji.ac.il/~razk/iWeb/My_Site/Teaching_files/Mechanics.pdf

COURSE OUTCOMES:

CO.NO.	CO STATEMENT	Knowledge Level
CO 1	Understands the basics concepts of Newtonian mechanics. Formulating equation of motion of mechanical systems using Lagrangian and Hamilton's method	K3
CO 2	Learn to generate the equations of rigid body motion using the linear and angular momentum principles. Simplifying complex problems into simple systems by choosing the suitable solution method.	K4
CO 3	Able to formulate dynamical problems into first order differential equations based on Hamiltonian function which serves as the basis for further developments in the field mechanics.	K5
CO 4	Learn to approximate the expressions for kinetic and potential energy using the theory of small oscillations to obtain the linearized equation of motion. Translating the physical problem into simpler matrix form and applying appropriate mathematical tool to solve the equations.	K5
CO 5	Gains knowledge on the basic ideas and equations of Einstein's Special Theory of Relativity. Acquire knowledge on relativistic Lagrangian and Hamiltonian for a free particle.	K3 & K4

MAPPING - COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	3	2	3
CO 2	3	3	2	3	2	3
CO 3	3	3	2	3	3	2
CO 4	3	2	3	3	3	2
CO 5	3	2	3	3	3	3
AVERAGE	**3**	**2.6**	**2.6**	**3**	**2.6**	**2.6**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

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SEMESTER I

ELECTROMAGNETIC THEORY – I

TOTAL HOURS: 75 **COURSE CODE: 14SP21/1C/EM1**
CREDITS: 4 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To specialize the students in different coordinate systems, mathematical tricks and notations
2. To apprise the fundamentals of electrostatics, concepts, laws, boundary conditions, its application to conductors and capacitors.
3. To use the boundary conditions and uniqueness theorems to solve the electric potential problems via the method of images.
4. To acquaint the dielectric system in detail: origin, boundary conditions, laws, formulas, energy and forces.
5. To impart the fundamentals of magnetostatics, concepts, laws, vector potential, boundary conditions and applications in material media.

COURSE OUTLINE:

UNIT I: Vector Algebra

Vector operations-component form-triple products-position, displacement and separation vectors-transformation of vectors- operator del-derivatives-gradient, divergence and curl-product rules-second derivatives-integrals-line, surface and volume integrals-Fundamental theorem-calculus-gradients-divergences-curls-curvilinear coordinates- spherical polar and cylindrical- Dirac delta function -one dimensional and three dimensional-theory of vector fields-Helmholtz theorem-Theorem on potentials. **15 Hrs**

UNIT II: Electrostatics

The electric field – Coulomb's law – charge distributions – divergence and curl of E – field lines, flux - Gauss law and its applications (problems)- electric potential-Poisson's and Laplace's equations- potential of a localized charge distribution-boundary conditions- work done to move a charge – energy of a point and continuous charge distribution-conductors-basic properties-induced charges-capacitors. **15 Hrs**

UNIT III: Electric Potential

Laplace's Equation, one dimension, two-dimension, three dimension- boundary conditions and uniqueness theorems – first and second- the method of images – the classic image problem - potential- induced surface charge – force- energy - applications: grounded conducting sphere - uniform line charge on an infinite straight wire -separation of variables- Cartesian coordinates - spherical coordinates (problems) **15 Hrs**

UNIT IV: Dielectrics

Multipole Expansion – monopole and dipole terms - origin of coordinates (problems) – electric field of a dipole- dielectrics - induced dipoles – alignment of polar molecules – (problems) - polarization – bound charges (problems) - Gauss's law in the presence of dielectrics- electric displacement – boundary conditions – susceptibility – permittivity - boundary values – energy in dielectric systems - Clausius Mossotti and Langevin Formula. **15 Hrs**

UNIT V: Magnetostatics

The magnetic field – Lorentz force law – currents - line – surface volume (problems) – Biot - Savart law – divergence and curl of B – Ampere's law - magnetic vector potential- boundary conditions – multipole expansion of the vector potential– magnetic fields in matter - torque and forces on magnetic dipoles – magnetization - bound currents - Ampere's law in magnetized materials – boundary conditions – magnetic susceptibility and permeability-ferromagnetism-energy in magnetic fields. **15 Hrs**

RECOMMENDED TEXT BOOKS:

1. D.J. Griffiths, Introduction to Electrodynamics, 4th Edition, Prentice-Hall of India, New Delhi, 2017.
2. J.D. Jackson, Classical Electrodynamics, 3rd Edition, Wiley Eastern Ltd, New Delhi, 2006.

REFERENCE BOOKS:

1. Chopra Agarwal, Electromagnetic Theory, 5th Edition, K.Nath & Co, Meerut, 2009.
2. Sathyaprakash, Electromagnetic Theory and Electrodynamics, 1st edition, New Ed,Kedarnath and Ramnath and Co., Meerut, 2021.
3. Bishwanath Chakraborty, Principles of Electrodynamics, 2nd Edition, Books and Allied (P) Ltd., Kolkatta, April 2008.
4. S.N.Goswami, Elements of Plasma physics, 2nd Edition, New Century Book Agency (P) Ltd., 2000.
5. John D. Kraus and Daniel Fleisch, Electromagnetics with Applications, 5th edition, Tata McGraw Hill Education, 2017.

JOURNALS:

1. Physical Review D
2. Proceedings of the London Mathematical Society
3. Pramana- Journal of Physics

E- LEARNING RESOURCES:

1. http://www.freebookcentre.net/physics-books-download/Electromagnetic-Theory-PDF-notes.html.
2. http://nptel.ac.in/courses/115101005/
3. https://ecee.colorado.edu/~bart/book/book/chapter1/ch1_3.htm
4. http://www.clerkmaxwellfoundation.org/html/electromagnetic_theory.html
5. https://ocw.mit.edu/courses/physics/8-311-electromagnetic-theory-spring-2004/

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Discuss the mathematical tricks, different notations, transformation of vectors and coordinate systems	K2
CO 2	Compute the terms, formulae, boundary conditions to solve electrostatic problems.	K3,K4
CO 3	Utilize the Separation of variables, Method of images mathematical tool to solve the potential problems.	K5
CO 4	Formulate the fundamental laws of dielectric system.	K3
CO 5	Compute the terms, formulae, boundary conditions to solve magnetostatic problems.	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	3	1	1
CO 2	3	3	1	3	1	1
CO 3	3	1	1	3	1	1
CO 4	3	1	1	3	1	1
CO 5	3	1	3	3	1	1
AVERAGE	**3**	**1.8**	**1.6**	**3**	**1**	**1**

KEY: STRONGLY CORELATED-3, MODERATELY CORELATED-2, WEAKLY CORELATED-1, NO CORELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER I

GENERAL EXPERIMENTS

TOTAL HOURS: 90 **COURSE CODE: 14SP21/1C/PR1**
CREDITS: 4 **L-T-P: 0 3 3**

COURSE OBJECTIVES:

1. To familiarize with the basics of experimental physics and its correspondence with the theory.
2. To explore the concepts involved in the thermodynamics and semiconductor physics
3. To understand the basic concepts in modern optics and electromagnetism.
4. To allow the student to understand the fundamentals of instruments involved in lasers
5. To introduce the basic nuclear experiment.

COURSE OUTLINE:

Any Fifteen Experiments to be done

1. Cornu's method – Young's modulus by Elliptical fringes
2. Stefan's constant
3. Band gap energy – Thermistor
4. B-H Curve using CRO
5. Hall Effect
6. Ultrasonics - Compressibility of a liquid
7. Susceptibility by Quincke's method
8. Solar constant
9. F.P. Etalon using spectrometer
10. Cornu's method - Young's modulus by Hyperbolic fringes
11. Susceptibility by Guoy's method
12. Specific charge of an electron – J.J. Thomson's method
13. Viscosity of liquid – Meyer's disc
14. GM counter – Characteristics, inverse square Law, absorption coefficient
15. Polarimeter – Specific Rotatory Power of an optically active solution
16. Hydrogen spectrum – Rydberg's constant
17. Solar spectrum – Hartmann's formula
18. Edser-Butler fringes – Thickness of air film
19. Laser experiments:
    a. Diffraction at straight edge.
    b. Interference of laser beams – Lloyds single mirror method.
    c. Interference using an optically plane glass plate and a laser.
    d. Laser diffraction at a straight wire.
    e. Laser diffraction at a circular aperture.
    f. Study of Laser Beam Parameter

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Design thermodynamical experimental unit to examine the physical constants.	K3
CO 2	Analyze the principles and properties of electromagnetic radiation using general and modern optics experiments.	K4,K5
CO 3	Revise basic concepts of mechanics with different experiments.	K3
CO 4	Apply the basic theory of semiconductors and magnetism and understand it through their experiments.	K4
CO 5	Identify the type of radiation with the help of nuclear experiment.	K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	3	1	1	1
CO 2	3	3	3	2	3	3
CO 3	3	2	3	2	1	2
CO 4	3	3	3	3	3	3
CO 5	3	2	3	2	3	3
AVERAGE	**3**	**2.2**	**3**	**2**	**2.2**	**2.4**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

SEMESTER I

ELECTRONICS

TOTAL HOURS: 75 **COURSE CODE: 14SP21/1E1/ELS**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To enrich the understanding of fundamentals of semiconductor devices.
2. To impart the knowledge of Microwave and photo electronic devices.
3. Teach the students to design sequential logic systems using Registers and counters.
4. To understand basic differential amplifier's Ideal and Practical characteristics and their mathematical applications.
5. To train the students on the basics of nonlinear applications of Op-amps and Data Converters.

COURSE OUTLINE:

Unit I: Semiconductor Devices

Field effect transistor, junction field effect transistor - metal oxide semiconductor field effect transistor - construction, working, characteristics - FET as an amplifier - uni junction transistor - construction, working, characteristics - UJT relaxation oscillator (problems) - silicon controlled rectifier – construction, working, characteristics – SCR for power control. Memory devices: CMOS and NMOS – charge coupled devices (CCD). **15 Hrs**

Unit II: Microwave Wave and Photo Electronic Devices

Klystron – Gunn diode – IMPATT diode - construction – working as MW oscillator. photonic devices - LED – diode photo detectors – solar cell - open circuit voltage and short circuit current- fill factor – diode lasers - conditions for population inversion in active region - light confinement factor. **15 Hrs**

Unit III: Sequential Logic Systems

Counters and Registers – Asynchronous Counters – Design of Asynchronous Feedback Technique Counters **–** Non-binary Counters - Design of Synchronous Counters – Design of Random Sequence Counters– BCD counters - shift registers and their applications. **15 Hrs**

Unit IV: Linear Integrated Circuits and Applications

Solution of simultaneous and differential equations using Op-Amps (problems) – active filters – low pass , high pass, band pass- 1^{st} order, 2^{nd} order butterworth filter circuits – wide band and narrow band reject filters - sample and hold circuits.

wave form generators using 555 timer – astable multivibrator – monostable multivibrator - phase locked loop. **15 Hrs**

Unit V: Non Linear Applications of Op-amps and Data Converters

Precision comparators – precision rectifiers - half wave and full wave rectifiers – peak detector - log and antilog amplifiers - binary weighted resistor D/A Converter – R-2R ladder D/A converter – flash, counter type – successive approximation and dual slope A/D converters. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. R.A. Gaekwad, Op-amps and Linear Integrated circuits, 3rd Edition, Prentice Hall of India Pvt Ltd, New Delhi, 1993.
2. Taub and Shilling, Digital Integrated Electronics, 13th Edition, McGraw Hill international, Singapore, 1987.
3. B.Somnath Nair, Electronic devices and applications, 1st Edition, Prentice-Hall of India, New Delhi, 2003.
4. Flyod & Jain, Digital Fundamentals, 8th Edition, Dorling Kindersley Pvt. Ltd., New Delhi., 2006.
5. V. Vijayendran, Introduction to Integrated Electronics, 1st edition, S.Viswanathan Printers and publishers Pvt. Ltd., Chennai, 2005.
6. R.F.Coughlin and F.F.Drisol, Op-amp and linear integrated circuits.6th edition, Prentice Hall of India Pvt., Ltd., New Delhi, 2008.
7. Millman and Halkias, Integrated Electronics, 25th Edition, Tata McGraw Hill, 1983.

REFERENCE BOOKS:

1. B.Somnath Nair, Digital Electronics and Logic Design, 1st Edition, Prentice-Hall of India, New Delhi, 2003.
2. A. Ghatak and K.Thyagarajan , Optical Electronics, 1st edition, Cambridge Univ. Press,2008.
3. S.P. Bali, Solid State devices & circuits, 1st Edition, New Age International Private Ltd, New Delhi, 1995.
4. R.K. Sharma, Semiconductor Electronics, 1st Edition, New Age International PrivateLtd, New Delhi ,1996.
5. Leach and Malvino, Digital Principles and Applications, 5th Edition, TataMcGraw Hill, 2005.
6. S.M.Sze, Physics of Semiconductor Devices, 3rd Edition , John Wiley & Sons, New York, 1985.

JOURNALS:

1. International Journal of Electronics
2. International Journal of Electronics and Communications
3. International Journal of Computer Networks and Communications

E- LEARNING RESOURCES:

1. https://www.elprocus.com/semiconductor-devices-types-and-applications/
2. https://www.elprocus.com/optoelectronics-devices-with-their-applications/
3. https://www.electronics-tutorials.ws/sequential/seq_6.html
4. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_op_amp_applications.htm
5. https://www.studyelectronics.in/linear-and-nonlinear-applications-of-op-amp/

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Discuss various characteristics semiconductors, transistors and with that memory devices.	K3
CO 2	Analyze output of different semiconductor devices in different operating modes.	K4
CO 3	Design simple combinational and sequential logic circuits.	K5
CO 4	Design Monostable and Astable Multivibrators using discrete components.	K5
CO 5	Analyze and design solid state power amplifier circuits.	K4

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	2	1	3	3	1	2
CO 2	3	2	3	3	2	1
CO 3	3	3	3	3	1	2
CO 4	3	3	3	3	1	2
CO 5	3	2	3	3	1	1
AVERAGE	**3**	**2.2**	**3**	**3**	**1.2**	**1.6**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER I
COMMUNICATION ELECTRONICS

TOTAL HOURS: 75 **COURSE CODE: 14SP21/1E1/CES**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To equip students with the broad outlines of different types of electronic communication systems and to study fiber optic communication
2. To expose them to transmission lines and wave guides
3. To be aware of broad band communication systems
4. To understand the satellite communication systems
5. To Study the principles of remote sensing and the data acquisition and analysis of satellite data

COURSE OUTLINE:

UNIT I: Light Transmission through Fibers

Propagation of light waves in optical fiber-Basic structure of an optical fiber-propagation of light waves through it- acceptance angle- numerical aperture(General) – Fiber Classification- stepped index fiber-stepped index -monomode fiber- graded index multimode fiber- plastic fibers- Importance of optical fibers- Light sources-process involved in LED & LASERS- Light Detectors- photoemissive-photoconductive- photovoltaic devices. **15 Hrs**

UNIT II: Aerials and Transmission Lines

Introduction to aerials- radiation from a short dipole in a free space- Propagation of radio waves- ground waves- sky waves- space waves- Transmission Lines-introduction to coaxial cables- strip lines- wave guide. **15 Hrs**

UNIT III: Broad Band Communication Systems

Multiplexing- time division multiplexing- frequency division multiplexing- Computer communication- Microwave links- line of sight (LOS) microwave links- tropospheric scatter microwave links- ISDN- LAN- PBX- Introduction to Cellular mobile communication: concept of cell- basic cellular mobile radio system- FAX(Fascimile). **15 Hrs**

UNIT IV: Satellite Communication System

Introduction to satellite communication systems- orbits- basic components of satellite communication systems- Constructional features of satellites- Commonly used frequency in satellite communication- Multiple Access- Satellite communication in India. **15 Hrs**

UNIT V: Physics of Remote Sensing

Introduction of Remote Sensing - Electro Magnetic Spectrum, Physics of Remote Sensing- Effects of Atmosphere- Scattering – Different types – Absorption-Atmospheric window- Energy interaction with surface features – Spectral reflectance of vegetation, soil and water –atmospheric influence on spectral response patterns-multi concept in Remote sensing. **15 Hrs**

RECOMMENDED TEXT BOOKS:

1. A.B.Carlson, Communication systems, 2nd Edition, Mc Graw Hill.,New Delhi,.
2. B.P.Lathi, Modern Digital and Analog Communication Systems, 3rd Edition, Oxford University Press, Newyork, 2005.
3. Dennis Roddy, Satellite Communication, McGraw Hill International, 4th Edition, 2006.
4. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, Satellite Communication Systems Engineering, Prentice Hall/Pearson, 2007.
5. N.Agarwal, Design of Geosynchronous Space Craft, Prentice Hall, 1986
6. Paul Curran P.J., Principles of Remote Sensing, ELBS, 1995.

