DEPARTMENT OF PHYSICS

ANNA UNIVERSITY, CHENNAI

VISION:

Department of Physics, at Anna University shall

- Strive towards the world class centre by producing students with higher technical knowledge, professional skills and other values.
- Provide an outstanding experience in teaching, research and consultancy.
- Perform frontier research and create knowledge base in pure and applied physics, materials science, laser engineering and areas of technological importance.

MISSION:

Department of Physics, Anna University shall

- Provide high quality physics education, producing well prepared students who are intellectually and technically equipped in their abilities and understanding of physics and in particular materials science.
- Promotes high quality academic and research programmes and providing extension services in cutting edge technologies in materials science and laser engineering.
- Ensures the supportive campus climate in academic and research activities by meeting the need of the students, faculty and staff.

Attested

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.Sc. MATERIALS SCIENCE (2 YEARS)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES(PEOs):

I. To make the students in mastering in the field of materials science and prepare them for research.

II. To provide students with a solid foundation in mathematical, scientific and fundamentals of Physics and Materials Science and to impart knowledge on preparation, processing, characterization and applications of various kinds of Materials.

III. To train students with good scientific and sound knowledge of Materials Science so as to comprehend, analyze, design, and provide solutions for the real life problems.

IV. To inculcate the students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Materials Science aspects to broader social context.

V. To provide students an academic environment to develop excellence in leadership qualities, practice ethical codes and guidelines, and achieve life-long learning needed for a successful professional career.

2. PROGRAMME OUTCOMES(POs):

After going through the two years of study, our Materials Science Post-Graduates will exhibit ability to:

PO #	Graduate	Programme Outcome
1.	Research aptitude	An ability to independently carry out research /Investigation and development work to solve practical problems
2.	Technical documentation	An ability to write and present a substantial technical report/document
3.	Technical competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4.	Modern Tool Usage	Students will develop and demonstrate an ability to work in laboratory, conduct experiments, visualize data and interpret the results.
5.	Impact in society	Students will show the understanding of impact of materials in the society and also will be aware of contemporary issues.
6.	Ethical responsibilities	Students will demonstrate knowledge of professional and ethical responsibilities.

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3. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	3	3	3	3	3	2
II	3	3	3	3	3	3
III	3	3	3	3	3	3
IV	3	3	3	2	3	3
V	3	3	3	2	3	3

4. Mapping of Course Outcome and Programme Outcome

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	Semester 1	Mathematical Physics	2.6	2.8	3	1.8	3	2
		Classical Mechanics	2.2	2.8	3	1.8	3	2
		Electronics and Instrumentation	3	2.2	2.2	3	2.2	2
		Solid State Physics	2.4	1.8	2.4	2	2	2
		Electromagnetic Theory and Optics	1.6	1	2	2.4	1	2.8
		Materials Science Lab – I	2.4	2	3	2.8	2	2.8
	Semester 2	Numerical Methods for Materials Science	3	2	2.8	2	1	2.4
		Thermodynamics and Statistical Mechanics	2.8	3	3	2.2	3	2
		Characterization of Materials	3	2.6	2	2.6	2	3
		Quantum Mechanics	3	2	2.4	2	2.6	2.4
		Physics of Materials	2.2	1	2.4	2.4	1.6	2
		Program Elective I (One from list of electives I)						
		Materials Science Lab – II	2.6	2.2	2.6	2.8	2.8	2.4
	Semester 3	Crystallography and Crystal Growth	3	2	2.4	2	2.6	2.4
		Polymer and Composite Materials	2.4	2.2	2.4	3	2.6	2.8
		Physical Metallurgy	2.4	2	2.6	2	2.2	2
		Program Elective II (One from list of electives II)						
		Program Elective III (One from list of electives III)						
		Materials Science Lab-III and Mini Project	3	2.4	3	3	2.8	2.8
		Technical Seminar	2	3	3	2	3	3

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YEAR 2	Semester 4	Program Elective IV (One from list of electives IV)						
		Program Elective V (One from list of electives V)						
		Program Elective VI (One from list of courses)						
		Project Work	3	3	3	3	3	3

CO-PO Mapping of Program Elective Courses

			Course Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	Semester 2	Program Elective I (One from list of electives I)	Semiconductor Materials and Devices	2	2	2	1	1	1
			Python Programming	2.4	1.8	2.4	2	2	2
			Materials Processing	2.8	2	2.8	2	2.4	2
			Laser and Applications	3	2	2.4	2	2.6	2.4
YEAR 2	Semester 3	Program Elective II (One from list of electives II)	Non-Destructive Testing	2	1.2	2.4	2.6	3	1
			Biomaterials	2.2	2.2	2.4	2.8	3	2
			Nonlinear Optical Materials	3	2	2.4	2	2.6	2.4
			Superconducting Materials and Applications	2	1.4	2	2.6	2.2	2
		Program Elective III (One from list of electives III)	Mechanical Properties of Materials	2.4	1.2	2	2.2	3	2
			Introduction to Nanoscience and Technology	2	1.6	2.4	2	1.6	1
			Corrosion Science and Engineering	2	1.6	2	2.2	2.4	2
			Nanoelectronics and Photonics	3	2.2	2.2	3	2.2	2
			Carbon Materials	2	1	2	2.2	2.4	2
	Semester 4	Program Elective IV (One from list of electives IV)	Thin Film Science and Technology	3	2.8	2.4	2.6	2.2	2
			Advances in Crystal Growth	2.2	2	2	2.4	1.8	1.8
			High Pressure Science and Technology	2	1	2	2.2	2.4	2
			Ceramic Materials	2	1.4	2.4	2	1.8	2