REFERENCE BOOKS:

1. Subir Kumar Sarkar, Optical Fibers and Fiber Optic Communication Systems, S.Chand Company Ltd, New Delhi, Reprint 2008
2. Anok Singh, A.K.Chhabra, Principles of Communication Engineering, 6thRevised Edition, S.Chand Company Ltd, New Delhi, 2004.
3. Gupta Kumar, Hand Book of Eectronics, 33rd Revised Edition, Pragati Prakashan, Meerut, 2006.
4. Pallab Battacharya, Semiconductor Optoelectronic Devices, 2nd Edition, Prentice Hall of India, New Delhi, 2004.
5. Charles Elachi and Jakob J. van Zyl, Introduction to the Physics and Techniques of Remote Sensing, Wiley Series in Remote Sensing and Image Processing, 2006.

JOURNALS:

1. International Journal of Electronics
2. International Journal of Electronics and Communications
3. International Journal of Computer Networks and Communications

E- LEARNING RESOURCES:

1. http://www.freebookcentre.net/networking-books-download/The-Fiber-Optic-Data-Communications-.html
2. http://fiberu.org/FOcomm/index.html
3. http://www.antenna-theory.com

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Can discuss Light Transmission through Fibers and fiber optic communication systems	K2
CO 2	Can demonstrates Transmission lines and different kind of waves	K3
CO 3	Can apply and analyze Multiplexing techniques and basic cellular mobile radio systems	K3, K4
CO 4	Is able to apply Basics of satellite communications and its applications	K4, K5
CO 5	Can formulate the concepts of remote sensing technology and analyze its applications	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3
CO 3	3	3	3	3	3	2
CO 4	3	3	3	3	3	2
CO 5	3	3	3	3	3	2
AVERAGE	3	2.2	3	3	1.2	1.6

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER II COURSE PROFILE – M.Sc.

Course Code	Course Title	Credits	Hrs/ Week	Total Hours	L-T-P	CA Marks	End Sem. Marks	Total
14SP21/2C/QM1	Quantum Mechanics – I	4	5	75	3 2 0	40	60	100
14SP21/2C/STM	Statistical Mechanics	4	5	75	3 2 0	40	60	100
14SP21/2C/EM2	Electromagnetic Theory II	4	4	60	2 2 0	40	60	100
14SP21/2C/PR2	Electronics Experiments	4	6	90	0 3 3	40	60	100
14SP21/2E2/MSY (or)	Molecular Spectroscopy (or)	3	4	60	2 2 0	40	60	100
14SP21/2E2/CRT	Characterization Techniques	3	4	60	2 2 0	40	60	100
14SP21/2E/MTG	Medical Technology	3	4	60	2 2 0	40	60	100
PG21/2S/LCE PG21/2S/FRE PG21/2S/GER	Soft Skill 2 - Communication Skills / Soft skills in French / German for beginners	2	2	30	-	-	50	50

TOTAL CREDITS 24

QUANTUM MECHANICS - I

TOTAL HOURS: 75 **COURSE CODE:14SP21/2C/QM1**
CREDITS: 4 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
2. To describe the propagation of a particle in a simple, one-dimensional potential.
3. To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional and spherically symmetric potentials.
4. To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
5. To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

COURSE OUTLINE:

Unit I: Basic Formalism

Postulates of quantum mechanics- probability interpretation and admissibility conditions of the wave function (problems) - Schrödinger equation- - stationary states - expectation value (problems) - operators - operator algebra –eigen values and eigen functions of operators - completeness of eigen functions- Hermitian operators and their properties - simultaneous measurability and commutators (problems) - Uncertainty principle for operators - Ehrenfest's theorem **15 Hrs**

Unit II: Applications of Schrödinger Equation- One Dimension

The free particle- square well potential – rigid walls (problems)- finite walls- potential barrier - barrier penetration – alpha emission - simple harmonic oscillator – Schrödinger Method - ladder operator method (problems). **15 Hrs**

Unit III: Applications of Schrödinger Equation- Three Dimension

Simple harmonic oscillator (problems) -orbital angular momentum- eigen value spectrum for L^2 and L_z - particle moving in a spherically symmetric potential- system of two interacting particles - hydrogen atom- rigid rotator. **15 Hrs**

Unit IV: General Formalism

Linear vector space - Hilbert space – Dirac's notation - Heisenberg's matrix representation of wave functions and operators -momentum representation-wave functions, operators and Schrödinger equation- symmetry transformations and conservation laws - translation and rotation - parity and time reversal- quantum mechanical pictures - Schrödinger, Heisenberg and Interaction pictures. **15 Hrs**

Unit V: Approximation Methods

Time-independent perturbation theory for non-degenerate and degenerate levels – Stark effect in hydrogen atom - Variation method – helium atom - WKB approximation - bound states in a potential well-application to simple harmonic oscillator. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw-Hill, New Delhi, 2010.
2. G.Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011
4. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, New Delhi,2017
5. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S Chand & Co., New Delhi, 1982.
6. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan, India, 1984.
7. L.I.Schiff, Quantum Mechanics,International Student3rd Edition, MacGraw-Hill, Kogakusha, Tokyo, 1968
8. Sathyaprakash, Advanced Quantum Mechanics, 5th edition, Kedarnath & Ramnath, Meerut, 2004.

REFERENCE BOOKS :

1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.
4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. R. P. Feynman, R. B. Leighton, and M. Sands, The Feynman Lectures on Physics, Vols. 3, Narosa Publishing House , New Delhi, 1998.
6. V. Devanathan, Quantum Mechanics, 2ndedition,Alpha Science International Ltd, Oxford , 2011.
7. V. Devanathan, Angular Momentum Techniques in Quantum Mechanics, 1st edition, Kluwer Academic Publishers, Dordrecht, 1999.

JOURNALS:

1. Reviews of Modern Physics
2. Physical Review A
3. Indian Journal of Pure and Applied Physics

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.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum mechanics	K3
CO 2	Is able to apply and analyse the Schrodinger equation to solve one dimensional problems	K3,K4
CO 3	Can apply and analyse the Schrodinger equation for particles in different three -dimensional potentials	K3,K4
CO 4	Can discuss the various representations, space time symmetries and formulations of time evolution	K3
CO 5	Can formulate and analyse the approximation methods for various quantum mechanical problems	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	1	3	1	1
CO 2	3	3	2	3	2	1
CO 3	3	3	2	3	2	1
CO 4	3	2	1	3	2	1
CO 5	3	3	1	3	2	1
AVERAGE	**3**	**2.6**	**1.6**	**3**	**1.8**	**1**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER II

STATISTICAL MECHANICS

TOTAL HOURS: 75 **COURSE CODE: 14SP21/2C/STM**
CREDITS : 4 **L-T-P : 3 2 0**

COURSE OBJECTIVES:

1. To interpret the macroscopic behavior of a system in terms of its microscopic properties for a system using mathematical methods and fundamental physics
2. To explore the general principle of statistical mechanics making use of classical physics to solve simple and complex cases.
3. To impart the method of fragmenting the given complex systems into small groups of non interacting, independent replicas, to compute the statistical behavior of complex system.
4. To introduce a new quantum idea of discrete exchange of energy between systems to explain several experimentally observed phenomena
5. To introduce a non equilibrium systems and to study its characteristics. To Understand the theory of fluctuations of macroscopic properties of thermodynamic systems about their equilibrium values.

COURSE OUTLINE:

UNIT I: Fundamentals of Statistical Mechanics

Phase Space – Concept of Ensembles – Density of Distribution in Phase Space – Liouville's Theorem – Density of Phase Points in a Classical Ensemble - Statistical Equilibrium - Postulate of Equal a Priori Probability – Time and Ensemble Average – Division of Phase Space into Cells – Microstates and Macrostates - Number of Microstates in the Energy Range E to $+\delta E$ **15 Hrs**

UNIT II: Classical Statistics

General Expression for Probability – Stirling's Formula – The Most Probable Distribution – Maxwell Boltzmann Distribution Law – Evaluation of Constants in the Maxwell Boltzmann Distribution Law – Law of Equipartition of Energy – Connection between the Partition Function and Thermodynamic Quantities – Atomicity of Gases – Interpretation of Temperature – Condition of Equilibrium between Two Systems in Thermal Contact – β parameter. **14 Hrs**

UNIT III: Ensembles

Micro Canonical Ensemble – Condition for Equilibrium: Thermal, Mechanical and Particle Equilibrium – Connection between Statistical and Thermodynamical Quantities - Perfect Gas in Micro Canonical Ensemble – Partition Functions: Derivation of Translational Partition Function for a Gas Molecule – Gibbs Paradox – Gibbs Canonical Ensemble – Perfect Monoatomic Gas in Canonical Ensemble – Grand Canonical Ensemble – Perfect Gas in Grand Canonical Ensemble – Comparison of Ensembles. **15 Hrs**

UNIT IV: Quantum Statistics

Density Matrix – Time Dependence of Density Matrix – Density Matrix in Microcanonical, Canonical and Grand Canonical Ensembles - Fermi-Dirac, Bose-Einstien and Maxwell-Boltzmann Statistics – Black Body Radiation and Planck's Radiation Law – Bose-Einstien Gas – Degeneracy and Bose-Einstien Condensation – Fermi-Dirac Gas – Degeneracy. **16 Hrs**

UNIT V: Fluctuations and Phase Transitions

Measure of Fluctuations: The Standard Deviation – an Illustration of Fluctuation : Molecules in Two Halves of a Box – Fluctuations in Ensembles: Canonical and Grand Canonical – Probability of One Dimensional Random Walk – Brownian Movement – Motion Due to Fluctuating Force – The Fokker-Planck Equation.

Phase Transition of First and Second Order – Ehrenfest's Equations – Ising Model – Bragg-William Approximation - One Dimensional Ising Model. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. B.K. Agarwal and M.Eisner, Statistical Mechanics, 2nd Edition, New age International, New Delhi, 2012.
2. Satyaprakash, J.P.Agrwal, Statistical Physics, 7th Edition, Kedarnath Ramnath & Co., Meerut, 2008.

REFERENCE BOOKS:

1. J.K.Bhatacharjee, Statistical Mechanics, 1st Edition, Sunil Sachdev, New Delhi 64, 2002.
2. F.W.Sears and G.L.Salinger, Thermodynamics, Kinetic theory and Statistical Thermodynamics, 2nd Edition, Narosa Publishing House. 2008.
3. Federick Reif, Fundamentals of statistical and Thermal Physics, Special Indian Edition, McGraw-Hill Kogakusha Ltd., New Delhi,2011.
4. Sathya Prakash, Thermodynamics, Statistical Physics and Kinetics, 2010 Edition, Kedar Nath Ram Nath, Meerut.
5. S.L.Gupta,V. Kumar, Elementary Statistical Physics ,18th Edition, Pragathi Prakasan, Meerut, 2012.

JOURNALS:

1. Indian Journal of Physics
2. Journal of Statistical Mechanics: Theory and Experiment

E-LEARNING RESOURSES:

1. https://www.cmi.ac.in/~kpnmurthy/StatisticalMechanics2017/book.pdf
2. https://www.coursera.org/lecture/statistical-thermodynamics/video-3-6-the-ensemble-partition-function-WOqoY
3. http://www.physics.mcgill.ca/~delrio/courses/phys559/lectures%20and%20notes/phys559_notes.pdf
4. http://www.complex.nbi.dk/courses/critical_phenomena.pdf
5. https://www.youtube.com/watch?v=2wF_CVuWyEg

COURSE OUTCOMES:

CO NO.	CO STATEMENT	Knowledge Level
CO 1	Able to draw inferences and making the deductions of some average or most probable properties of large assemblies of electrons, atoms, molecules, quanta etc.,	K3
CO 2	Learn to apply Classical Statistics method to simple and selected problems that follow classical dynamics.	K4
CO 3	Able to differentiate various systems as the Micro-Canonical, Canonical, and Grand Canonical Ensembles and able to apply advanced mathematical techniques to analyze the same.	K5
CO 4	To inspect the importance and consequences of quantum mechanics for macroscopic particle systems and able to compare it with different microscopic models. Use the tools and methodologies of quantum statistics, such as Fermi-Dirac and Bose-Einstien statistics, to solve problems in some physical systems.	K5
CO 5	Learn to apply the techniques involved in first and second order phase transitions to different thermodynamic systems. Gets acquainted with necessary topics that lead them to expand their knowledge in the recent research field of statistical mechanics.	K3 & K4

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	2	3	2	3
CO 2	3	3	1	3	2	1
CO 3	2	3	3	3	2	2
CO 4	3	3	3	3	3	2
CO 5	2	2	3	3	3	2
AVERAGE	**2.6**	**2.4**	**2.4**	**3**	**2.4**	**2**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER II

ELECTROMAGNETIC THEORY – II

TOTAL HOURS: 60 **COURSE CODE:14SP21/2C/EM2**
CREDITS: 4 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To formulate the Maxwell equations, conservation laws, theorems and to familiarize the students to different gauge transformations
2. To introduce different types of potentials, their fields; explain charged particle dynamics and radiation from localized time varying electromagnetic sources.
3. To describe the nature of electromagnetic wave and its propagation through vacuum and other media.
4. To describe the reflection and transmission at the interfaces and degree of polarization
5. To expose the students to the ideas of guided waves and its type

COURSE OUTLINE:

UNIT 1: Potential Formulation of Electrodynamics

Maxwell equations-Maxwell equations in free space and matter- boundary conditions-Conservation law - charge and energy – the continuity equation – Poynting's theorem – momentum – Maxwell's stress tensor – conservation of momentum– scalar and vector potential – Gauge transformations – Coulomb gauge – Lorentz gauge (problems)

12 Hrs

UNIT II: Electromagnetic Potentials and Radiation

Continuous distributions – retarded potentials – point charges – Lienard Wiechert potential – the electric and magnetic fields of a moving point charge – velocity and acceleration fields –radiation from an arbitrary source – power radiated by a point charge – Larmor formula **12 Hrs**

UNIT III: Electromagnetic Waves I

The wave equation – plane electromagnetic waves in free space-plane electromagnetic waves in non-conducting isotropic medium- plane electromagnetic waves in anisotropic non-conducting medium- plane electromagnetic waves in conducting medium **12 Hrs**

UNIT IV: Electromagnetic Waves II

Boundary conditions at the surface of discontinuity –reflection and refraction of electromagnetic waves at the interface of non-conducting media-Fresnel's equations-reflection and transmission coefficients at the interface between two non-conducting media-Brewster's angle and degree of polarization **12 Hrs**

UNIT V: Wave Guides

Total internal reflection – wave guides- Transverse electric waves-transverse magnetic waves-transverse electric and magnetic waves -rectangular wave guide-circular wave guide and resonant cavities **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. D.J. Griffiths, Introduction to Electrodynamics, 4th Edition, Prentice-Hall of India, New Delhi, 2017.
2. J.D. Jackson, Classical Electrodynamics, 3rd Edition, Wiley Eastern Ltd, New Delhi, 2006.

REFERENCE BOOKS:

1. Chopra Agarwal, Electromagnetic Theory, 5th Edition, K.Nath & Co, Meerut, 2009.
2. Sathyaprakash, Electromagnetic Theory and Electrodynamics, 1st edition, New Ed,Kedarnath and Ramnath and Co., Meerut, 2021.
3. Bishwanath Chakraborty, Principles of Electrodynamics, 2nd Edition, Books and Allied (P) Ltd., Kolkatta, April 2008.
4. S.N.Goswami, Elements of Plasma physics, 2nd Edition, New Century Book Agency (P) Ltd., 2000.
5. John D. Kraus and Daniel Fleisch, Electromagnetics with Applications, 5th edition, Tata McGraw Hill Education, 2017.

JOURNALS:

1. Journal of Applied Physics
2. Annals of Physics
3. Pramana-Journal of Physics

E-LEARNING RESOURCES:

1. https://arxiv.org/abs/1411.6446
2. http://farside.ph.utexas.edu/teaching/em/lectures/node50.html
3. https://depts.washington.edu/mictech/optics/me557/week2.pdf
4. https://www.allaboutcircuits.com/textbook/alternating-current/chp 14/waveguides/
5. http://www.feynmanlectures.caltech.edu/II_24.html

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Discuss the electromagnetic potentials and gauge transformations. Calculate force, momentum and energy of the electromagnetic field.	K2, K3
CO 2	Explain retarded potentials and radiation associated with	K4,K5

	various charge configuration.	
CO 3	Outline electromagnetic waves and their propagation in vacuum and in media.	K3
CO 4	Explain reflection and transmission at the interface and the degree of polarization	K5
CO 5	Discuss the concepts of guided structures and its types.	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	2	3	1	1
CO 2	3	1	1	3	1	1
CO 3	3	1	1	3	1	2
CO 4	3	1	2	3	2	2
CO 5	3	1	1	3	2	2
AVERAGE	**3**	**1.2**	**1.4**	**3**	**1.4**	**1.6**

KEY:STRONGLY CORELATED-3, MODERATELY CORELATED-2, WEAKLY CORELATED-1, NO CORELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER II

ELECTRONICS EXPERIMENTS

TOTAL HOURS: 90 **COURSE CODE: 14SP21/2C/PR2**
CREDITS: 4 **L-T-P: 0 3 3**

COURSE OBJECTIVES:

1. To give hands on training in the construction of simple electronic circuits.
2. To produce skillful graduates who can analyze, design and develop a simple electronic system/component/ process for the required needs under the realistic constraints.
3. To make the students understand practically the characteristics of transistors, amplifiers, oscillators and filters.
4. To give exposure in understanding digital to analog and analog to digital conversion, use of logic gates etc.,

Any Fifteen Experiments to be done

1. Half-Adder, Half-Subtractor and Full-Adder and Full-Subtractor using NAND/NOR gates.
2. Arithmetic Operations using IC 7483.
3. BCD Counter – Decoding and Display
4. Up/Down Counters using IC 7476/7473.
5. Shift Register, Ring Counter, Johnson Counter using J-K flip flops 7476/7473.
6. Digital to Analog Converter using IC 741 – R/2R ladder.
7. D/A Converter – Binary Weighted Resistor.
8. Multiplexer and De-multiplexer
9. Decoders and Encoders
10. Construction of Two Stage Transistor Amplifier.
11. FET Characteristics and Design of a FET Amplifier
12. UJT Characteristics and Design of Saw Tooth Generator.
13. Design of a Square Wave Generator using IC 741 and Timer 555.
14. Design of the Wien Bridge Oscillator and the Study of its Attenuation Characteristics.
15. Design of the Phase Shift Oscillator and the Study of its Attenuation Characteristics.
16. Analog Computer Circuit Design – Solving Simultaneous Equations.
17. Design of Second Order Butter Worth Active Filter Circuits –Low Pass, High Pass and Multiple Feed Back Band Pass Filters.
18. Design of Monostable Multivibrator using IC 741 and Timer 555.
19. Design of Schmidt Trigger using IC 741 and Timer 555.
20. Construction of Colpitts and Hartley Oscillators using Transistor

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Explain the construction of simple electronic circuits	K4
CO 2	Apply the theoretical concepts behind electronics experiments	K3
CO 3	Compile the characteristics of transistors, amplifiers, oscillators and filters.	K4
CO 4	Compare the conceptual differences between analog and digital electronics.	K4
CO 5	Demonstrate practically the response of various special purpose electronic devices.	K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	3	3	1	2
CO 2	3	2	3	3	1	1
CO 3	2	2	2	3	2	2
CO 4	3	2	2	3	1	2
CO 5	3	2	3	3	2	2
AVERAGE	**2.8**	**2**	**2.6**	**3**	**1.4**	**1.8**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

SEMESTER II

MOLECULAR SPECTROSCOPY

TOTAL HOURS: 60 **COURSE CODE: 14SP21/2E2/MSY**
CREDITS: 3 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

1. To understand the basic features of microwave and electronic spectroscopy.
2. To expose the students to the fundamental concepts of infrared spectroscopy of different type of molecules.
3. To introduce students to the theory and application of Raman spectroscopy.
4. To impart the knowledge of diverse Resonance techniques.
5. Explain ESR and Mossbauer spectroscopy and their applications.

COURSE OUTLINE:

UNIT I: Microwave and Electronic Spectroscopy

Classification of molecules- rotational spectra – diatomic molecules: rigid diatomic molecule – intensities of spectral lines – isotope effect in rotational spectra – non rigid rotator: spectrum of non-rigid rotator – polyatomic molecules: linear molecules – symmetric top molecules – asymmetric top molecules – outline – techniques and instrumentation of microwave spectroscopy.

Theory of electronic spectroscopy –Frank -Condon principle – rotational and vibrational structure of electronic spectra - applications. **12 Hrs**

UNIT II: Infrared Spectroscopy

IR spectroscopy –theory of infrared spectrum-origin of infrared spectrum-selection rules vibrating diatomic molecule – simple harmonic oscillator – anharmonic oscillator - vibrations of polyatomic molecules-fundamental vibrations and their symmetry – overtone and combination frequencies – influence of rotation on the spectra of polyatomic molecules – linear molecules – influence of nuclear spin – symmetric top molecules – techniques and instrumentation ; double and single beam operation – Fourier transform spectroscopy. **12 Hrs**

UNIT III: Raman Spectroscopy

Classical and quantum theory of Raman effect – molecular polarizability -– pure rotational Raman spectra: linear molecules – symmetric top molecules – spherical top molecules -vibrational Raman spectra – overtone and combination vibrations – rotational fine structure – polarization of light and the Raman effect – vibrations of spherical top molecules – structural determination from Raman and IR Spectroscopy: techniques and instrumentation – sources – sampling methods **12 Hrs**

UNIT IV: NMR Techniques

Magnetic properties of nuclei – theory of NMR method – Bloch equations – steady state solution –instrumentation-single coil and double coil method-pulse R.F method-theory of chemical shifts – relaxation processes – types of coupling-spin-spin coupling-high resolution NMR **12 Hrs**

UNIT V: ESR and Mossbauer Spectroscopy

Principle of ESR – quantum mechanical treatment of ESR – ESR spectrometer – total Hamiltonian – hyperfine structure effects – application of ESR method - principles of Mossbauer spectroscopy- instrumentation- – chemical shift - quardrupole splitting and Zeeman Splitting– simple chemical Applications of Mossbauer Spectroscopy. **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. C.N.Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, 5th Edition, TMH New Delhi, 2013.
2. Gurdeep R.Chatwal and Sham K.Anand, Spectroscopy, 1st Edition, Himalaya Publishing House, 2010.
3. H.Kaur,Spectroscopy, 4th Edition, Pragati Prakasan,2008
4. G.Aruldhas, Molecular Structure and Spectroscopy, 2nd Edition Prentice-Hall of India, New Delhi, 2009.

REFERENCE BOOKS:

1. Walker and Straughan, Spectroscopy, Vols, I and II, 4th Edition, Chapman and Hall, 1976.
2. D.N.Sathyanarayana, Vibrational Spectroscopy and Applications, 2nd Edition, New Age International Publication, 2004.
3. V.B.Patania, Spectroscopy, 1st Edition, Campus books International, 2002.
4. J.L. Mc.Hale, Molecular Spectroscopy, 1st Edition, Prentice Hall, 1999.
5. W.L. Struve, Fundamentals of Spectroscopy,1st Edition, Wiley, 1989.

JOURNALS:

1. Journal of Molecular Spectroscopy
2. Spectrochimica Acta Part A: Molecular Spectroscopy
3. Indian journal of Physics

E- LEARNING RESOURCES:

1.https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_TextbookMaps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Spectroscopy/Rotational_Spectroscopy/Microwave_Rotational_Spectroscopy
2.http://www.umsl.edu/~orglab/documents/IR/IR2.html
3.http://www.horiba.com/in/scientific/products/raman-spectroscopy/raman-academy/raman-tutorial/enhancements/
4.https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Spectrpy/nmr/nmr1.htm
5.http://phyp10.epgpbooks.inflibnet.ac.in/chapter/esr-nmr-and-mossbauer-spectroscopy/

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Apply the techniques of microwave and electronic spectroscopy to explain the structure of molecules.	K3
CO 2	Use the vibrational spectra for analyzing the different type of samples.	K4
CO 3	Apply the principle of Raman spectroscopy and its applications in the different field of science & Technology.	K5
CO 4	Discuss different resonance spectroscopic techniques and its applications in various fields.	K3
CO 5	Compile different spectroscopic problems and interpret its results	K6

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	1	3	3	1
CO 2	3	2	1	3	3	2
CO 3	3	1	2	3	3	1
CO 4	3	1	2	3	2	2
CO 5	3	3	2	3	2	1
AVERAGE	**3**	**1.8**	**1.6**	**3**	**2.6**	**1.4**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER II

CHARACTERIZATION TECHNIQUES

TOTAL HOURS: 60 **COURSE CODE:14SP21/2E2/CRT**
CREDITS: 3 **L-T- P: 2 2 0**

COURSE OBJECTIVES:

1. To introduce the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques
2. To apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials
3. To determine crystal structure of specimen and estimate its crystallitesize and stress
4. To apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.

COURSE OUTLINE:

UNIT I: Optical Microscopy

Optical microscope-Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination,Phase contrast, Polarised light, Hot stage, Interference techniques), Stereomicroscopy, Photo-microscopy,Colour metallography,Specimen preparation, Applications.

15Hrs

UNIT II: Electron Microscopy

Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy. **15Hrs**

UNIT III: DiffractionMethods

Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction. **15Hrs**

UNIT IV: Spectroscopic Techniques and SurfaceAnalysis

Atomic force microscopy, scanning tunneling microscopy, X-ray photo electron spectroscopy. **Spectroscopic Instrumentation Techniques:** Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy. **15Hrs**

UNIT V: Thermal Analysis

Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry. **15Hrs**

RECOMMENDED TEXTBOOKS:

1. Cullity,B.D.,and Stock,R.S.,Elements of X-Ray Diffraction, 4th Edition, Prentice-Hall, 2001.
2. Murphy,DouglasB,Fundamentals of Light Microscopy and Electronic Imaging, 2nd Edition Wiley-Liss,Inc. USA,2001.
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series),Volumes49 – 51,(2009).

REFERENCE BOOKS:

1. Li,Lin,Ashok Kumar Materials Characterization Techniques SamZhang; 3rd Edition, CRCPress, 2008.
2. Wendlandt,W.W.,Thermal Analysis, 5th reprint, John Wiley&Sons,1986.
3. Wachtman,J.B.,Kalman,Z.H.,Characterization of Materials, 7th reprint, Butterworth- Heinemann, 1993.

JOURNALS:

1. An International Journal on Materials Structure and Behavior.
2. npj Computational Materials
3. Nature Reviews Physics
4. Indian Journal of Pure and Applied Physics

E- LEARNING RESOURCES:

1. https://www.nanoscience.com/techniques/scanning-electron-microscopy/
2. https://microbenotes.com/scanning-electron-microscope-sem/
3. https://www.slideshare.net/RaihanathusSahdhiyya/atomic-force-microscopy-afm-principle- working-mode-applications
4. https://en.misis.ru/academics/masters-english/material-science/courses/spectroscopic/
5. https://www.mri.psu.edu/materials-characterization-lab/mcl-characterization-techniques
6. https://www.perkinelmer.com/CMSResources/Images/44-74542GDE_DSCBeginnersGuide.pdf

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO1	Explain the Basicprinciplesandcomponents of optical microscope	K4
CO2	Analyse electron microscopic characterisation techniques	K5
CO3	Can analyse the application of diffraction methods	K5

CO4	Discuss the spectroscopic techniques and surface analysis	K4
CO5	Explain thermo gravimetric analysis and Differential thermal analysis	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	3	1	1
CO 2	3	3	3	3	2	3
CO 3	3	3	2	2	3	2
CO 4	3	2	2	2	2	3
CO 5	3	2	1	2	3	2
AVERAGE	**3**	**2.6**	**2**	**2.4**	**2.2**	**2.2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 2, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total
K3	A- 5 x 8 Marks (either or type)	500	40	100
K4, K5	B- 3/5 x 20 Marks	1500	60	

SEMESTER II

MEDICAL TECHNOLOGY

TOTAL HOURS: 60 **COURSE CODE: 14SP21/2E/MTG**
CREDITS: 3 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

1. To introduce the fundamentals of various biosignals and devices for their acquisition.
2. To familiarize the students to the theory and instrumentation of EEG and ECG
3. To equip the students with basic principles of instrumentation used in clinical measurements.
4. Introduce the students to the physics behind imaging systems.
5. Teach the use of therapeutic techniques using Lasers in modern medical field.

COURSE OUTLINE:

Unit I: Bio potentials and Signal Acquisition

Cells and their structure – transport of ions through the cell membrane –resting and action potentials-bioelectric potentials in our body - Medical instruments- factors – components – fundamentals of electrodes and transducers – bioelectric amplifiers – desired properties – operational amplifiers – basic configurations (an overview). **12 Hrs**

Unit II: Potential Sources: Heart and Brain

Electrical signals from the heart- ECG - origin of cardiac action potential- placement of electrodes – lead configurations – electrical signals from the brain- EEG – origin – action potentials- evoked potentials- brain waves - placements of electrodes. **12 Hrs**

Unit III: Support Systems

Measurements of heart sounds – stethoscope – clinical temperature measurements – liquid crystal thermometer – mercury thermometer – measurement of BP - sphygmomanometer- patient care & monitoring - elements of intensive care monitoring – patient monitoring displays. **12 Hrs**

Unit IV: Imaging Systems

X- rays in medicine – CT scan- principle- mathematical basis – instrumentation- applications.

Ultrasound- principle - instrumentation- construction of an ultrasonic transducer- ultrasonic propagation through tissues- display – recording devices – applications- limitations. **12 Hrs**

Unit V: Therapeutic Techniques

Lasers in medicine – basic principles – instrumentation – advantages of laser surgery - radiation safety instrumentation – effects of radiation exposure – radiation monitoring instruments – introduction to diathermy-surgical diathermy.

12 Hrs

RECOMMENDED TEXTBOOKS:

1. M.Arumugam, Bio Medical Instrumentation, 2nd Edition, Anuradha Agencies, Kumbakonam, India, 1994.
2. Cromwell, Biomedical instrumentation and measurements, 2nd Edition, Prentice Hall, 1980.
3. John G.Webster, Bio Instrumentation, 1st Edition, John Wiley & sons, 2003.
4. Joseph J.Carr & John M.Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, 2004.

REFERENCE BOOKS:

1. Khandpur, A Handbook of Biomedical Instrumentation, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd., Elevier, 2003.
2. Jacobson & Webster, Clinical Engineering, 1st edition, Prentice Hall, 1977 .
3. Geddes & Baker, Applied Biomedical instrumentation, 3rd Edition, John wiley & Son – New York.
4. Guyton and Hall, Medical Physiology, 10th Edition, Elsevier, 2004.
5. Maqbool, Muhammad, An Introduction to medical Physics, 2nd Edition, Springer, 2017.

JOURNALS:

1. Journal of Medical Engineering and Technology
2. International Journal of Healthcare Technology and Management
3. Journal of Medical Society

E- LEARNING RESOURCES:

1. https://ieeexplore.ieee.org/document/7754368
2. https://www.emedicinehealth.com/electrocardiogram_ecg/article_em.htm
3. https://www.uptodate.com/contents/auscultation-of-heart-sounds
4. https://wp.optics.arizona.edu/optomech/wp-content/uploads/sites/53/2016/10/F2009-Tutorial.pdf
5. https://www.healthline.com/health/laser-therapy

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Explain the origin of biosignal and basic physical components of medical instruments.	K2
CO 2	Analyse the functions and principles of various biomedical equipments used in heart and brain diagnosis.	K5

CO 3	Discuss in detail clinical diagnosis and relevant therapeutic procedures with basic instruments.	K3
CO 4	Compare the different types of imaging system with its applications.	K4
CO 5	Discuss the Laser and its applications for diagnosis and Therapy.	K3

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**
CO 1	2	1	2	1	2	3
CO 2	1	1	2	1	2	3
CO 3	2	1	2	2	1	3
CO 4	1	2	2	1	2	3
CO 5	2	1	2	1	1	3
AVERAGE	**1.6**	**1.2**	**2**	**1.2**	**1.6**	**3**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III COURSE PROFILE – M.Sc.