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			Smart Materials and applications	2.6	1.4	2.6	2.2	2.4	2
		Program Elective V (One from list of electives V)	Advances in X-ray Analysis	1.6	1.4	2.4	2	1.4	2
			Computational Material Science	2.2	2.4	2.2	1.6	2	1.8
			Solid State Ionics	2	1.2	2.4	2	1.6	2
			Preparation and Fabrication of nanoscale materials	2	1.8	2.4	2	1.6	1.6
		Program Elective VI (One from list of electives VI)	Energy Conversion and Energy Storage Devices	2.8	2.4	2.4	2.4	2.6	3
			Nuclear Physics and Reactor Materials	2	1.2	2.4	2	1.6	2
			Non-linear Electronics	3	2.2	2.2	3	2.2	2
			Composite Materials and Structures	2.6	1.4	2.6	2.2	2.4	2

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.Sc. MATERIALS SCIENCE (2 YEARS)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MC3101	Mathematical Physics	FC	4	0	0	4	4
2.	MC3102	Classical Mechanics	PCC	3	0	0	3	3
3.	MC3103	Electronics and Instrumentation	PCC	3	0	0	3	3
4.	MC3104	Solid State Physics	PCC	3	0	0	3	3
5.	MC3105	Electromagnetic Theory and Applied Optics	PCC	4	0	0	4	4
PRACTICAL								
6.	MC3111	Materials Science Lab - I	PCC	0	0	6	6	3
			TOTAL	**17**	**0**	**6**	**23**	**20**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MC3201	Numerical Methods for Materials Science	FC	4	0	0	4	4
2.	MC3202	Thermodynamics and Statistical Mechanics	PCC	3	0	0	3	3
3.	MC3203	Characterization of Materials	PCC	3	0	2	5	4
4.	MC3204	Quantum Mechanics	PCC	3	0	0	3	3
5.	MC3205	Physics of Materials	PCC	3	0	2	5	4
6.		Professional Elective I	PEC	3	0	0	3	3
PRACTICAL								
7.	MC3211	Materials Science Lab - II	PCC	0	0	6	6	3
			TOTAL	**19**	**0**	**10**	**29**	**24**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MC3301	Crystallography and Crystal Growth	PCC	4	0	0	4	4
2.	MC3302	Polymer and Composite Materials	PCC	3	0	0	3	3
3.	MC3303	Physical Metallurgy	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
PRACTICAL								
6.	MC3311	Materials Science Lab-III and Mini Project	EEC	0	0	6	6	3
7.	MC3312	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**16**	**0**	**8**	**24**	**20**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICAL								
4.	MC3411	Project Work	EEC	0	0	24	24	12
			TOTAL	**9**	**0**	**24**	**33**	**21**

Total No. of Credits: 85

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MC3101	Mathematical Physics	4	0	0	4	1
2.	MC3201	Numerical Methods for Materials Science	4	0	0	4	2
					Total Credits	8	

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PROGRAM CORE COURSES (PCC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MC3102	Classical Mechanics	3	0	0	3	1
2.	MC3103	Electronics and Instrumentation	3	0	0	3	1
3.	MC3104	Solid State Physics	3	0	0	3	1
4.	MC3105	Electromagnetic Theory and Applied Optics	4	0	0	4	1
5.	MC3111	Materials Science Lab - I	0	0	6	3	1
6.	MC3202	Thermodynamics and Statistical Mechanics	3	0	0	3	2
7.	MC3203	Characterization of Materials	3	0	2	4	2
8.	MC3204	Quantum Mechanics	4	0	0	4	2
9.	MC3205	Physics of Materials	3	0	0	3	2
10.	MC3211	Materials Science Lab - II	0	0	6	3	2
11.	MC3301	Crystallography and Crystal Growth	4	0	0	4	3
12.	MC3302	Polymer and Composite Materials	3	0	0	3	3
13.	MC3303	Physical Metallurgy	3	0	0	3	3
					Total Credits	**43**	

PROGRAM ELECTIVE COURSES (PEC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	GROUP
			Lecture	Tutorial	Practical		
1.	MC3001	Semiconductor Materials and Devices	3	0	0	3	1
2.	MC3002	Python Programming	3	0	0	3	1
3.	MC3003	Materials Processing	3	0	0	3	1
4.	MC3004	Laser and Applications	3	0	0	3	1
5.	MC3005	Non-Destructive Testing	3	0	0	3	2
6.	MC3006	Biomaterials	3	0	0	3	2
7.	MC3007	Nonlinear Optical Materials	3	0	0	3	2
8.	MC3008	Superconducting Materials and Applications	3	0	0	3	2
9.	MC3009	Mechanical Properties of Materials	3	0	0	3	3
10.	MC3010	Introduction to Nanoscience and Technology	3	0	0	3	3
11.	MC3011	Corrosion Science and Engineering	3	0	0	3	3
12.	MC3012	Nanoelectronics and Photonics	3	0	0	3	3
13	MC3013	Carbon Materials	3	0	0	3	3
14	MC3014	Thin Film Science and Technology	3	0	0	3	4

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15	MC3015	Advances in Crystal Growth	3	0	0	3	4
16	MC3016	High Pressure Science and Technology	3	0	0	3	4
17	MC3017	Ceramic Materials	3	0	0	3	4
18	MC3018	Smart Materials and applications	3	0	0	3	4
19	MC3019	Advances in X-ray Analysis	3	0	0	3	5
20	MC3020	Computational Material Science	3	0	0	3	5
21	MC3021	Solid State Ionics	3	0	0	3	5
22	MC3022	Preparation and Fabrication of nanoscale materials	3	0	0	3	5
23	MC3023	Energy Conversion and Energy Storage Devices	3	0	0	3	6
24	MC3024	Nuclear Physics and Reactor Materials	3	0	0	3	6
25	MC3025	Non-linear Electronics	3	0	0	3	6
26	MC3026	Composite Materials and Structures	3	0	0	3	6