Course Code	Course Title	Credits	Hrs/ Week	Total Hrs	L-T-P	CA Marks	End Sem. Marks	Total
14SP21/3C/QM2	Quantum Mechanics - II	4	5	75	3 2 0	40	60	100
14SP21/3C/SSP	Solid State Physics	4	5	75	3 2 0	40	60	100
14SP21/3C/MPC	Microprocessor 8085 and Microcontroller 8051	4	4	60	2 2 0	40	60	100
14SP21/3C/PR3	*Microprocessor 8085 & Microcontroller 8051 Experiments	4	6	90	0 3 3	40	60	100
14SP21/3E3/CMC (or)	Computational Methods and C Programming (or)	3	4	60	2 2 0	40	60	100
14SP21/3E3/MAT	Programming in MATLAB	3	4	60	2 2 0	40	60	100
14SP21/3E/PHO	Digital Photography	3	4	60	2 2 0	40	60	100
14SP21/3S/CPS	Soft Skill 3 - Computing Skills	2	2	30	1 0 1	-	50	50

TOTAL CREDITS 24

SEMESTER III

QUANTUM MECHANICS – II

TOTAL HOURS: 75 **COURSE CODE: 14SP21/3C/QM2**
CREDITS: 4 **L-T- P: 3 2 0**

COURSE OBJECTIVES:

1. Formal development of the theory and the properties of angular momenta.
2. To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Born approximation.
3. Develop the time-dependent Perturbation theory and discuss its application to study of interaction of an atom with the electromagnetic field
4. To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
5. To introduce the concept of covariance and the use of Feynman diagrams for depicting interacting fields.

COURSE OUTLINE:

Unit I: Angular Momentum

Spin angular momentum - non-relativistic Hamiltonian including spin - generalized angular momentum - eigenvalue spectrum for J^2 and J_z - matrix representation - addition of angular momenta - Clebsch - Gordan coefficients (problems) –identical particles and their properties- symmetry and anti-symmetry of wave functions – spin and Pauli matrices. **15 Hrs**

Unit II: Scattering Theory

Scattering cross sections- scattering amplitude – spinless particles – asymptotic solution -Born approximation and validity - partial wave analysis – phase shifts – optical theorem –connecting scattering angles and cross sections in lab and centre of mass frames. **15 Hrs**

Unit III: Perturbation Theory

Time dependent perturbation theory - constant and harmonic perturbations - transition probabilities – Fermi Golden rule - semi-classical treatment of an atom with electromagnetic radiation – Einstein's coefficients - selection rules for dipole radiation. **15 Hrs**

Unit IV: Relativistic Quantum Mechanics

Klein-Gordon equation – plane wave solutions – charge and current densities- Dirac equation – Dirac matrices -plane-wave solutions - interpretation of negative energy states - spin of electron - magnetic moment of an electron due to spin. **15 Hrs**

Unit V: Dirac Equation

Covariant notation - covariant form of Dirac equation -properties of the Gamma matrices - traces - invariance of Dirac equation under Lorentz transformations (forms of transformations not included) – probability density-current four vector – bilinear covariants -Feynman diagrams (elementary ideas only without propagation formalism). **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, New Delhi, 2009.
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968.
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Sathyaprakash, Advanced Quantum Mechanics, 5th Edition, Kedarnath & Ramnath, Meerut, 2004.
6. S.L Gupta and I.D Gupta, Advanced Quantum Theory and Fields, 1st Edition, S Chand & Co, New Delhi, 1982.
7. David J Griffiths, Introduction to Quantum Mechanics. 2nd Edition, Pearson, 2011
8. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017

REFERENCE BOOKS:

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition,Oxford University Press, London, 1973.
2. B.K.Agarwal & Hari Prakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt.Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics,1st edition, I.K.International Publishing house Pvt.Ltd., 2006.
4. A. 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. W.Greiner, Relativistic Quantum Mechanics, 3rd edition , Springer International, New Delhi,2000.
7. Amitabha Lahiri and Palash B.Pal, A First book of Quantum Field theory,2nd edition, Narosa Publishing house, New Delhi ,2000.

JOURNALS:

1. Reviews of Modern Physics
2. Physical Review A
3. Indian Journal of Pure and Applied Physics

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

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO1	Explain the concepts of angular momenta and spin, as well as the rules for their quantisation and addition.	K4
CO2	Analyse scattering cross section, optical theorem and low energy scattering	K5
CO3	Can analyse the application of time dependent approximation method to semi classical treatment of atom in an electromagnetic field	K5
CO4	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	K4
CO5	Explain the phenomena of covariance and the rules for depicting interacting fields using Feynman diagrams	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME**:**

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	3	1	1
CO 2	3	3	2	3	2	1
CO 3	3	3	2	2	2	1
CO 4	3	2	1	2	2	1
CO 5	3	2	1	2	2	1
AVERAGE	**3**	**2.6**	**1.6**	**2.4**	**1.8**	**1**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 2, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III

SOLID STATE PHYSICS

TOTAL HOURS: 90 **COURSE CODE : 14SP21/3C/SSP**
CREDITS: 4 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To refresh the fundamental physics behind simple crystal structures. To emphasize the importance of crystal symmetry that leads to substantial mathematical simplifications when dealing with solids.
2. To explore the electronic properties of crystalline solids and to analyze its properties based on the behavior of electrons.
3. To make use of various theoretical models to predict the characteristic nature of crystalline solids thereby using those materials effectively for the suitable applications.
4. Learn to classify different kinds of materials according to their properties and applications.
5. To explore the conducting mechanism of superconductors and to explain all its associated property changes with respect to other materials.

COURSE OUTLINE:

UNIT I: Crystal Physics

periodicity in crystalline solids – Wigner-Seitz primitive cell – Bravais lattices in 2D and 3D – symmetric operations – Miller indices of lattice planes (problems) – atomic packing fraction of SC, BCC and FCC – density and lattice constant (problems) – reciprocal lattice – brillouin zones – reciprocal lattice to SC, BCC and FCC lattices – crystal structures- NaCl, CsCl, hexagonal closed packed structure, diamond and ZnS – diffraction by crystals – Bragg's law (Problems). **15 Hrs**

UNIT II: Theory of Free Electrons

Classical free electron theory of metals: basic postulates – contribution of classical free electron theory – electrical conductivity and Ohm's law (problems) – thermal conductivity – Wiedemann-Franz law (problems) – drawbacks – quantum free electron theory: density of states – Fermi-Dirac distribution and filling of bands – outcome of the quantum free electron theory: heat capacity of the electron gas – electrical conductivity and Ohm's law – motion of electrons in combined electric and magnetic fields – hall effect (problems)– nearly free electron model – Brillouin zone – Bragg reflection of electrons in a crystal – Bragg's formula in terms of K(problems) – first Brillouin and convention of notation – origin of forbidden bands – standing wave at zone boundary – electron filling in metals, insulators and semiconductors. **15 Hrs**

UNIT III: Energy Band Theory

An overview of bands – Bloch theorem – one dimensional approach: the Kronig-Penny (K-P) model – reduced, periodic and extended zone schemes – number of electrons per band (problems) – the effective mass of an electron (problems) – distinction between metals, insulators and intrinsic semiconductors – concept of the

hole – limitations of K-P Model – many-electron problem – one electron approximation – Hartree method – Hartree-Fock method – density functional theory (DFT) an overview – Kohn-Hohenberg theorems – Kohn-Sham equations – limitations of band structure methods. **14 Hrs**

UNIT IV: Fermi Surfaces and Semiconductors

Introduction to Fermi surfaces - Harrison's method of constructing Fermi surfaces – extended zone scheme – periodic zone scheme

bands in solids – elemental and compound semiconductors – conduction in semiconductors – formation of holes – band structure of semiconductors – direct and indirect band gap semiconductors – nature of band gaps from absorption curves – concentration of charge carriers – intrinsic semiconductors – extrinsic semiconductors – intrinsic and extrinsic natures and doping concentration – mobility and conductivity in semiconductors – influence of temperature on mobility – recombination of electron-hole pairs – electrical conductivity in semiconductors. **15 Hrs**

UNIT V: Superconductivity

Experimental survey – occurrence of superconductivity – destruction of superconductivity by magnetic fields - Meissner effect – type i and ii superconductors – heat capacity – energy gap – isotope effect – thermodynamics of the superconducting transition – London equation – coherence length – BCS theory of superconductivity – BCS ground state – flux quantization in a superconducting ring – single particle tunnelling - Josephson superconductor tunnelling - Ac and Dc Josephson effect. **16 Hrs**

RECOMMENDED TEXTBOOKS:

1. Charles Kittel, Introduction to Solid State Physics, 8th edition, John Willey & sons, Inc., New York, 2012
2. Rita John, Solid State Physics, 1st Edition, McGraw Hill Education (India) private Limited, New Delhi 2014.
3. M A Wahab, Solid State Physics, 2nd Edition, Narosa publishing House, New Delhi, 2009.

REFERENCE BOOKS:

1. A.J.Dekker, Solid State physics, 1st Edition, Macmillan India Ltd., New Delhi, 2000.
2. Ashcroft & Mermin, Solid State Physics, 1st Edition, Rhivehart & Winton, New York 2005.
3. R.Asokamani, Solid State Physics:Principles and Applications,1st Edition, Anshan Ltd;
4. M. Ali.Omar, Elementary Solid State Physics Principles and Application, 1st Edition, Pearson education, Addison – Wesley 2001.
4. V.Raghavan, Materials Science and Engineering, 3rd Edition, Prentice Hall India, New Delhi 2001.
5. S.O. Pillai, Solid State Physics, 7th Edition, New Age International, New Delhi, 2015.

JOURNALS:

1. Physics of the Solid State
2. Indian Journal of Physics

E-LEARNING RESOURCES:

1. http://xrayweb.chem.ou.edu/notes/symmetry.html
2. http://www.sjsu.edu/faculty/watkins/brillouin.htm
3. https://www.globalspec.com/learnmore/materials_chemicals_adhesives/electrical_optical_specialty_materials/superconductors_superconducting_materials
4. http://www-rjn.physics.ox.ac.uk/lectures/metalsnotes10.pdf
5. https://encyclopedia2.thefreedictionary.com/free-electron+theory+of+metals

COURSE OUTCOME:

CO NO.	CO STATEMENT	Knowledge Level
CO 1	Develops the proficiency on the basic concepts that are used to describe the structure and physical properties of crystalline substances. Able to analyze different types of matter depending on nature of chemical bonds and their properties. Should be able to analyze the crystal structures by applying crystallographic parameters.	K3
CO 2	Able to evaluate and analyze the electrical properties of solids. Realizing the importance of conceptual understanding of electron transport and energy related systems and thus applying it to study the properties of crystalline structures.	K3
CO 3	Able to differentiate between metals, insulators and semiconductors through the study of energy band theory. Gets acquainted to various approximation techniques and theoretical models to analyze and interpret the behavior of electrons in semiconductor devices.	K4
CO 4	Able to construct the Fermi surface for SC, BCC and FCC crystalline structure and also learn to analyze the band structures of direct and indirect band gap semiconductors. Understands the basic elements of solid state electronics: Intrinsic and impurity doped semiconductors.	K4 & K5
CO 5	Invokes objective knowledge on superconductors and to analyze the properties of superconducting materials	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME**:**

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	2	3
CO 2	3	3	3	3	3	3
CO 3	3	2	3	3	3	2
CO 4	3	3	3	3	3	2

CO 5	3	2	3	3	3	3
AVERAGE	**3**	**2.6**	**3**	**3**	**2.8**	**2.6**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 2, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	One of the choices in one question of Section A may be a problem. Problems to be given from topics specified in course outline
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III

MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

TOTAL HOURS: 60 **COURSE CODE: 14SP21/3C/MPC**
CREDITS: 4 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

- To provide an entry point to learn about microprocessor and controllers
- To became familiar with the architecture and the instruction set of an Intel 8085 microprocessor.
- To familiarize the students with interface a microprocessor to external input/output devices
- To provide the mach components and working principles of the Intel 8051 microcontroller
- To design and implement programs on 8085 Microprocessor and 8051 Microcontroller
- To expose the students to aware the applications of microprocessor and microcontroller

COURSE OUTLINE:

Unit I: Microprocessor 8085

Organization of 8085 Microprocessor – Register Structure – Architecture – Pin Configuration – Addressing Modes – Instruction Set – Interrupts. **12 Hrs**

Unit II: Interfacing Devices

Programmable Peripheral Interface 8255 – Programmable Interval Timer 8253/54 – 8251Serial Communication Interface – 8279 Programmable Keyboard/Display Interface. **12 Hrs**

Unit III: Microcontroller 8051

Organization of 8051 Microcontroller – Register Structure – Architecture – Program Memory – Data Memory – Special Function Register – Input/Output Pins – Ports and Circuits – Counters and Timers – Interrupts – Addressing Modes – Instruction Set. **12 Hrs**

Unit IV: Programming

Assembly Language Program in 8085 – Addition, Subtraction, Multiplication and Division of 16-Bit Data – Interfacing Stepper Motor – Interfacing Key Board – Ascending and Descending Order – Evaluation of Simple Expressions.

Delay – Routines – Calculation of Time Delay.

Assembly Language Program in 8051 – Addition, Subtraction, Multiplication and Division of 8-Bit Data – Smallest and Largest Number – Interfacing DAC and ADC – Pattern Comparison. **12 Hrs**

Unit V: Applications

Digital to Analog Interface – Analog to Digital Interface – Stepper Motor Interface – Speech Synthesizer – Temperature Measurement and Controller – Frequency Measurement and Pulse Width Calculation – Hex Key Board Interface. **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. R.S.Gaonkar, Microprocessor Architecture Programming and Application with the 8085, 5th Edition, Penram International Publishing, Mumbai, 1999.
2. Kenneth J.Ayala, The 8051 Microcontroller – Architecture, Programming and Applications, 3rd Edition, Penram International Publishing (India) Pvt. Ltd. 1996.
3. Douglas V. Hall, Microprocessors and Interfacing – Programming and Hardware, 2nd Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
4. V.Vijayendran, Fundamentals of Microprocessor 8085 , Architecture, Programming and Interfacing, 2nd Edition, Viswanathan Pvt. Ltd., Chennai, 2004.

REFERENCE BOOKS:

1. I. Scott MacKenzie, The 8051 microcontroller, 4th Edition, illustrated, Pearson Prentice Hall, 2007, Digitized 19 Aug 2009.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Janice G. Mazidi, The 8051 Microcontroller: A Systems Approach, Pearson Education, 2012.
3. Aditya P.Mathur, Introduction to Microprocessor, 3rd Edition, Tata McGrawHill Pub.Co., Ltd., New Delhi.
4. B.Ram, Fundamentals of Microprocessors and Microcomputers, 4th revised and Enlarged edition, Dhanpat Rai Publications, New Delhi, 2005.
5. A.Nagoor Kani, Microprocessor and its applications, 1st Edition, RBA Pub., Chennai.

JOURNALS:

1. Microprocessors and Microsystems
2. Journal of Microprocessor Engineering
3. International journal of computer networks and communications

E-LEARNING RESOURCES:

1. https://www.javatpoint.com/microprocessor-introduction
2. https://www.tutorialspoint.com/microprocessor/microprocessor_overview
3. https://gradeup.co/8085-microprocessor-i-98c6e670-c040-11e5-90e9-37a8af81db5e
4. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_pin_description.htm
5. https://www.elprocus.com/8051-microcontroller-architecture-and-applications/

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Able to explain the construction and organization of Microprocessor 8085	K2
CO 2	Invokes objective knowledge on various peripheral devices to interface with 8085 Microprocessor	K4
CO 3	Able to explain the construction and organization of Microcontroller 8051	K3
CO 4	Able to prepare and compile programs to perform mathematical operations using interfacing peripheral devices in 8085 and 8051	K4
CO 5	Develops the proficiency on the interfacing devices for various applications	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	3	3	2	2
CO 2	3	3	3	3	3	3
CO 3	3	3	2	3	2	2
CO 4	3	3	3	3	3	3
CO 5	3	3	3	3	3	3
AVERAGE	**3**	**2.8**	**2.8**	**3**	**2.6**	**2.6**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III

MICROPROCESSOR 8085 & MICROCONTROLLER 8051 EXPERIMENTS

TOTAL HOURS: 90 **COURSE CODE**: **14SP21/3C/PR3**
CREDITS: 4 **L-T-P: 0 3 3**

COURSE OBJECTIVES:

1. To provide practical hands on experience with Assembly Language Programming
2. To familiarize the students with interfacing of various peripheral devices with 8085 microprocessor.
3. To develop the quality of assessing and analyzing the obtained data
4. To prepare the students to be able to solve different problems by developing different programs using 8051 microcontroller.
5. To study the Binary to BCD conversion using assembly language programming and perform it using microprocessor trainer kit & 8085 simulator.