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	MC3311	Materials Science Lab-III and Mini Project	0	0	6	3	3
2	MC3312	Technical Seminar	0	0	2	1	3
3	MC3411	Project Work	0	0	24	12	4
					Total Credits:	16	

SUMMARY

	M.Sc. MATERIALS SCIENCE (FT)					
	Subject Area	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	**FC**	04	04	00	00	**08**
2.	**PCC**	16	17	10	00	**43**
3.	**PEC**	00	03	06	09	**18**
4.	**EEC**	00	00	04	12	**16**
	Total Credit	**20**	**24**	**20**	**21**	**85**

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MC3101 **MATHEMATICAL PHYSICS** **L T P C**
4 0 0 4

OBJECTIVES:

- To introduce the students to understand the vector calculus and matrices.
- To make the students to understand the special functions.
- To make the student to study the complex variables.
- To involve the student to learn the integral transform.
- To educate the students to develop the understanding partial differential equation and group theory.

UNIT I VECTOR CALCULUS AND MATRICES 12

Laplacian-Vector operators in curvilinear coordinates Gauss, Green and Stokes theorems-Applications - Vector spaces - Linear dependence and independence - Eigenvalue problem - Diagonalization - Similarity transformation.

UNIT II SPECIAL FUNCTIONS 12

Beta and Gamma functions - Bessel, Legendre, Hermite, Chebyshev and Laguerre functions and their properties-Series solutions - Recurrence relations-Rodrigue's formulae, Orthogonality, Generating functions – Applications - Dirac delta function.

UNIT III THEORY OF COMPLEX VARIABLES 12

Functions of complex variables - Cauchy Riemann conditions - Analytic functions - Conformal mapping - Simple and Bilinear transformations -Applications-Cauchy's Integral Theorem and Integral Formula-Taylor's and Laurent's series- Singularities-Zeros, Poles and Residues-Residue theorem -Contour integration with circular and semicircular contours.

UNIT IV INTEGRAL TRANSFORMS 12

Harmonic analysis, Fourier transform-properties-transforms of simple functions and derivatives-Convolution theorems – Applications - Laplace's transform – properties -Transform of simple functions and derivatives-periodic functions-Convolution theorem-Application to solve differential equation.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS AND GROUP THEORY 12

Transverse vibration of a string - Wave equation - One dimensional heat conduction - Diffusion equation - Two dimensional heat flow - Laplace's equation - Method of separation of variables - Fourier series solution in cartesian coordinates. Definition of group - symmetry elements - Reducible and irreducible representation - Orthogonality theorem.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to

CO1: Apply ideas of vector calculus and matrices to physics problems.
CO2: Crack the physics problems with special formula.
CO3: Make use of complex variable to solve integrals.
CO4: Use integral transform in physics and optics.
CO5: Utilize the partial differential equation to boundary value problems.

REFERENCES

1. L.A.Pipes and L.R.Harvill. Applied Mathematics for Engineers and Physicists. Dover Publications Inc.,2014.
2. E.Kreyszig. Advanced Engineering Mathematics. Wiley,2015.
3. E. Butkov. Mathematical Physics. Addison Wesley, New York,1973.
4. B.S.Grewal. Higher Engineering Mathematics, Khanna Publishers,2015.
5. Sathya Prakash. Mathematical Physics. Sultan Chand & Sons,2014.
6. B.D.Gupta. Mathematical Physics. Vikas Publishing House Pvt. Ltd.,2009.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	1	3	2
CO2	3	3	3	1	3	2
CO3	2	3	3	2	3	2
CO4	3	3	3	3	3	2
CO5	3	2	3	2	3	2
Avg.	**2.6**	**2.8**	**3**	**1.8**	**3**	**2**

High–3, Medium-2, Low -1

MC3102 CLASSICAL MECHANICS L T P C
3 0 0 3

OBJECTIVES:

- To illustrate the students about the Lagrangian formulation of mechanics of a systems of particles
- To introduce the students to Hamiltonian formulations and conservation theorems
- To make students familiar with independent coordinates, rigid body kinematics and moment of inertia
- To introduce the concepts of small oscillations, Legendre transformations and Hamilton's equation
- To educate the students with the concept of Hamilton Jacobi theory and Poisson bracket

UNIT I LAGRANGIAN FORMULATION 9

Mechanics of a particle and a system of Particles – Constraints - D'Alembert's principle and Lagrange's Equations - Simple applications of the Lagrangian formulation –Variational principle and Lagrange's Equation – Advantages of a variational principle Formulation

UNIT II HAMILTONIAN FORMULATION 9

Conservation theorems and symmetry Properties – Two body central force problem: Reduction to the equivalent one body problem - Hamilton's Principle - Basic techniques of calculus of Variations – Derivation of Lagrange's equations from Hamilton's principle

UNIT III RIGID BODY DYNAMICS 9

The kinematics of rigid body motion – The independent coordinates of a rigid body - The Euler Angles -Euler's theorem on the motion of a rigid Body - Finite and infinitesimal Rotation - Angular momentum and kinetic energy of motion about a fixed Point - Moment of inertia-Equation of Torque

UNIT IV THEORY OF SMALL OSCILLATIONS 9

Small oscillations - Formulation of the Problem - Eigenvalue equation and the principle axes Transformation - Legendre transformation and Hamilton's equations of motion Cyclic coordinates and conservation theorems - Derivation of Hamilton's equation from a variational principle

Attested

UNIT V HAMILTON JACOBI THEORY 9

The equations of canonical transformation – Examples - Poisson brackets and other canonical invariants – Equations of motion – Infinitesimal canonical transformations and conservation theorems - Poisson bracket – formulation – Hamilton - Jacobi equation and its application to the harmonic oscillator problem

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completing the course, the student should be

CO1: Familiar with the Lagrangian formulation of mechanics for a system of particles and will apply the equations to solve problems

CO2: Efficient in understanding Hamiltonian formulations and conservation theorems

CO3: Competent with the knowledge of rigid body kinematics and moment of inertia

CO4: Thorough with the concepts of small oscillations, Legendre transformations and Hamilton's equation

CO5: Familiar with the concept of Hamilton Jacobi theory and Poisson bracket

REFERENCES

1. L.D. Laudau and E.M. Lifshitz, Mechanics
2. T.W.B. Kibble Classical Mechanics, 5th edition, Imperial College Press, 2004.
3. H. Goldstein, C.P. Pooleand J. Safko. Classical Mechanics, 3rd edition, Pearson Education, Inc.2011
4. N.C. Ranaand P.S. Joag Classical Mechanics, Mc Graw Hill, 2017.
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CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	3	2
CO2	2	3	3	1	3	2
CO3	2	3	3	2	3	2
CO4	3	3	3	3	3	2
CO5	2	2	3	2	3	2
Avg.	**2.2**	**2.8**	**3**	**1.8**	**3**	**2**

High – 3, Medium-2, Low -1

MC3103 ELECTRONICS AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES:

- To make the students understand the importance of op-amp.
- To introduce the advanced concepts of op-amp circuits.
- To educate the students on the concepts of digital electronics.
- To equip the students for designing electronic instruments.
- To familiarize the students with the importance of nano and nonlinear electronics.

Attested

UNIT I OPERATIONAL AMPLIFIER 9

Introduction, Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit, differential amplifiers, op-amp parameters - Op-Amp Characteristics and importance of negative feedback.

UNIT II APPLICATOINS OF OP-AMP 9

Comparators - mathematical operations– active filters. Oscillators: Feedback oscillator principles – oscillators with RC and LC feedback circuits – relaxation oscillators – 555 timer as an oscillator and Schmitt trigger. Log and antilog amplifier - Phase-locked Loop (PLL) - IC566 operation - Analog simulation circuits and op-amp voltage regulators.

UNIT III DIGITAL ELECTRONICS 9

CMOS logic: CMOS logic levels, Basic CMOS Inverter, NAND and NOR gates, CMOS direct and inverter logic gates. Combinational circuits: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). Sequential circuits: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

UNIT IV ELECTRONIC INSTRUMENTATION 9

Basics of instrumentation system – Transducers: resistive, strain gauge, resistive thermometer, thermistor, LVDT, load cell, piezoelectric transducers. Signal conditioning – instrumentation amplifier - analog switches - sample & hold circuits - data acquisition and conversion- D/A and A/D converters – successive approximation technique - Voltage-to-frequency and frequency – to – voltage converters - data transmission. IC Voltage Regulators.

UNIT V NONLINEAR ELECTRONICS 9

MOSFETs - `channel length scale, new Ohm's law, electron transport in nanostructures - resonant tunneling diodes – single electron transfer devices – nano-electromechanical systems - quantum dot cellular automata. Effect and importance of nonlinearity in electronic devices and circuits – chaos and soliton dynamics – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completing this course, the students should be able to

CO1: Understand the working principles of op-amps.
CO2: Design various op-amp circuits.
CO3: Design digital electronic circuits.
CO4: Design electronic instruments.
CO5: Gain knowledge on nonlinear electronic devices.

REFERENCES

1. A.P. Malvino and David J. Bates and Patrick E. Hoppe, Electronic Principles, McGraw Hill; 9th edition, Noida, 2021.
2. T.L. Floyd. Electronic devices. Pearson Education; Tenth edition, New Delhi, 2021.
3. Paul Horowitz and Winfiled Hill, Art of electronics, Cambridge Univ. Press; Third edition, Kolkata, 2015.
4. P. Bhattacharya. Semiconductor Optoelectronic Devices. Pearson Education, Second edition, New Delhi, 2017.
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6. G.W. Hanson. Fundamentals of Nanoelectronics. Pearson Education; New Delhi, 2009.
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8. M.Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific, Singapore, 1996.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	2
CO2	3	2	2	3	2	2
CO3	3	2	2	3	2	2
CO4	3	3	3	3	2	2
CO5	3	2	2	3	2	2
Avg.	**3**	**2.2**	**2.2**	**3**	**2.2**	**2**

High – 3, Medium-2, Low -1

MC3104 SOLID STATE PHYSICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basic crystal structures, bonding of solids and the lattice energy calculations.
- To discuss how our understanding of lattice dynamics is formulated in terms of travelling waves, together with the role of the interatomic forces.
- To explain electrical and thermal conduction in metals and Fermi distribution function.
- To understand the electrons in solid move under the influence of a periodic potential due to ions arranged along a periodic lattice and the theory developed on the basis of this model.
- To study the properties of magnetic materials and superconducting materials and their applications.

UNIT I CRYSTAL STRUCTURE AND BONDING 9

Crystalline solids - crystal systems - Bravais lattices –coordination number – packing factors – cubic, hexagonal, diamond structure, Sodium Chloride Structure – lattice planes and Miller Indices - interplanar spacing – directions. Types of bonding - lattice energy - Madelung constants – Born Haber cycle – cohesive energy.