COURSE OUTLINE:

Any Fifteen Experiments to be done

Microprocessor 8085 experiments

1. Addition, Subtraction, Multiplication – 16-bit
2. Code Conversions:
   a) Binary to BCD & BCD to Binary – 16-bit
   b) Binary to ASCII & ASCII to Binary
   c) BCD to ASCII & ASCII to BCD
3. Clock Program
4. LED Interface - Single LED ON-OFF – Binary Counter, BCD Counter, Ring Counter And Johnson Counter (8-bit)
5. DAC 0800 Interface and Waveform Generation
6. ADC 0809 Interface
7. Hex Keyboard Interface
8. Stepper Motor Interface
9. 8253/54 Timer Interface
10. Interfacing Traffic Controller

Microcontroller 8051 experiments

11. Addition, Subtraction, Multiplication and Division 8 - bit
12. Pattern Comparison
13. Interfacing Stepper Motor
14. Smallest and Largest of an Array
15. Ascending and Descending Order of n Elements.
16. Hex Keyboard Interface
17. ADC 0809 Interface
18. DAC 0800 Interface and Waveform Generation
19. Interfacing Traffic Controller
20. Elevator

COURSE OUTCOMES:

CO NO.	CO STATEMENT	Knowledge Level
CO 1	Able to develop the simple assembly language programs using microprocessor 8085. To demonstrate the assembly language programming for delays & subroutines.	K3
CO 2	Demonstrate the programming & interfacing of 8255 Programmable Peripheral Interface. 9. To demonstrate the interfacing of 8279 Display and keyboard controller.	K4
CO 3	Examine the Working of hardware interrupts and be able to distinguish between inbuilt interrupts and hardware interrupts.	K5
CO 4	Able to perform the various applications of 8085 microprocessor and 8051 microcontroller.	K5
CO 5	Program 8051 microcontroller for various internal organization uses. To Interface peripheral devices with 8051 microcontroller for instrumentation applications	K4 & K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	2	3
CO 2	3	3	3	3	3	3
CO 3	3	2	3	3	3	3
CO 4	3	3	3	3	3	3
CO 5	3	2	3	3	3	3
AVERAGE	**3**	**2.6**	**3**	**3**	**2.8**	**3**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

SEMESTER III

COMPUTATIONAL METHODS AND C PROGRAMMING

TOTAL HOURS: 60 **COURSE CODE: 14SP21/3E3/CMC**
CREDITS: 3 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

1. To acquaint the student with basic concepts in numerical methods like finding the roots of nonlinear algebraic and simultaneous equations
2. Teaches the student to deduce approximate polynomials to represent data using interpolation and curve fitting.
3. To introduce the methods of numerical differentiation and integration
4. To teach the syntax and semantics of the C language as well as data types offered by the language
5. Development of programming skills using loop operations, arrays and functions

COURSE OUTLINE:

Unit I: Solutions for Transcendental and Simultaneous Equations

Roots of transcendental equations–Bisection method, Newton-Raphson method, Iteration method, Regula–Falsi method

Solution of simultaneous linear equations – Gauss Elimination – Gauss Seidal – matrix inversion – eigen values and eigen vectors - Power and Jacobi methods.

12 Hrs

Unit II: Interpolation and Curve Fitting

Interpolation with equally and unequally spaced points – Newton's forward and backward interpolation – Lagrange interpolation – curve fitting – least square fitting – nonlinear curve fitting –power function – exponential function - polynomial fitting.

12 Hrs

Unit III: Differentiation, Integration and Solution of Differential Equations

Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rules – Error estimates – Numerical solutions of ordinary differential equations – Euler's method - Runge Kutta second and fourth order. **12 Hrs**

Unit IV: Fundamental Concepts of C Programming

Basic structure of C program – character set – C tokens – keywords and identifiers - constants – variables - data types – declarations – assigning values to variables – operators – types of operators – arithmetic expressions and their evaluation – precedence of arithmetic operators – type conversions – formatted inputs and outputs.

12 Hrs

Unit V: Loops, Arrays and Functions

Decision making and branching: types of IF statements – Switch statement – GOTO statement – Decision making and looping: WHILE, DO and FOR statements – jump in loops.

Arrays – one, two and multi-dimensional arrays – character arrays – declaring and initializing – string handling functions.

User defined functions – definition – return values and their types – function calls and declaration – nesting of functions – recursion. **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. M.K Jain, SRK Iyenkar, R.K.Jain, Numerical methods for scientific and engineeringcomputation, 5th Edition, New Age International Pvt Ltd., New Delhi, 2007.
2. S.S.Sastry, Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall of India (P) Ltd., New Delhi.
3. Dr.A.Singaravelu,Numerical methods, New revised edition Dec 2007
4. Dr.P.Kandasamy, Dr.K.Thilagavathy,Dr.K.Gunavathy, Numericalmethods, New revised edition Dec 2008 (Reprint 2009).
5. E.Balaguruswami, Programming in ANSI C, 4th Edition,Tata McGraw-Hill Pub. Com Ltd., New Delhi, 2008.
6. Yashvant Kanetkar, Let us C, 8th Edition, BPB Pub., New Delhi, 2007.

REFERENCE BOOKS:

1. Francis scheid, Numerical Analysis, 2nd Edition, Tata Mc Graw Hill Publishing company Ltd., New Delhi.
2. Schaum's Outlines, Numerical analysis, 2nd Edition, Tata McGraw Hill Pub.Co., Ltd., New Delhi-15, 2004
3. Radhey. S Gupta, Elements of Numerical Analysis, 1st Edition, Macmillan India Ltd., New Delhi, 2009.
4. T. Veerarajan and T. Ramachandran, Numerical Methods with Programs in C, 2nd Edition, Tata Mc Graw Hill Education Pvt. Ltd., New Delhi, 2006.
5. Ashok N. Kamthana, Programming with ANSI and TURBO C, 1st Edition, Dorling Kindersley India Pvt. Ltd., New Delhi, 2006.

JOURNALS:

1. Journal of Computational Physics
2. Journal of Physics A: Mathematical and Theoretical
3. Journal of Computational Methods in Sciences and Engineering

E- LEARNING RESORUCES:

1. https://www.math.ust.hk/~machas/numerical-methods.pdf
2. http://nitkkr.ac.in/docs/15%20Solutions%20of%20Algebric%20and%20Transcendental%20Equations.pdf
3. https://www.svce.ac.in/departments/maths/CITM/MA6465-MARINE%20II%20YR/unit%20V %20Mr.pdf
4. http://www.vssut.ac.in/lecture_notes/lecture1424354156.pdf
5. http://www-personal.acfr.usyd.edu.au/tbailey/ctext/ctext.pdf

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Solve large systems of linear, transcendental and simultaneous equations numerically	K3
CO 2	Analyse data by constructing appropriate polynomials using methods like interpolation and principles of Least Squares	K4
CO 3	Numerically evaluate differentiation and integration of functions	K4
CO 4	Apply the basics of C programming language to write programs for simple computing problems	K3
CO 5	Construct C programs using decision making statements, arrays, functions and other features of C language in real life applications	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	3	2	1
CO 2	3	3	3	3	2	1
CO 3	3	3	3	3	2	1
CO 4	3	3	1	3	1	1
CO 5	3	3	1	3	1	1
AVERAGE	**3.0**	**3.0**	**2.2**	**3**	**1.6**	**1.0**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III

Programming in MATLAB

TOTAL HOURS:60 **COURSE CODE: 14SP21/3E3/MAT**
CREDITS: 3 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

1. To enable programming using conditional statements and loops.
2. To provide a knowledge on user defined functions and function files
3. To acquaint calculations with polynomials, curve fitting and interpolation.
4. To use MATLAB in numerical analysis.
5. To describe in great detail how to use MATLAB in symbolic operations.

COURSE OUTLINE:

Unit 1 – Statements and Loops

Introduction to MATLAB – Relation and logical operators – conditional statement – if-end structure – if-else-end structure – if-else-if-else-end structure – switch – case statement – loops-for-end loops-while-end loops – nested loops and nested conditional statements – the break and continue commands – examples of MATLAB applications. **12 Hrs**

Unit 2 – User defined functions and function files

Function files – structure and creation – local and global variables – saving a function file – user-defined function – Anonymous and inline functions – function functions – sub functions – nested functions. **12 Hrs**

Unit 3 – Polynomials, curve fitting and Interpolation

Polynomials – values – roots – addition – multiplication – division – derivatives – curve fitting – polynomials – other than polynomials – interpolation – Basic fitting interface. **12 Hrs**

Unit 4 – Numerical Analysis

Solving an equation with one variable – finding a minimum or a maximum of a function -m Numerical integration – ordinary differential equations – problems. **12 Hrs**

Unit 5 – Symbolic Math

Symbolic objects and expression – changing the form of an existing symbolic expression – solving algebraic equation – differentiation – integration – solving an ordinary differential equation – plotting symbolic expressions – numerical calculations with symbolic expressions – problems. **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. Amos Gilat,. MATLAB – An introduction with applications, 4th edition-John Wiley & sons, Inc, 2011.
2. Biran R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A guide to MATLAB for beginners and experienced users, illustrated reprint, Cambridge University press, 2001.
3. Peter Issa Kattan, MATLAB for Beginners: A Gentle Approach, 1st edition, Createspace Independent Pub, 2008.
4. Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, 5th edition, BH publication, Elsevier, 2018.

REFERENCE BOOKS:

1. Delores M. Etter, Introduction to MATLAB, 2nd edition, Pearson Education Inc. 2011.
2. Timothy A. Davis, MATLAB Primer, 8th edition, CRC Press, Taylor & Francis Group, 2011.
3. Cleve Moler and Peter J. Costa, MATLAB Symbolic Math Tool Box, User's Guide, Version 2.0, 1997.
4. Duane C. Hanselman, Bruce Littlefield, Mastering MATLAB 7, 1st edition, Pearson/Prentice Hall, 2005.
5. Andrew Knight, Basics of MATLAB and Beyond, 1st edition, CRC Press, Taylor & Francis Group, 2019.
6. William J. Palm III, Introduction to MATLAB for engineers, 3rd edition, The McGraw-Hill companies, 2010.

JOURNALS:

1. International Journal of scientific research
2. Journal of Physics: IOP science
3. Pramana-Journal of Physics

E- LEARNING RESORUCES:

1. https://www.mathworks.com/support/learn-with-matlab-tutorials.html
2. https://www.tutorialspoint.com/matlab/index.htm
3. http://engineering.nyu.edu/mechatronics/vkapila/matlabtutor.html
4. https://matlabacademy.mathworks.com/
5. https://www.javatpoint.com/matlab

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Construct commands using statements and loops	K3
CO 2	Discuss different types of functions and the related files	K3
CO 3	Evaluate polynomials, interpolation and fits different curve types	K4

CO 4	Solve equations of different types and evaluate integration	K4
CO 5	Compute the numerical calculations with symbolic expressions	K4

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	2	1	1
CO 2	3	3	3	2	1	1
CO 3	3	3	3	2	1	1
CO 4	3	3	3	2	1	1
CO 5	3	3	3	2	1	1
AVERAGE	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**1.0**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total
K3	A- 5 x 8 Marks (either or type)	500	40	100
K4, K5	B- 3/5 x 20 Marks	1500	60	

SEMESTER III

DIGITAL PHOTOGRAPHY

TOTAL HOURS: 60 **COURSE CODE: 14SP21/3E/PHO**
CREDITS: 3 **L-T-P: 2 2 0**

COURSE OBJECTIVES:

1. To introduce the basic principles of light, lenses and their types, nature of the image formed by them.
2. To appreciate the "Photographer's Art" by studying historic and contemporary trends in photography.
3. To learn to capture images with digital cameras maximizing the quality of the output from them.
4. To develop and practice skills in digital photography tools and the internet including different file formats, downloading and emailing.
5. To familiarize the post processing procedures including digital editing, saving, sizing, and posting of images.

COURSE OUTLINE:

UNIT I: Basic Principles of Light

Electromagnetic theory - Wavelength – Visible spectrum – Inverse Square Law– Changes when light meets a surface - Transmission – Reflection – Refraction- Pinhole camera –practical limitations to pin hole images –Simple positive lens – focal length and image size- Compound lenses- focal length. **12 Hrs**

UNIT II: The Camera and its types

Light Sensitive Films and Sensors – Digital Camera – Types of Cameras – Beginner's Cameras – Advanced Compacts - Single Lens Reflex (SLR) Cameras – Manual SLR's - Automatic SLR's - Accessories. **12 Hrs**

UNIT III: Creative use of camera controls

Aperture - Effective and Relative aperture - F numbers – Circles of Confusion - Depth of field– Depth of focus– practical significance – Shutters –selection of shutter speeds and subject movements – Filters –Performance - types of filters – Correction –Contrast-Special. **12 Hrs**

UNIT IV: Digital camera

Digital image capture – The megapixel debate – Screen output- Grain and noise – Optical and digital zoom – Image stabilizer – White balance – Transferring picture from camera to computer– file types –TIFF(tagged image file format) – RAW – JPEG (joint photographic experts group)- The digital archive – Downloading . **12 Hrs**

UNIT V: Digital Image - Post Production Editing

Program structure – Navigating the program interface- navigating within an image-– Basic image editing – undo/redo/history – crop, rotate, level horizon-dodge/burn –brightness/contrast – color adjustments (color balance) – hue/saturation – cloning /retouching – image size-red eye reduction – Saving digital file –file formats – Printing. **12 Hrs**

RECOMMENDED TEXTBOOKS:

1. Michel J.Langford &Philip Andrews, Starting photography, 6th Edition, Focal press, London,2009
2. Michel J.Langford , Anna Fox & Richard Sawdon Smith, Basic photography, 8th Edition, Focal press, London, 2007
3. Michael J. Langford, Basic Photogrphy, 14th impression, Focal Press, London, 1978.

REFERENCE BOOKS:

1. Henry Carroll, Read this if you want to take great photographs of people, illustrated reprint, Laurence King Publishing, 2015.
2. Mark Galer, Digital Photography in Available Light essential skills, 3rd edition, Focal press, London,2006
3. Paul Harcourt Davies, The Photographer's practical handbook, 1st edition, UK,2005.
4. Deke McClellannd & Katrin Eismann, Real World Digital Photography, 1st Edition, Peachpit press, California, 1999.
5. Ben Long, Complete Photography, 5th edition, Course Technology, 2009

JOURNALS:

1. Visual Communication
2. British Journal of Photography
3. Pramana- Journal of Physics

E-LEARNING RESOURCES:

1. https://www.creativelive.com/photography-guides/post-processing
2. https://iopscience.iop.org/chapter/978-0-7503-1242-4/bk978-0-7503-1242-4ch1.pdf
3. https://www.explainthatstuff.com/digitalcameras.html
4. https://physicsworld.com/a/painting-with-light/
5. https://in.pcmag.com/photo-editing-from-p/52404/the-best-photo-editing-software

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Demonstrate the importance of light in photography	K2, K3
CO 2	Create an habit of looking closely at the visible world around and build up confidence in camera handling with different camera types	K3,K4
CO 3	Demonstrate the essential skills required to become a professional photographer	K4
CO 4	Outline the fundamental technical aspects of photographing with a digital camera.	K2
CO 5	Utilize the unique and unlimited power of post processing of a digital image and unleash their creative potential.	K3, K4

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	1	1	1	3
CO 2	3	1	2	1	1	3
CO 3	3	3	3	1	1	3
CO 4	3	3	3	1	1	2
CO 5	3	3	3	1	1	2
AVERAGE	**3**	**2.2**	**2**	**1**	**1**	**2.6**

KEY: STRONGLY CORELATED-3, MODERATELY CORELATED-2, WEAKLY CORELATED-1, NO CORELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER III

SOFT SKILLS 3 – COMPUTING SKILLS

TOTAL HOURS: 30 **COURSE CODE: PG21/3S/CPS**
CREDITS: 2 **LTP : 0 1 1**

Course Outline:

Unit – 1

Windows Basics – Introduction – Control Panel – Managing multiple windows – Windows Explorer – Restore items – Managing Files and Folders – Network Neighborhood. **10 hrs**

Unit – 2

Introduction to word – Editing a document - Finding and Replacing Text - Inserting Symbols - Changing Dictionaries – Using Thesaurus - Enhancing document – Columns, Tables and Other features. **10 hrs**

Unit – 3

Introduction to worksheet– Editing cell & using Commands and functions – Formatting a Work Sheet - Printing work sheet.- Creating charts – Naming ranges and using statistical, math and financial functions– Additional formatting commands and drawing toolbar – multiple worksheet and macros. **10 hrs**

RECOMMENDED TEXTBOOK:

1. PC Software for Windows 98' made simple – R.K.Taxali – Tata McGraw Hill Publishers, 2005.

REFERENCE BOOKS:

1. Sanjay Saxena : A First Course in Computers, Vikas Publishing House Pvt. Ltd., New Delhi, 1999.

SEMESTER IV COURSE PROFILE – M.Sc.

Course Code	Course Title	Credits	Hrs/ Week	Total Hours	L-T-P	CA Marks	End Sem. Marks	Total
14SP21/4C/NPP	Nuclear and Particle Physics	4	6	90	3 3 0	40	60	100
14SP21/4C/PRO	Project & Viva voce	4	6	90	0 3 3	40	60	100
14SP21/4C/PR4	Computational Methods & C Programming Experiments	4	6	90	0 3 3	40	60	100
14SP21/4E4/NST (or)	NanoScience and Technology (or)	3	5	75	3 2 0	40	60	100
14SP21/4E4/TFT	Crystal Growth and Thin Film Technology	3	5	75	3 2 0	40	60	100
14SP21/4E5/XRC (or)	X- Ray Crystallography (or)	3	5	75	3 2 0	40	60	100
14SP21/4E5/BPY	Bio Physics	3	5	75	3 2 0	40	60	100
PG21/3S/SPS	Soft Skill 4 – Spoken and Presentation Skills	2	2	30	1 1 0	-	50	50

TOTAL CREDITS 20

SEMESTER IV

NUCLEAR AND PARTICLE PHYSICS

TOTAL HOURS: 90 **COURSE CODE: 14SP21/4C/NPP**
CREDITS: 4 **L-T-P: 3 3 0**

COURSE OBJECTIVE:

1. To enable students to explore the interior of nucleus and interaction between nucleons.
2. To make the students aware of the great number of nuclear reactions which are possible provide, a wealth of experimental data for the theory of nuclear structure.
3. To study the properties of the β and γ particles and hence the structure and properties of atomic nuclei were studied
4. To understand the physical system – the model, the properties of which are known and they in turn are analogous to the properties of nucleus
5. Students also familiarise with fundamental particles of nature and how these particles are interacting with each other and matter

COURSE OUTLINE:

Unit I: Two Body Problem and Nuclear Forces

Theory of Ground state of Deuteron – Problems – Nucleon – nucleon interactions – Partial wave analysis – Low energy n-p scattering – Effective range Theory – Spin dependence of nuclear forces – Low energy p-p Scattering – Tensor forces – Meson theory of nuclear forces – Yukawa potential – Charge independence of nuclear forces – Isobaric analogue states **18 Hrs**

Unit II: **Nuclear Stability and Nuclear Models**

Nuclear stability – Liquid drop model – Magic numbers – Nuclear shell model – Spin and Parity of nuclei - Nuclear magnetic moments – Nuclear quadrupole moments – Short comings of shell model – Collective model of Bohr and Mottelson - Schmidt limits **18 Hrs**

Unit III: Nuclear Reactions

Energetic of nuclear Reaction – Q-value equation – Problems - Nuclear Reaction cross-section and partial wave analysis – Problems – Black nucleus – Compound nucleus – Energy levels of compound nucleus and resonance – Resonance scattering – Breit-Wigner one level formulae – Direct reactions - Types of direct reactions **18 Hrs**

Unit IV: Nuclear Decay

Introduction to alpha decay - Beta decay – Disintegration energies – Continuous beta ray spectra – Consequences – Fermi theory of beta decay – Kurie plot – Angular momentum and Selection rules in beta decay processes – Energy levels and decay schemes – Non conservation of parity in beta decay – Neutrino hypothesis – Gamma

Emission – Multi-pole Transition - Selection rules – Internal conversion – Nuclear isomers – Problems **18 Hrs**

Unit V: Elementary Particle Physics

Types of interaction between elementary particles – Classification of elementary particles – Conservation laws – Invariance principles and Symmetries – Properties of elementary particles – Massless Bosons – Leptons – Mesons – CP violation in neutral K-meson decay – Baryons – Hyperons – Eight fold way – SU(2) and SU(3) multiplets – Gell-Mann-Okubo Mass Formula – Quarks and its types - Elementary concepts of weak interaction **18 Hrs**

RECOMMENDED TEXTBOOKS:

1. K.S.Krane, Introductory Nuclear Physics, 4th Edition, Wiley, NY, 1987.
2. D.C. Tayal, Nuclear Physics, 5th Revised & Enlarged Edition, Himalaya Publishing House, New Delhi, 2008.
3. R.C. Sharma, Nuclear Physics, 6th Revised & Enlarged Edition, K. Nath & Co. Meerut, 2007.

REFERENCE BOOKS:

1. R.R.Roy and B.P.Nigam, Nuclear Physics, Ist US Edition, New Age International, 1967.
2. S. N. Ghoshal, Nuclear Physics, 1st Edition (Reprint 2013), S.Chand & Co. Ltd., New Delhi. 1994
3. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989.
4. D. Griffiths, Introduction to Elementary Particles, 2nd Edition, Harper and Row, NY 1987.
5. M.L. Pandya, R.P.S. Yadav, Elements of Nuclear Physics, 7th Edition, Reprint 2010, Kedarnath Ramnath, Meerut, Delhi.1995.

JOURNALS:

1. Journal of Nuclear Materials
2. Journal of High Energy Physics
3. Journal of Nuclear Physics, Material Sciences, Radiation and applications
4. Indian Journal of Physics

E-LEARNING RESOURCES:

1. http://www.umich.edu/~ners311/CourseLibrary/bookchapter17.pdf
2. https://ocw.mit.edu/courses/nuclear-engineering/22-02-introduction-to-applied-nuclear-physics-spring-2012/lecture-notes/MIT22_02S12_lec_ch7.pdf
3. http://web.mst.edu/~sparlin/Phys107/Lecture/chap11.pdf
4. https://indico.cern.ch/event/447008/contributions/1953687/attachments/1184942/1717323/ParticlePhysicsFOR_TEACHERS.pdf

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Able to discuss forces, interactions and potentials between nucleons from the results of various scattering processes.	K5
CO 2	Able to demonstrate various predicted nuclear models to describe the properties of the atomic nuclei.	K4,K5
CO 3	Able to explain different nuclear reactions and formulate their laws and equations	K4
CO 4	Invokes objective knowledge on various decay processes (α,β,γ) and selection rules of nuclear reactions.	K3
CO 5	Invokes objective knowledge on the fundamentals of elementary particles and utilize the concept of group theory to generate ways of representation of particles.	K4

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	2	2	3	2	3	2
CO 2	2	3	2	3	2	2
CO 3	3	3	3	3	3	2
CO 4	3	2	3	3	3	2
CO 5	3	3	3	3	3	3
AVERAGE	**2.6**	**2.6**	**2.8**	**2.8**	**2.8**	**2.2**

KEY: STRONGLY CORELATED-3, MODERATELY CORELATED-2, WEAKLY CORELATED-1, NO CORELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER - IV

PROJECT & VIVA VOCE

TOTAL HOURS: 90 **COURSE CODE: 14SP21/4C/PRO**
CREDITS: 4 **L-T-P: 0 3 3**

COURSE OBJECTIVES:

1. To train the student to acquire knowledge through reviewing of literature in the area of research interest.
2. To give a practical understanding of research problems, planning and implementing various methodologies to solve them.
3. Familiarize the student to the various synthesis methods, characterization techniques and software programs.
4. Guiding the students to collect and graphically represent data using necessary software. Analyze the results and tackle the issues identified.
5. Enriching the project work towards research presentations and journal publications thereby, contributing towards the scientific growth of the country.

SEMESTER IV

COMPUTATIONAL METHODS AND C PROGRAMMING EXPERIMENTS

TOTAL HOURS: 90 **COURSE CODE: 14SP21/4C/PR4**
CREDITS: 4 **L-T-P: 0 3 3**

COURSE OBJECTIVE:

1. To teach the students to write programs in C for simple numerical problems
2. To understand and trace the execution of programs written in C
3. To make the student fluent with the use of input output routines
4. To familiarize the student to basic loops operations and decision making statements
5. To acquaint the student to implementing programs using arrays and functions.

COURSE OUTLINE:

Any sixteen experiments to be done

1. Summation of series Sin(x), Exp(x), Cos(x) and comparison with built in functions.
2. Sum of the first ten terms of the Fibonacci series
3. Bisection method with Algorithm, Flow chart, C PROGRAM, and output.
4. Addition , subtraction and multiplication of two matrices.
5. Generation of Legendre Polynomial (n=2,3) ,Roots by Newton Raphson Method.
6. Generation of Chebyshev Polynomial (n=2,3) ,Roots by Newton Raphson Method
7. Newton forward interpolation with Algorithm, Flow chart, C PROGRAM and output.
8. Newton backward interpolation with Algorithm, Flow chart, C PROGRAM and output.
9. Numerical integration by the trapezoidal rule, with Algorithm, Flow chart, C PROGRAM, and output.
10. Numerical integration by the Simpson rule, with Algorithm, Flow chart, C PROGRAM, and output.
11. Determination of Trace & Determinant of a matrix
12. Determination of Transpose and inverse of a square matrix.
13. Curve-fitting: Least-squares fitting with Algorithm, Flow chart, C PROGRAM, and output.
14. Generation of Laguerre Polynomial (n=2,3) ,Roots by Newton Raphson Method.
15. Generation of Hermite Polynomial (n=2,3) ,Roots by Newton Raphson Method
16. Lagrange interpolation with Algorithm, Flow chart, C PROGRAM, and output
17. Numerical solution of ordinary first-order differential equations by the Euler method, with Algorithm, Flow chart, C PROGRAM, and output.
18. Numerical solution of ordinary first-order differential equations by the Runge-kutta method, with Algorithm, Flow chart, C PROGRAM, and output
19. Gauss Elimination method, Flowchart, Algorithm, C program and output.
20. Gauss Jacobi's iteration method, Flowchart, Algorithm, C program and output.

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Execute , debug, and document programs in C	K5
CO 2	Apply input and output routines	K3
CO 3	Evaluate numerical problems with programs using loops and decision making statements	K5
CO 4	Evaluate numerical problems using C programming data structures like arrays	K5
CO 5	Demonstrate proficiency in implementing programs using functions	K3, K4

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME**:**

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	3	2	1	2
CO 2	3	3	2	2	1	1
CO 3	3	3	3	2	1	1
CO 4	3	3	3	2	1	1
CO 5	3	3	3	2	1	1
AVERAGE	**3**	**3**	**2.8**	**2**	**1**	**1.2**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

SEMESTER IV

NANO SCIENCE AND TECHNOLOGY

TOTAL HOURS: 75 **COURSE CODE: 14SP21/4E4/NST**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To familiarize the students with basics of Nanoscience.
2. To impart the knowledge of size dependent properties at nanolevel.
3. Well established and novel synthesis methods of nanostructures will be discussed giving a broad overview of the state of art nano manufacturing process.
4. Standard characterization methods will be elucidated using various examples and exercise throughout the course.
5. Current and future applications of nanostructured materials will be reviewed with respect to their impact on commercial products and technologies.

COURSE OUTLINE:

Unit I: Introduction to Nanoscience

Basics of Nanoscience – Idea of Band Structure – Density of States: Zero dimensional - One Dimensional - Two Dimensional & Three dimensional – Quantum Confinement – quantum well – wire - dot. **15 Hrs**

Unit II: Properties of Nanomaterials

Mechanical-Thermal- Electrical – Optical – Structural Properties - Factors affecting Particle size – Size dependent properties – Determination Particle Size – Increase in width of XRD peaks of nanoparticles. **15 Hrs**

Unit III: Methods of Synthesis

Physical Method – Solid state reaction – High energy Ball milling – Sputtering – MBE – Laser ablation – Chemical Method – Sol-gel method – Hydrothermal method – CVD – Biological Method- Green Synthesis. **15 Hrs**

Unit IV: General Characterization Techniques

X- Ray Diffraction studies – Bragg's law – Particle size – Scherrer's equation - UV – Vis- NIR – Spectroscopy – Determination of Band gap - Photoluminescence (PL) studies –SEM, AFM, VSM – Principle- Instrumentation- Application. **15 Hrs**

Unit V: Application of Nanomaterials.

Introduction to Nanoelectronics – Quantum electronic devices – Nanostructure as single electron transistor - Energy – Solar cells – OLED, OFET- Medical Applications – Imaging of Cancer cells – Biological tags – targeted nano drug delivery system – Carbon Nanotubes – Field emission – Fuel cells and Display devices. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay, A.N. Banerjees, Fifth edition, PHI Learning Private edition, 2012.
2. Nano Materials, B. Viswanathan, second edition, Narosa Publishing house, 2011.
3. Structure and Properties of solid state materials, B. Viswanathan, 2nd edition , Alpha science international, 2006.
4. Nano – the essentials, T. Pradeep, New edition, Tata McGraw – Hill publishing company, 2007.
5. Nanotechnolgy : Principles and Practicals, S. K. Kulkarni, New edition, Capital Publishing co., 2014

REFERENCES BOOKS:

1. Vladimir V. Mitin, V.A. Kochelap, M.A.Stroscio, Introduction to Nanoelectronics, 2nd Edition , Cambridge University press, 2011.
2. Sujaul Chowdhury, Nanosructure Physics an Microelectronics, 2nd Edition, Narosa Publishing house, New delhi, 2015
3. H. Nejo, Nanostructures – Fabrication and Analysis, 1st Edition , Springer International, Berlin. 2007
4. Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd Edition, Wiley, VCH, GMBH& Co, 2006.
5. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, 3rd Edition, Springer, 2015.

JOURNALS:

1. ACS Nano
2. Nano Materials Science
3. Bulletin of materials science

E- LEARNING RESOURCES:

1. https://www.oreilly.com/library/view/engineering-physics/9788131775073/xhtml/ch13-sub13.1.xhtml
2. https://www.news-medical.net/life-sciences/Properties-of-Nanoparticles.aspx
3. https://www.ttu.ee/public/m/Mehaanikateaduskond/Instituudid/Materjalitehnika_instituut/MTX9100/Lecture11_Synthesis.pdf
4. https://www.nanoscience.com/techniques/scanning-electron-microscopy/
5. https://www.understandingnano.com/nanomaterials.html

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Outline the basic science of materials at the nanometre scale.	K2

CO 2	Utilize the the properties of nano materials to identify their e 0D, 1D and 2D nature.	K2
CO 3	Revise the synthesis of nanomaterials and the impact of nanomaterials on environment.	K2,K3
CO 4	Explain the principles of characterization of nanomaterials and nanostructures.	K3, K4
CO 5	Assess and Design the preparation strategies of nanomaterials suited for various industries.	K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	1	3	2	2
CO 2	2	1	2	3	3	2
CO 3	3	1	2	2	3	3
CO 4	2	2	1	2	3	2
CO 5	2	3	2	2	3	3
AVERAGE	**2.4**	**1.6**	**1.6**	**2.4**	**2.8**	**2.4**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER IV

CRYSTAL GROWTH AND THIN FILM TECHNOLOGY

TOTAL HOURS: 75 **COURSE CODE: 14SP21/4E4/TFT**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

- To provide basic knowledge on vacuum technology, nucleation and growth mechanisms and various methods used in the deposition of thin films.
- The course covers the understanding of theories involves in crystal growth nucleation process and solution, melt and vapour growth techniques and Characterization tools.

COURSE OUTLINE:

Unit 1: Vacuum technology

Fundamentals of vacuum, basic definition and pressure regions of vacuum, kinetic theory of gases mean free path, types of flow, conductance, vacuum pumps and systems, rotary mechanical pump, roots pump, diffusion pump, turbo molecular pump, sputter ion pump, measurement of vacuum, concept of different gauges, capacitance gauges, Pirani gauge, ionization gauge and penning gauge, vacuum system components and operation. **15 Hrs**

Unit II :Thin film deposition techniques

Preparation of Thin Films: Thermal evaporation, e-beam deposition, Cathode Sputtering, DC sputtering, Magentron sputtering, Chemical vapor Deposition, Laser Ablation, Molecular Beam epitaxy, electro-plating, sol-gel method (Spin and Dip coatings), Langmur-Blochet Films **15 Hrs**

Unit III: Crystal Growth phenomena

The historical development of crystal growth – significance of single crystals - the chemical physics of crystal growth Crystal growth: Phase equilibria and Crystallization Techniques, phase diagrams and solubility curves, Kinetics of Nucleation, Rate equation, Heterogeneous and secondary nucleation, Crystal surfaces, growth mechanisms, mass transport, crystal morphology,, influence of supersaturation, temperature, solvents, impurities; Polymorphism – phase transition and kinetics.