UNIT II LATTICE DYNAMICS 9

Mono atomic and diatomic lattices – anharmonicity and thermal expansion- phonon –Momentum of phonons, Inelastic scattering of photons by long wavelength phonons, Local phonon model – Einstein and Debye model, density of states, Thermal conductivity of solids- due to electron-due to phonons – thermal resistance of solids – phonon-phonon interaction-normal and Umklapp processes - scattering experiments.

UNIT III FREE ELECTRON THEORY 9

Drude theory – Wiedemann-Franz Law and Lorentz number –Quantum state and degeneracy-density of states, concentration - free electron statistics (Fermi-Dirac), Fermi energy and electronic Specific heat, Electrical resistivity and conductivity of metals – Boltzmann transport theory –- electrical and thermal conductivity of electrons.

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UNIT IV PERIODIC POTENTIALS AND ENERGY BANDS 9

Bloch's theorem – Kronig-Penney model-Construction of Brillouin Zones-Effective mass of electron-nearly free electron model – Tight binding approximation-Construction of Fermi Surfaces- density of states curve-electron, holes and open orbits-Fermi surface studies - Cyclotron resonance – anomalous skin effect –de Hass van Alphen effect- semiconductors direct and indirect band gap.

UNIT V MAGNETIC PROPERTIES AND SUPERCONDUCTIVITY 9

Magnetic dipole moment – origin: atomic magnetic moments – magnetic materials: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, ferromagnetism- origin and the exchange interaction- saturation magnetization and Curie temperature – ferromagnetic materials: magnetic domains magneto crystalline anisotropy, domain walls and motion – M versus H behaviour, demagnetization – soft and hard magnetic materials – examples and uses – Giant Magneto Resistance and materials – superconductivity: properties and classifications – High Tc superconductors – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students should be able to:

CO1: Make use of fundamental concepts of various crystal systems, types of bonding and calculate the cohesive energy.

CO2: Understand the basics concepts of free electron theory and Boltzmann transport theory.

CO3: To gain knowledge on atomic lattice vibrations, phonon-phonon interactions and Einstein and Debye models.

CO4: The students would have gained knowledge on periodic potentials and Fermi surface studies.

CO5: Would have known the applications and various properties of semiconductors and superconductive materials.

REFERENCES

1. M.A.Wahab. Solid State Physics: Structure and Properties of Materials. Narosa Publishing House Pvt. Ltd., 2015.
2. M.Ali Omar. Elementary Solid State Physics. Pearson Education, 2002.
3. M.S.Rogalski and S.B.Palmer. Solid State Physics. Gordon Breach Science Publishers, 2000.
4. N.W.Ashcroft and N.D.Mermin. Solid State Physics, Cengage Learning, 2003.
5. A.J Dekker. Solid State Physics. Laxmi Publications, 2008.
6. James D.Patterson and Bernard C.Bailey. Solid-State Physics: Introduction to the Theory. Springer, 2018.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	2
CO2	2	2	3	2	2	2
CO3	3	1	2	2	3	1
CO4	2	2	2	2	2	2
CO5	2	2	2	2	1	3
Avg.	**2.4**	**1.8**	**2.4**	**2**	**2**	**2**

High – 3, Medium-2, Low -1

Attested

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MC3105 ELECTROMAGNETIC THEORY AND APPLIED OPTICS **L T P C**
4 0 0 4

OBJECTIVES:

- To impart knowledge on the concepts of electrostatics and magneto statics.
- To impart knowledge on the fundamentals of Maxwell's equation and applications
- To provide understanding in the theory of generation and propagation of electromagnetic waves in vacuum and different media
- An overview on various optical activities and their applications in material characterization
- To understand the importance of LASER and non-linear optical effects.

UNIT I ELECTRO AND MAGNETOSTATICS 12

Electrostatics: Coulomb's law– Electric field - Gauss law - electric potential and electrostatic energy – Laplace and Poisson Equations –Boundary value Problems-multipole expansion

Magnetostatics: Lorentz force law -Biot-Savart law –Divergence and curl of Magnetic Induction – Magnetic scalar and vector potentials – Magnetic dipole in a uniform field – Magnetic susceptibility and permeability Hysteresis – Correspondences in electrostatics and magneto statics.

UNIT II ELECTRODYNAMICS 12

Faraday's law – Induced electric field –Displacement current - Maxwell's Equations - differential and integral forms – Energy in electromagnetic fields - Poynting's theorem - Electromagnetic potentials - Maxwell's equations in terms of electromagnetic potentials - Gauge transformations - Lorentz Gauge - Coulomb Gauge - Green function for the wave function.

UNIT III ELECTROMAGNETIC WAVE PROPAGATION 12

Plane electromagnetic waves in free surface - characteristic impedance - wave equation in an isotropic medium - wave equation in insulators and conductors - reflection by a perfect conductor-Reflection and refraction of electromagnetic waves - TM and TE modes - Propagation in Rectangular waveguides - Cavity Resonator - Radiation from a localized source - Oscillating electric dipole

UNIT IV POLARIZATION AND CRYSTAL OPTICS 12

Light propagation in anisotropic media: Refractive indices, wave propagation along a Prinicipal axis and any arbitrary direction –double refraction - Index ellipsoid – Polarization Devices: wave plates – polarizers, polarization rotators–Optical activity – Faraday effect – Linear Electro-optic effect

UNIT V LASERS AND NONLINEAR OPTICS 12

Einstein Coefficients – Characteristics of Lasers – Requisites of a laser – He-Ne laser, CO_2 laser – Diode laser - Second order nonlinear optics: Second harmonic generation, rectification and three wave mixing - Third order nonlinear optics: Third harmonic generation, Optical Kerr effect, phase conjugation. - stimulated Raman scattering (Qualitative).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of this paper the students will understand the effect of light propagation in materials and how materials change the nature of electromagnetic wave. Specifically, they will be able to:

CO1: Learn the fundamentals of electrostatics and magnetostatics.
CO2: Derive Maxwell's equations and apply them to study the electrostatics and magnetostatics.
CO3: Analyze and solve simple problems related to generation and propagation electromagnetic waves in various media.
CO4: Elucidate how optical activities occur in anisotropic materials and how they can be used to further characterize materials.
CO5: Apprehend the fundamentals of Laser and Non-linear optical effects and their applications.