15 Hrs

Unit IV: Crystal Growth Technology

Silicon, Compound semiconductors, CdTe, CdZnTe, Czochralski technique, Bridgman technique, Float zone Process, Liquid Phase expitaxy, Molecular Beam epitaxy. Growth of Oxide & Halide crystals- Techniques and applications. **15 Hrs**

Unit 5: Characterization methods of thin films

X-Ray Diffraction (XRD) – Powder and single crystal – UV-Visible spectrometer – Photoluminescence - TG-DTA /DSC - Vickers Micro hardness - scanning electron microscopy (SEM), Field emission scanning electron microscopy (FESEM), energy dispersive analysis (EDS), Auger electron spectroscopy, X-ray photoelectron spectroscopy, Rutherford backscattering spectroscopy, secondary ion mass spectrometry.

15 Hrs

RECOMMENDED TEXTBOOKS:

1. Govindhan Dhanaraj, Kullaiah Byrappa, Vishwanath Prasad, Michael Dudley (Eds.), Hand book of Crystal Growth, Springer, Heidelberg Dordrecht London New York, 2010.
2. J. C. Brice, Crystal Growth Processes, 2nd Edition John Wiley and Sons, New York, 1986.
3. P. Santhana Ragavan and P. Ramasamy, Crystal Growth Processes and Methods New Edition, KRU Publications, Kumbakonam, 2001.
4. M. Ohring, Materials Science of Thin Films: Deposition and Structure, 2nd Ed., Academic press, 2002.
5. Kaufmann, Characterization of Materials, 2nd Ed., Wiley, 2003.
6. N. Yoshimura, Vacuum Technology: Practice for Scientific Instruments, 4th Edition, Springer, 2014

REFERENCE BOOKS:

1. S. Campbell, The Science and Engineering of Microelectronic Fabrication, 2nd Ed., Oxford University press, 2009
2. Introduction to Crystal Growth Principles and Practice H.L. Bhat, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015.
3. Sam Zhang, Lin Ki, Ashok Kumar, Materials Characterization Techniques, New edition, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009.
4. K.L.Chopra, Thin Film Phenomena, 1st edition, Robert E.Krieger Publishing Company, 1979.

JOURNALS:

1. Crystal Growth and Design
2. Journal of Crystal Growth
3. Crystal Engineering and Communicaiton
4. Thin Solid Films

E- LEARNING RESOURCES:

1. https://pubs.rsc.org/en/content/chapterhtml/2020/bk9781788012140-00001?isbn=978-1-78801-214-0

2. https://www.acadpubl.eu/hub/2018-119-12/articles/2/489.pdf
3. https://www.sciencedirect.com/science/article/abs/pii/S0038092X18311642

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Outline the basic science of materials at the three dimension and two dimension scale.	K2
CO 2	Understanding of Structural, surface morphology, stress/strain, crystalline quality, chemical composition, chemical states of thin films.	K2
CO 3	Revise the synthesis of Crystals and Thin solid films by different methods.	K2,K3
CO 4	Explain the principles of characterization of materials and Analysis the properties of the materials	K3, K4
CO 5	Assess and Design the preparation strategies of materials suited for various industries.	K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	1	3	2	2
CO 2	2	1	2	3	3	2
CO 3	3	1	2	2	3	3
CO 4	2	2	1	2	3	2
CO 5	2	3	2	2	3	3
AVERAGE	**2.4**	**1.6**	**1.6**	**2.4**	**2.8**	**2.4**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED
WEAKLY CORRELATED -1, NO CORRELATION - 0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)

Flipped learning/ Blended class room – E-content, Videos

Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER IV

X- RAY CRYSTALLOGRAPHY

TOTAL HOURS: 75 **COURSE CODE: 14SP21/4E5/XRC**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To present basic ideas on the geometries and symmetries of crystals
2. Introduce the student to fundamental concepts and methods of diffraction
3. To familiarise the student to the phase problem its solutions and plotting of electron density map
4. To acquaint the student with the data collection and correction processes for determination of structure factor amplitudes
5. To elucidate the methodology of refinement, structural and conformational analysis

COURSE OUTLINE:

UNIT I: Symmetry in Crystals

Crystal- one dimensional lattice – plane lattice – space lattice- primitive cell- points in lattice- crystal systems –representation of directions - crystallographic axes -Miller indices - symmetry operations- proper rotations – reflections -inversions- screw rotations – glides - Point Groups- Space Groups - equivalent positions **15 Hrs**

UNIT II: Diffraction of X-rays

Reciprocal lattice – role and construction - diffraction and fourier transforms - production of X-rays –Laue equations – Bragg's law - Laue diffraction – Powder diffraction – principle - Debye Scherrer method- interpretation of powder photographs - applications - atomic scattering factor – structure factor –Friedel's law – systematic absences. **15 Hrs**

UNIT III: Crystal Structure Determination

Phase problem in crystallography- significance of centrosymmetry -methods of solving phase problem – Patterson methods – Isomorphous replacement method- Anomalous dispersion method –unitary and normalized structure factors - Direct methods procedure- electron density map. **15 Hrs**

UNIT IV: Data collection techniques

Four Circle Diffractometer - CCD Detector –Image Plates – data reduction: extinction, Lorentz –polarization and absorption corrections- determination of thermal & scale factors – Wilson's plot. **15 Hrs**

Unit V: Crystal Structure Refinement & Analysis

Structure Refinement – Successive Fourier Synthesis – Least squares refinement - residual factor - locating hydrogen atoms- structural analysis- bond lengths – bond angles – torsion angles – conformational analysis – conformation of rings – Vander Waal's Interactions – hydrogen bonds –crystal packing. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. Dennis Sherwood & Jon Cooper, Crystal, X-ray and Proteins, 1st Edition, Oxford University press, London, 2011
2. D. Velmurugan, Elementary Crystallography, 1st Edition, MJP Publishers, Chennai, 2008
3. Stout and Jensen, X-ray Structure Determination, 2nd Edition, John Wiley Publications.
4. Ladd and Palmer , Structure Determination by X-ray Crystallography, 2nd Edition, Plenum Press, London
5. M.A.Wahab, Essentials of Crystallography, 1st Edition, Narosa publishing house,2009.
6. A. R. Verma; O. N. Srivastava, Crystallography Applied to Solid State Physics. New Age International (1991).

REFERENCE BOOKS:

1. C.Giacovazzo, H.L.Monaco, D.Viterbo, F.Scordari, G.Gill, G.Zanotti and M.Catti , Fundamentals of Crystallography ,2nd Edition, Oxford Press,1992.
2. M.M.Woolfson, Introduction to X-ray Crystallography, 1st Edition, Cambridge University Press Publications
3. Leonid V. Azaroff, Elements of X-ray crystallography, 1st Edition McGraw Hill Publications
4. Glusker, Lewis and Rossi , Crystal Structure analysis for Chemist and Biologist, 1st Edition, Wiley - VCH Publishers Inc. 7.

JOURNALS:

1. Acta Crystallographica Section C & E
2. Journal of Applied Crystallography
3. Resonance- Journal of Science Education
4. Indian Journal of Engineering and Materials Sciences

E- LEARNING RESOURCES:

1. http://folk.uio.no/ravi/cutn/scm/symmetry_and_crystallography /Compendium_ H_Fjellvag Crystallography.pdf
2. http://www.nato-us.org/analysis2000/papers/hauptman.pdf
3. https://journals.iucr.org/d/issues/2003/11/00/ba5050/
4. https://application.wiley-vch.de/books/sample/3527310525_c01.pdf

5. http://www.chem.ucalgary.ca/courses/351/Carey5th/Ch03/ch3-0-1.html

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Elucidate concepts such as lattice, point and space groups	K3
CO 2	Demonstrate a clear understanding of the theoretical concepts of X-ray diffraction and the different diffraction methods	K4
CO 3	Interpret the Phase problem and various methods of its solution. Evaluate and assign structures to X-ray diffraction patterns.	K4, K5
CO 4	Discuss the instrumentation and hardware used in X-ray diffraction, the processes of collection and reduction of raw single crystal diffraction data	K5
CO 5	Explain the methods of refinement of crystal data and interpret structural and conformational details from the obtained structure	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME**:**

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	1	3	2	1
CO 2	3	1	2	3	2	1
CO 3	3	2	2	3	2	1
CO 4	3	1	2	3	2	1
CO 5	3	2	2	3	2	1
AVERAGE	**3**	**1.6**	**1.8**	**3**	**2**	**1**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

TEACHING METHODOLOGY:

Lecture (Chalk and talk / OHP / LCD)
Flipped learning/ Blended class room - E-content, Videos
Problem solving, Group Discussion, Peer learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER IV

BIOPHYSICS

TOTAL HOURS: 75 **COURSE CODE: 14SP21/4E5/BPY**
CREDITS: 3 **L-T-P: 3 2 0**

COURSE OBJECTIVES:

1. To acquaint the student to the fundamental energy pathways and intermolecular forces in biological systems
2. To impart an in depth understanding of structures of biomolecules and the central dogma of molecular biology
3. To educate the student on the biological mechanisms of sensing and monitoring external and internal stimuli and transmittance of information
4. To explain the nature of enzymatic activity and structure and dynamics of bio membranes
5. To familiarise the student with the separation and physicochemical techniques used to analyse biomolecular structures

COURSE OUTLINE:

Unit I: Bioenergetics and Intermolecular Forces

Free energy - Gibbs free energy – Chemical potential – Photosynthesis- Photosystems I & II- Photophosphorylation and carbon fixation – Energy conversion pathways – Oxidation – glycolysis - Krebs cycle – respiratory chain.
Intermolecular forces - Strong forces – weak forces – Vander Waals forces – hydrogen bonds – hydrophobic and hydrophilic forces **15 Hrs**

Unit II: Physics of Biomolecules

Structural organisation of proteins -amino acids and primary structure – peptide bond and secondary structure - Ramachandran map – supersecondary and domain structures -quaternary structure.
Structural organisation of Nucleic acids- Nucleotides - pentose sugar -nitrogenous base – phosphate group – conformational possibilities of monomers – double helical structure of DNA- structure of RNA- genetic code – replication of DNA – requirements and mechanism- transcription –translation.
Carbohydrates- structure and classification – glycoside linkage - polysaccharides- starch, cellulose and chitin- glycoproteins **15 Hrs**

Unit III: Neurobiophysics

Anatomy of neuron – physicochemical nature of membrane potential – resting potential – nerve excitation –depolarization-the generating potential - the action potential – conduction mechanism of action potential -synaptic transmission - sensory mechanisms – The eye – visual receptor- electrical activity and visual generator

potentials – neural aspects of vision – bioluminescence –physical aspects of hearing – The ear –theories of hearing **15 Hrs**

Unit IV: Enzyme and Membrane Biophysics

Enzymes – structure -enzyme activity - features of active site- mechanisms of enzyme action- - Michaelis-Menten equation-enzyme inhibition - competitive and noncompetitive inhibitors.

Structure of cell membrane-membrane asymmetry - membrane transport –passive transport - Fick's law of diffusion – facilitated diffusion – active transport. **15 Hrs**

Unit V: Physicochemical techniques in Biophysics

Sedimentation –Ultra centrifuge- Separation techniques – Chromatography – Principles of Thin Layer, Ion Exchange, HPLC and Affinity chromatography- Electrophoresis–principle and types - Gel electrophoresis and SDS-PAGE

Spectroscopy - Fluorescence spectroscopy -– Nuclear Magnetic Resonance –basic principles - NMR parameters – applications in biophysics

Optical and diffraction methods – Circular dichroism – X-ray Crystallography- X-ray diffraction – data collection – structure solution and refinement (qualitative treatment) – least square method. **15 Hrs**

RECOMMENDED TEXTBOOKS:

1. VasanthaPattabhi & N. Gautham, Biophysics, 2nd edition, Narosa Publishing House, New Delhi, 2009
2. Claycomb& Jonathan Quoc P.Tran, Introductory Biophysics , 1st edition , James, Jones and Bartlett Publishers , New Delhi, 2011.
3. M.A. Subramanian, Biophysics Principles and Techniques, MJP Publishers, Chennai, 2016.
4. P.K.Srivastava, Elementary Biophysics, 2nd edition , Narosa Publishing House, New Delhi
5. T. DevasenaBiomoleculesMJP Publishers , Chennai,2019

REFERENCE BOOKS:

1. Stryer.LBiochemistry,W.H. Freeman and Co., Newyork,1997
2. Pranab Kumar Banargy, Introduction of Biophysics,S Chand and Co.,2010
3. John G. Webster, Bioinstrumentation,Wiley & Sons, New Delhi,2010
4. Jay Nadeau,Introduction to Experimental Biophysics,CRC Press, USA,2012
5. W.Hoppe, Lohmann,H.Markl& H., Ziegler, Biophysics,Springer – Verlag,1983
6. P. Narayanan, Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi,2000.

JOURNALS

1. Biophysical Reviews and letters (International)
2. Progress in Biophysics and Molecular Biology(International)
3. Biochimica et Biophysica Acta (International)
4. Annual Review of Biophysics (International)
5. Indian Journal Of Biochemistry and Biophysics (National)

E- LEARNING RESOURCES

1. https://canvas.ucsc.edu/courses/1077/pages/useful-links
2. https://www.youtube.com/watch?v=CQhxWCPC00k
3. http://www.snn.ru.nl/~bertk/biofysica/handouts.pdf
4. http://www.physics.drexel.edu/~brigita/COURSES/BIOPHYS_2011-2012/
5. https://users.wfu.edu/~shapiro/Biophysics14/

COURSE OUTCOMES

CO No.	CO Statement	Knowledge Level
CO 1	Discuss the crucial energy pathways and molecular forces in biomolecular systems	K4
CO 2	Demonstrates a clear understanding of structure of the biomolecules and the genetic information transfer mechanism	K4
CO 3	Deliberates the physics behind sensory mechanisms and propagation of nerve impulses	K3
CO 4	Discuss the role of membranes in regulation of transport of substances and the catalytic mechanism of enzymes	K4, K5
CO 5	Acquires knowledge on the working principles and instrumentation of various bio-analytical instruments	K3, K4

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	1	2	2	3
CO 2	3	1	3	2	3	2
CO 3	3	2	2	1	3	1
CO 4	3	1	1	1	3	3

CO 5	3	1	3	2	3	1
AVERAGE	**3**	**1.4**	**2**	**1.6**	**2.8**	**2**

KEY: SRONGLY CORELATED – 3 MODERATELY CORELATED – 2 WEAKLY CORELATED – 1 NO CORELATION – 0

Teaching Methodology

Lecture by chalk and talk, Flipped learning, e-content, problem solving, group discussion, assignment, quiz, peer learning, seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word limit	Marks	Total	Special instructions if any
K3	A- 5 x 8 Marks (either or type)	500	40	100	-
K4, K5	B- 3/5 x 20 Marks	1500	60		

SEMESTER IV

SOFT SKILLS 4 – SPOKEN AND PRESENTATION SKILLS

TOTAL HOURS: 30 **COURSE CODE: PG21/4S/SPS**
CREDITS: 2 **L T P: 1 1 0**

Objectives:

- Illustrate role of skills in real-life work situations with case studies, role play, etc.
- enable students to perceive cultural codes involved in presentation and design language performance accordingly

Course Outline:

Unit – I:

Communication Skills for effective Presentation - Reading Skills Formal and Informal Conversations - Introducing, Opening and closing speeches - Inviting, thanking, Apologizing, Expressing anger Resolving conflict - Giving and taking information.

UNIT II:

Social Communication Skills for Presentation – socializing – ice breakers; small talk – dialogue, debate, discussion – overcoming shyness, hesitation – understanding cultural codes.

UNIT III:

Professional Communication Skills for Presentation – technical presentations – presentation by over head projector – board and chalk method – power point presentation. Etiquettes for presentations –Individual presentation.

RECOMMENDED TEXTBOOKS:

1. Lucas, Stephen, Art of Public Speaking, 10th edition, Mc-Graw Hill, 2001.
2. Pillai, Radhakrishnan, Spoken English for you, 8th edition, Emerald Publishers, 2006.
3. Peter Francis, Soft Skills and Professional Communication, 2nd edition, Tata McGraw Hill, 2012.
4. Howard E. Gardner, Multiple Intelligences: The Theory in Practice: A Reader, Basic Book, 1993.
5. De Bono, Edward, Six Thinking Hats, 2nd Edition, Penguin Books, 2000.

SELF STUDY COURSES PROFILE – M.Sc.

SEMESTER III

S.No.	Course Title	Credits
1	Energy Physics	2
2	An introduction to LATEX and MATHEMATICA	2
3	CARBON NANOSTRUCTURES	2
4	Astro Physics	2

SEMESTER III

ENERGY PHYSICS

CREDITS: 2

COURSE OBJECTIVES:

1. To explore the practical usage of solar energy in various forms and other alternative energy sources.
2. To comprehend the energy and energy types.
3. To analyse the use and effectiveness of one renewable source of energy
4. To understand the benefits and drawbacks of using alternate energy sources.