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REFERENCES
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2. Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics,2019
3. D.Corson and P.Lorrain, Introduction to Electromagnetic Fields and Waves, Literary Licensing, LLC, 2013.
4. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.
5. A.Yariv and P.Yeh. Photonics. Oxford University Press, 2007
6. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York
7. D.J.Griffiths. Introduction to Electrodynamics. Pearson Education, 2015.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
1.	2	1	2	2	1	3
2.	1	1	2	3	1	2
3.	2	1	2	3	1	3
4.	1	1	2	2	1	3
5.	2	1	2	2	1	3
Avg.	1.6	1	2	2.4	1	2.8

High – 3, Medium-2, Low -1

MC3111 MATERIALS SCIENCE LAB – I

L T P C
0 0 6 3

OBJECTIVES:
- To familiarize the students with band gap determination and dielectric behavior of materials
- To make the students to acquire knowledge on the determination of elastic constants
- The make the students to have basic knowledge on the different crystal structures and and also on the velocity of ultrasonic waves in liquid medium
- To enable the students to perform experiments related to electronics and apply them.
- To enable the students to gain knowledge on microprocessor and its applications

LIST OF EXPERIMENTS

Any Fifteen experiments

1. Determination of elastic constants – Hyperbolic fringes
2. Determination of elastic constants – Elliptical fringes
3. Ultrasonic diffractometer - Ultrasonic velocity in liquids
4. Viscosity of liquid - Meyer's disc
5. Magnetostriction measurements
6. Study of crystal lattices
7. Strain gauge meter – Determination of Young’s modulus of a metallic wire
8. Conductivity of ionic crystals
9. Instrumentation Amplifier

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10. Regulated power supply
11. 555 Timer – A stable multivibrator
12. Operational amplifier - characteristics and applications.
13. Active filter
14. RC Phase Shift Oscillator (FET)
15. AD/DA convertor
16. Arithmetic operations- 8 bit and 16 bits.
17. Code conversion (BCD to Binary and Binary to BCD).
18. Temperature Conversions (F to C & C to F).
19. Temperature controller measurements (Digital thermometer).
20. Stepper motor interfacing.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

CO1: The students will familiarize with band gap determination and dielectric behavior of materials.

CO2: The students will acquire knowledge on the determination of elastic constants.

CO3: The students will acquire basic knowledge on the different crystal structures and experimental determination of velocity of ultrasonic waves in liquid medium.

CO4: The students will gain knowledge and perform experiments related to electronics and apply them.

CO5: The students will gain knowledge on microprocessor and its applications.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	2	3
CO2	2	2	3	2	1	3
CO3	2	2	3	3	2	2
CO4	3	2	3	3	2	3
CO5	2	2	3	3	3	3
Avg.	**2.4**	**2**	**3**	**2.8**	**2**	**2.8**

High – 3, Medium-2, Low -1

MC3201 NUMERICAL METHODS FOR MATERIALS SCIENCE **L T P C**
4 0 0 4

OBJECTIVES:

- To improve and enhance the analytical ability in problem solving skills of students using numerical methods and MatLab Program.
- To solve the large system of linear equations and find the roots of non-linear equations.
- To familiarize interpolation and curve fitting using numerical methods.
- To understand and use the appropriate method of numerical differentiation and integration when the function is too complicated and difficult to solve.
- To demonstrate the use of different methods to find the solution of ordinary differential equation and get exposed to basic statistics
- To demonstrate the understanding of numerical methods to solve problems using MatLab.

UNIT I SYSTEM OF EQUATIONS 12

Linear equations: Introduction – linear systems – Gaussian elimination – singular systems – Jacobi iteration - Gauss-Seidel iteration. Nonlinear equations: Introduction – bisection method – rule of false position – Secant method – Newton-Raphson method – Comparison of methods for a single equation – Seidel and Newton's methods for systems of nonlinear equations. Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION & CURVE FITTING AND ERROR ANALYSIS 12

Polynomial interpolation theory - Newton's forward, backward and central interpolation formulae - Lagrange's method - Lagrange's inverse interpolation – piecewise linear interpolation – interpolation with cubic spline – Principle of Least Squares-Fitting of curves-Fitting of linear, quadratic and exponential curves.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Numerical differentiation: Differentiating continuous functions, differentiating tabulated functions, Higher order derivatives- Richardson extrapolation. Numerical integration: introduction to Newton – cotes integration formula – composite Trapezoidal and Simpson's rule – recursive rules and Romberg integration – Gaussian integration.

UNIT IV DIFFERENTIAL EQUATIONS SOLVING AND STATISTICS 12

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method. Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations- Boundary value problems: finite-difference method. Statistics: random variable – frequency distribution – expected value, average and mean – variance and standard deviation – covariance and correlation.

UNIT V MATLAB/SCILAB PROGRAMMING 12

Overview of Matlab – data types and variables, comments, Matlab workspace, simple math, complex numbers, mathematical function, operation on vectors and matrices, Logical arrays, control structure: For loops, while loops, If-else end- writing and running programs – plotting – overview of simulink environment.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to

- Acquire knowledge and apply it to solve large system of linear equations and find the roots of non-linear equations.
- Familiarize interpolation and curve fitting using numerical methods.
- Understand and use the appropriate method of numerical differentiation and integration to solve complicated problems in Physics.
- Demonstrate the methods to solve differential equations and solve problems related to boundary value and get exposed to statistics
- Write efficient mat lab code for various problems , analyze and interpret numerical results.

REFERENCES

1. Kharab and R.B. Guenther. An Introduction to Numerical Methods: A MATLAB Approach. CRC Press, 2018.
2. J. H. Mathews and K. D. Fink. Numerical Methods using MATLAB. Pearson Education India, 2015.
3. Woodford and C. Phillips. Numerical Methods with worked examples: MATLAB edition. Springer, 2014.
4. M.K. Venkatraman, Numerical Methods in Science and Engineering. National Publishing Company, Madras, 1997.
5. S.S. Sastry. Introductory Methods of Numerical Analysis. Prentice Hall India Learning Private Limited, 2012.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	3
CO2	3	2	2	2	1	2
CO3	3	2	3	2	1	2
CO4	3	2	3	2	1	2
CO5	3	2	3	2	1	3
Avg.	3	2	2.8	2	1	2.4

High – 3, Medium-2, Low -1

MC3202 THERMODYNAMICS AND STATISTICAL MECHANICS **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the students to laws of thermodynamics, Maxwell's relations and relevant concepts
- To facilitate the students to know about phase transitions and critical exponents
- To develop deep knowledge about fundamentals of statistical mechanics and ensembles
- To enable the students familiar with the applications of quantum statistical mechanics.
- To equip the students understanding the concepts of heat and mass transfer and its applications

UNIT I THERMODYNAMICS 9

Review of Thermodynamics and Laws – Thermodynamic relations – Maxwell's relations and applications – Chemical Potential – Gibbs phase rule –phase equilibria (single and multicomponent systems) - Clausius–Clayperon equation – law of mass action.

UNIT II PHASE TRANSITIONS 9

Basic introduction to phase transitions: first order and continuous; Critical phenomena: critical exponents and scaling hypothesis; Ising model: exact solution in one dimension, mean-field approximation and calculation of critical exponents, Landau theory.

UNIT III CLASSICAL AND QUANTUM STATISTICS 9

Objectives of statistical mechanics; Microstates and macrostates; Phase space and concept of an ensemble; Liouville's theorem and concept of equilibrium; Microcanonical, canonical and grand canonical ensembles -Maxwell –Boltzmann, Bose-Einstein and Fermi-Dirac statistics– Comparison of MB, BE and FD statistics.

UNIT IV APPLICATION OF QUANTUM STAISTICAL MECHANICS 9

Planck's Radiation law - Stefan-Boltzmann law– Einstein model of a solid–Bose condensation – Classical partition function and classical ideal gas – Equipartition theorem –Semiconductor statistics–Statistical equilibrium of electrons in semiconductors.

UNIT V HEAT AND MASS TRANSFER 9

Basic concepts of conduction, convection and radiation – Hydrodynamics – Dimensionless numbers – Rayleigh's number- Reynold's number- Heat balance equation–Mass transfer convective flow– diffusion - Fick's law – diffusion coefficient – mass transfer coefficient – Application to melt growth.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will gain knowledge about the laws of thermodynamics, Maxwell's relations.
- The students will understand about phase transitions and critical exponents and will apply this knowledge in designing new materials
- The students will obtain deep knowledge about fundamentals of statistical mechanics and ensembles and derive the distribution laws
- The students will be familiar with the statistics and will apply the statistical mechanics to solve problems
- The students will understanding the concepts of heat and mass transfer and will apply his knowledge in finding solutions to hydrodynamics

REFERENCES

1. M.C.Gupta.Statistical Thermodynamics. New Age Publications, 2nd edition, 2007.
2. T.Engeland P. Reid. Thermodynamics, Statistical Thermodynamics & Kinetics,Pearson Education, Inc.2006.
3. H.B.Callen.Thermodynamics and an Introduction to Thermostatistics, Wiley India Pvt.Ltd. 2014.
4. J.P.Holman. Heattransfer.Tata McGraw Hill, New Delhi,2008.
5. F.Reif. Fundamentals of Statistical and Thermal Physics. McGraw Hill,2010.
6. B.K.Agarwal and M.Eisner, Statistical Mechanics.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	3	2
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
Avg.	2.8	3	3	2.2	3	2

High – 3, Medium-2, Low -1

MC3203 CHARACTERISATON OF MATERIALS **L T P C**
3 0 2 4

OBJECTIVES:

To introduce the important characterization techniques to the students

- To make the students understand some important thermal analysis techniques.
- To make the students familiarize with image formation in an optical microscope and learn other specialized microscopic techniques.
- To make the students learn the principle of working of electron microscopes and scanning probe microscopes.
- To make the students understand some important semiconductor characterization techniques.
- To introduce the students the basics of some important spectroscopic techniques

UNIT I THERMAL ANALYSIS 9

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – Thermomechanical Analyzer - determination of thermomechanical parameters.

UNIT II MICROSCOPIC METHODS 9

Optical Microscopy: optical microscopy techniques – Bright field – Dark field optical microscopy – phase contrast microscopy -differential interference contrast microscopy - fluorescence microscopy - confocal microscopy – Metallurgical microscope.

UNIT III ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY 9

SEM- FESEM- EDAX,- TEM - working principle and Instrumentation – sample preparation – scanning probe microscopy - STM – AFM - working principle, Instrumentation and modes of operation.