COURSE OUTLINE:

UNIT I: Conventional Energy Sources

Energy sources and their availability – Various forms of energy – Renewable and conventional energy systems–Comparison– Principles of energy conversion, conversion between different forms of energy. Coal, oil and natural gas.

UNIT II: Solar Energy

Solar Energy-Thermal application and solar radiation –Solar cell characteristics, efficiency and spectral response of solar cells – Energy alternatives–Thermal applications – Water heating – Space heating–Power generation–Instruments for measuring solar radiation and sunshine.

UNIT III: Thermal Energy Storage

General characteristics - Definitions - Methods of classifications - Thermal energy storage - Solar Radiation Collectors - Conversion of solar radiation into heat. Liquid flat plate collectors - Sensible heat storage - Liquids - Solids – Latent heat storage - Thermal chemical storage.

UNIT IV: Photo Conversion

Photovoltaic conversion – Principle and working of solar cells–Conversion efficiency – Single crystal and Polycrystalline silicon - Cadmium sulphide - Cadmium telluride.

UNIT V: Other Forms of Energy

Wind energy - Recent developments – Hydel energy - Energy from waves and tides – Thermal energy – Energy from biomass – Bio diesel – Physical and chemical properties of Bio diesel.

RECOMMENDED TEXTBOOKS:

1. P.Sukhatme, Solarenergy 2nd Edition,TataMcGraw-Hill,2008.
2. D.P.Kothari, K.C.Singaland Rakesh Ranjan, Renewable energy sources and emerging Technologies, 2nd Edition, Prentice Hall of India, 2008.
3. S.A.Abbasiand Nasema Abbasi, Renewable Energy sources and their Environmental Impact, 1st Edition, PHIL earning Pvt.Ltd., 2008.
4. G.D.Rai, Solar Energy Utilisation, 5th Edition, Khanna Publishers, 2008.

REFERENCE BOOKS:

1. J.A.Duffie and W.ABeckman,Solar Engineering of Thermal Process, 2nd Edition, JohnWiley and sons, 2007.
2. Bent Sorensen, Renewable Energy, 5th Edition, Academic Press, 2013.
3. Alan Fahrenbruch and Richard Bube, Fundamentals of Solar Cells: Photovoltaic Solar Energy Conversion, 3rd Edition, Academic Press, 2012.

JOURNALS:

1. Journal of High Energy Physics
2. Advances in High Energy Physics
3. Modern Physics Letters A

E- LEARNING RESOURCES:

1. https://www.energy.gov/eere/solar/solar-energy-technologies-office
2. https://www.energy.gov/eere/wind/wind-energy-technologies-office
3.https://www.dummies.com/home-garden/green-living/energy-sources/how-do-photovoltaic-cells-convert-sunlight-into-electricity/
4. https://news.energysage.com/most-common-solar-energy-uses/
5. https://www.conserve-energy-future.com/solarenergy.php
6.https://vikaspedia.in/energy/energy-production/wind-energy/types-of-wind-energy-conversion-devices

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO1	Explain the concepts and principle of conventional energy sources.	K4
CO2	Understand the Solar cell characteristics and its efficiency.	K5
CO3	Explore different types of solar cells and its storage principle.	K5
CO4	Discuss the different conversion techniques.	K4
CO5	Explain the other forms of energy available energy resources.	K4, K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	3	2	1
CO 2	3	3	2	3	2	1
CO 3	3	3	2	2	3	2
CO 4	3	2	1	3	2	1
CO 5	3	2	3	2	3	2
AVERAGE	**3**	**2.6**	**2**	**2.6**	**2.4**	**1.4**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0

SEMESTER III

An introduction to LATEX and MATHEMATICA

CREDITS: 2

COURSE OBJECTIVES:

1. To specialize the students in LaTeX programming to help them write their thesis and other documents in more professional way
2. To use the tricks to make the document elegant.
3. To apprise the fundamentals of Mathematica
4. To introduce the methods to define functions and plot graphics
5. To impart the knowledge of programming to solve the algebraic equations

COURSE OUTLINE:

Unit 1: Working with LATEX

Introduction – installation- basic operations-creating a document-navigation and editing-viewing and printing-basic formatting-document classes-paragraph environments-part, section, subsection, sub subsection, enumerate-itemize-quotation, quote-list- character styles-clever formatting-tables and boxes-footnotes-changing fonts-columns-nesting lists-special formatting.

Unit 2: LATEX Tricks

Inserting equations-aligning equations-inserting figures-positioning floats on the page-inserting text files-creating tables-printing a LYX document- inserting tables-figures-equations-tables and figures-adding an index -Publishing to PDF- page format-Margins-front matter, sections, back matter-subsection-table of contents-list of nomenclature-list of figures-references

Unit 3: Working with Mathematica

Launching Mathematica - The Basic Technique for Using Mathematica -Opening Saved Notebooks - Adding Text to Notebooks - Printing - Creating Slide Shows - Creating Web Pages - Converting a Notebook to Another Format - Mathematica's Kernel - Tips for Working Effectively - Getting Help from Mathematica - Loading Packages - Troubleshooting

Unit 4:Functions and Their Graphs

Defining a Function - Plotting a Function - Using Mathematica's Plot Options - Investigating Functions with Manipulate - Producing a Table of Values - Working with Piecewise Defined Functions - Plotting Implicitly Defined Functions - Combining Graphics - Enhancing Your Graphics - Working with Data - Managing Data - An Introduction to Lists - Importing Data - Working with Difference Equations

Unit 5: Algebra

Factoring and Expanding Polynomials - Finding Roots of Polynomials with Solve and NSolve - Solving Equations and Inequalities with Reduce - Understanding Complex Output - Working with Rational Functions - Working with Other Expressions - Solving General Equations - Solving Difference Equations - Solving Systems of Equations

RECOMMENDED TEXT BOOKS:

1. David F. Griffiths, Desmond J. Higham, Learning LaTeX, 2nd edition, Society for Industrial and Applied Mathematics, 2016.
2. Wolfram Mathematics tutorial collection, Mathematics and Algorithms, Wolfram Research Inc, 2008.

REFERENCE BOOKS:

1. Bruce F. Torrence, Eve A Torrence, The student's introduction to Mathematica, A handbook for precalculus, calculus and linear algebra, 2nd edition, Cambridge University Press, 2009.
2. Chetan Shirore, A Beginners Guide to LaTeX, Learn LaTeX in easy tutorials
3. Helmut Kopka and Patrick W. Daly, A guide to LaTeX document preparation for beginners and advanced users, 2nd edition, Addison-Wesley, 1995.
4. Paul R. Wellin, An introduction to programming with Mathematica, 4th edition Cambridge, 2013.
5. Stephen Wolfram, The Mathematica book, 5th edition, wolfram media Inc, 2003.

JOURNALS:

1. The Mathematica Journal
2. Historia Mathematica
3. Pramana-Journal of Physics

E- LEARNING RESOURCES:

1. https://www.latex-project.org/
2. https://www.tug.org/begin.html
3. https://www.wolfram.com/mathematica/
4. https://www.wolfram.com/
5. https://www.wolframcloud.com/

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Discuss the fundamentals to work with LaTeX	K2
CO 2	Compute the technique for working with equations, figures	K3,K4

	and tables	
CO 3	Discuss the fundamentals of Mathematica	K3
CO 4	Analyze the functions and explore their plots	K4
CO 5	Compute the algebra for solving equations	K5

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	2	3	3	1	1	1
CO 2	2	3	3	1	1	1
CO 3	2	3	3	1	1	1
CO 4	2	3	3	1	1	1
CO 5	2	3	3	1	1	1
AVERAGE	**2**	**3**	**3**	**1**	**1**	**1**

KEY: STRONGLY CORELATED-3, MODERATELY CORELATED-2, WEAKLY CORELATED-1, NO CORELATION -0

SEMESTER III

CARBON NANOSTRUCTURES

CREDIT: 2

COURSE OBJECTIVES:

1. To acquire knowledge of Carbon nanotube (CNT) and its Applications
2. To provide an indepth knowledge of Graphene and its Functionalization
3. To enable the students to learn Carbon Nanomaterials for Environment and Biology
4. Able to demonstate the effectiveness of Nanomaterials for Photovoltaic Solar Energy Conversion Systems
5. To be able to develop a energy storage systems using nanomaterials

COURSE OUTLINE:

Unit I :Carbon nanotube (CNT) and its Applications

Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT and Fullerenes.

Unit II: Graphene and its Functionalization

Graphene, structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide.

Unit III : Carbon Nanomaterials for Environment and Biology

Carbon nano-adsorbents, Carbon Based Nanomaterials and its Environmental Effects, Biological aspects of Carbon Nanostructures, Fullerene and its derivatives.

UNIT IV: Nanomaterials for Photovoltaic Solar Energy Conversion Systems

Principles of photovoltaic energy conversion (PV), Types of photovoltics Cells, Physics of Photovoltaic cells, Organic photovoltaic cell cells, thin film Dye Sensitized Solar Cells, Quntum dot (QD) Sensitized Solar Cells (QD-SSC), Organic- Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, Current status and future trends.

UNIT V: Nanomaterials for Energy Storage Systems

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium ion Batteries), Cathode and anode materials, Capacitor Electrochemical supercapacitors, electrical double layer model, Principles and materials design, Nanostructured Carbon based materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

RECOMMENDED TEXTBOOKS:

1. Charles P Poole & Frank J. Ownes, Introduction to Nanotechnology. 1st edition,

Wiley, 2003
2. R Satio,Physical properties of Carbon Nanotube, New edition, Imperial College Press, London, 1998
3. S. Subramony & S.V. Rotkins (Eds),Applied Physics Of Carbon Nanotubes : Fundamentals Of Theory, Optics And Transport Devices, Springer, 2005
4. Michael J. O'Connell, Carbon Nanotubes: Properties and Applications, New edition, Taylor and Francis, 2006.
5. CNR Rao and A Govindaraj,Nanotubes and Nanowire, New edition, RCS Publishing. 2005

REFERENCE BOOKS:

1. James E. Morris, Krzysztof Iniewski (Eds),Graphene, Carbon Nanotubes, and Nanostructures Techniques and Applications, CRC Press, 2013.
2. Zhao, Jijun, Liu, Lizhao, Li, Fen, (Eds)Graphene Oxide: Physics and Applications, Springer, 2015.
3. J. Larmine and A, Dicks, Fuel Cell System, John Wiley, New York, 2000.
4. A. Manthiram, Kulwer , Science and Technology of Lithium Batteries-Materials Aspects: An Overview,1st edition, Academic Publisher, 2000.
5. M. Wakihara, O. Yamamoto (Eds.), Lithium Ion Batteries: Fundamentals and Performance, Wiley –VCH, Weinheim, 1996.

JOURNALS

1. Carbon
2. Carbon letters
3. Crystal Engineering and Communication

E- LEARNING RESOURCES:

1. https://www.sciencedirect.com/science/article/pii/S1026309812002477
2. https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/abs/10.1002/elan.200804340
3. https://www.sciencedirect.com/science/article/abs/pii/S0925400506004527

COURSE OUTCOMES:

CO No.	CO STATEMENT	Knowledge Level
CO 1	Outline the basic science of carbon nanotube materials and their properties.	K2
CO 2	Synthesis of graphene and grapheneoxide with their properties	K2
CO 3	Application of the carbon Nanomaterials to various fields.	K3,K4

CO 4	Explain the principles of photovoltatics and different types of solarcells	K3, K4
CO 5	Assess and Design the preparation strategies of Energy systems using Nanomaterials suited for various industries.	K5

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	1	3	2	2
CO 2	2	1	2	3	3	2
CO 3	3	1	2	2	3	3
CO 4	2	2	1	2	3	2
CO 5	2	3	2	2	3	3
AVERAGE	**2.4**	**1.6**	**1.6**	**2.4**	**2.8**	**2.4**

KEY: STRONGLY CORRELATED – 3; MODERATELY CORRELATED

WEAKLY CORRELATED -1, NO CORRELATION - 0

SEMESTER III

ASTROPHYSICS

CREDITS: 2

COURSE OBJECTIVES:

1. To acquaint the student with basic concepts of celestial co-ordinates magnitudes and stellar classifications

2. To develop a clear understanding of the physical features and activities in the sun

3. To provide a deeper understanding of the stellar structure and its evolution process

4. To develop a basic understanding of the structure and content of Milky Way galaxy and features of external galaxies

5. To introduce the basic concepts of Cosmology and models of the Universe

COURSE OUTLINE:

Unit I: Stellar Magnitudes and Classifications

Apparent and absolute magnitude and distance modulus – color index of stars - stellar parallax- celestial co-ordinates - equatorial, ecliptic and galactic systems of co-ordinates - Classification of stars – Saha's equation of thermal ionization- H-D classification - Hertzsprung-Russel (H-R) diagrams- Empirical mass- luminosity relation.

Unit II: The Sun

Physical characteristics – photosphere - chromosphere - corona of the sun- solar magnetic fields - sunspots - solar activity- flares, prominence and solar wind- activity cycle - apparent and mean solar time.

Unit III: Stellar Structure and Evolution

Equation of steady state for stellar interior - Virial theorem – hydrostatic equilibrium- energy generation in stars – p-p and C-N cycles – stellar evolution - pre-main sequence contraction, main sequence stage and formation of super dense objects -White dwarfs- Chandrasekharan limit - Neutron stars & Pulsars - Black holes.

Unit IV: Galactic Physics

Star clusters – Galactic and globular clusters - The Milky Way galaxy- general structure – central region and nucleus – galactic disk- galactic halo- mass of galaxy -differential rotation of galaxies – External galaxies - Classification of galaxies -Hubble sequence – elliptical, spiral, lenticular, irregular galaxies - distribution of galaxies - luminosity distribution in galaxies

Unit V: Elements of Cosmology

Cosmological Principle – redshift and expansion of universe - Hubble's law -matter density in the universe and deceleration parameter - open, closed and flat universes- important models of the universe (qualitative discussion only) – cosmic microwave background - Dark matter.

RECCOMENDED TEXT BOOKS

1. V.B.Bhatia ,Textbook of Astronomy and Astrophysics with Elements of Cosmology, 1 st edition, Narosa Publishing House, New Delhi, 2001.
2. Baidyanath Basu, An Introduction to Astrophysics, 2ndedition, Prentice Hall India Learning Pvt. Ltd., 2004.
3. Astrophysics – Stars and Galaxies, K. D. Abhyankar, University Press Pvt. Ltd., 2001.
4. T. Padmanabhan , Theoretical Astrophysics (Vols.I,II,III) , Cambridge University Press , New York, 2000
5. J. V. Narlikar, Introduction to Cosmology , Cambridge Univ, Press, New York, 1993.

REFERENCE BOOKS:

1. S. Chandrasekhar, An Introduction to the Study of Stellar Structure, 1st edition, S Dover Publications Inc., 2003.
2. Donald D. Clayton, Principles of Stellar Evolution and Nucleosynthesis, 1st edition, University of Chicago Press, 1983.
3. W.M.Smart: Foundations of Astronomy, Longmans (1965)
4.Frank H. Shu: The Physical Universe-An Introduction to Astronomy, Univ Science Books (1981)

JOURNALS

1. Journal of Cosmology and Astroparticle Physics (International)
2. Nature Astronomy (International)
3. Research in Astronomy and Astrophysics (International)
4. Bulletin of the Astronomical Society of India (National)

E-LEARNING RESOURCES

1. http://www.ignouhelp.in/ignou-phe-15-study-material/
2. http://astronomy.nmsu.edu/holtz/a535/supplement/node1.html
3. http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/galax.html
4. https://arxiv.org/pdf/1803.00070.pdf

COURSE OUTCOMES:

CO No.	CO Statement	Knowledge Level
CO 1	Apply the system of celestial coordinates and classification of stars to comprehend the celestial sphere.	K3
CO 2	Discuss the physical features of the sun and solar activity	K3
CO 3	Explain the stages of evolution of stars and the energy generation process in it	K4,K5
CO 4	Outline the features of the milky way and classification of external galaxies	K4
CO 5	Deliberate on current theories on the origin , evolution and	K4, K5

	topographies of cosmos and presence of dark matter	

MAPPING – COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	2	2	3	2	2
CO 2	3	1	2	2	2	3
CO 3	3	2	1	2	1	3
CO 4	3	2	1	2	1	2
CO 5	3	1	1	2	1	2
AVERAGE	**3**	**1.6**	**1.4**	**2.2**	**1.4**	**2.4**

KEY: STRONGLY CORRELATED -3, MODERATELY CORRELATED -2, WEAKLY CORRELATED – 1, NO CORRELATION -0