UNIT IV ELECTRICAL METHODS AND OPTICAL CHARACTERISATION 9

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V, I-V characteristics – Schottky barrier capacitance – impurity concentration –- Photoluminescence – light–matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

UNIT V SPECTROSCOPY 9

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, NMR, ESCA and SIMS- proton-induced X-ray Emission spectroscopy (PIXE) – applications.

TOTAL: 45 PERIODS

CHARACTERIZATION LAB

Any **FIVE** experiments:

1. Photoluminescence measurement.
2. TGA – Measurement and interpretation of results
3. FTIR studies - sample preparation, recording and analysis
4. Identification of phases using a metallurgical microscope
5. Optical absorption –spectrophotometer
6. Four Probe - Electrical resistivity measurement.
7. Thermomechanical analysis

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- Students will be able to describe TGA, DTA, DSC and TMA, its applications and interpretation of results.
- Students have understood the concept of image formation in Optical microscope and other specialized microscopes..
- Students have learned the working principle and operation of SEM, TEM, STM and AFM.
- Students have understood the necessary theory of Hall measurement, four –probe resistivity measurement, C-V, I-V, Photoluminescence and electroluminescence techniques
- Students have learned basics and necessary theory of some important spectroscopic techniques and its applications.

REFERENCES

1. R.A.Stradling and P.C.Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol,1990.
2. J.A.Belk. Electron Microscopy and Microanalysis of Crystalline Materials. Applied Science Publishers, London,1979.
3. L.E.Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York,1991.
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6. C.N.Banwell and E.M.McCash. Fundamentals of Molecular Spectroscopy. McGraw-Hill Education, 2017.

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CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	2	2	3
CO3	3	2	2	2	2	3
CO4	3	3	2	3	2	3
CO5	3	2	2	3	2	3
Avg.	3	2.6	2	2.6	2	3

High – 3, Medium-2, Low -1

MC3204 QUANTUM MECHANICS **L T P C**
3 0 0 3

OBJECTIVES:

- To expose the students to the basic formulation of quantum mechanics.
- To impart knowledge to the students about potential problems.
- To introduce knowledge on angular momentum to the students.
- To explore the ideas on approximation methods to the students.
- To inspire the students with knowledge of scattering theory.

UNIT I BASIC FORMULATION 9

Inadequacy of Classical Mechanics - Postulates of quantum mechanics-wave function, probabilistic interpretation, observables and operators – Eigen values and Eigen functions, Expectation values - Commutators - Bra & Ket vectors, completeness, orthonormality, Basic theorems - Uncertainty principle - Ehrenfest's theorem - Schrodinger wave equation-stationary state solutions.

UNIT II POTENTIAL PROBLEMS 9

Free particle in three dimensions, particle in a box-one dimension and three dimension-potential step, potential barrier, tunnel effect, square well potential, periodic potential, linear harmonic oscillator, rigid rotator, the hydrogen atom, atomic orbitals.

UNIT III ANGULAR MOMENTUM 9

Rotation operators, angular momentum operators, commutation rules, Eigenvalues of angular momentum operator, matrix representations, addition of two angular momenta, Clebsch-Gordon coefficients, properties-Pauli matrices.

UNIT IV APPROXIMATION METHODS 9

Time-independent perturbation theory, non degenerate and degenerate cases, Examples of Anharmonic oscillator and Stark effect, The variation method, Application to the deutron and helium atom, Time dependent perturbation theory, Harmonic perturbation.

UNIT V SCATTERING THEORY 9

Centre of mass and Laboratory systems-Scattering amplitude and cross sections-Scattering of a wave packet-Born approximation-validity-partial wave analysis-phase shifts.

TOTAL: 45 PERIODS

Attested

COURSE OUTCOMES:

After end of the course, the students will be able to

- Make use of fundaments of quantum mechanics to various physics problems.
- Utilize the potential problems to solve real practical problems.
- Gain the understandings of angular momentum and its usefulness in spectroscopy.
- Learn about the approximation methods and its usefulness to various physics problems
- Understand the basic knowledge about scattering theory and its uses in various physics problems.

REFERENCES

1. N.Zettili. Quantum Mechanics: Concepts and Applications. Wiley India Pvt. Ltd.,2016.
2. V. Devanathan. Quantum Mechanics. Narosa Publishing House Pvt. Ltd, New Delhi,2011.
3. L.I.Schiff. Quantum Mechanics, McGraw Hill Education,2017.
4. P.M.Mathews and K.Venkatesan. A Text book of Quantum mechanics, McGraw Hill Education, 2017
5. J.J.Sakurai and J.Napolitano. Modern Quantum Mechanics, Cambridge University Press, 2017.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	2
CO5	3	2	2	2	3	3
Avg.	3	2	2.4	2	2.6	2.4

High – 3, Medium-2, Low -1

MC3205 PHYSICS OF MATERIALS

L T P C
3 0 2 4

OBJECTIVES:

To impart knowledge on various properties of materials

- To introduce the concepts of mechanical test and plastic deformation the students
- To introduce the students about various dielectric materials and their application.
- to expose the students to different types of semiconducting materials and their properties
- To study the properties of various optical materials, LED and LCD and their applications
- To make the students understand about the various properties of shape memory alloys, CCD, Nanomaterials and NLO materials and their applications

UNIT I MECHANICAL PROPERTIES 9

Factors affecting mechanical properties- Plastic deformation by slip and twinning - shear strength of perfect and real crystals-work hardening and recovery- mechanical tests- tensile, hardness, impact, creep and fatigue -fracture-Types-Griffith's theory-creep resistant materials - diffusion– Fick’s law.

UNIT II DIELECTRIC PROPERTIES 9

Dielectric constant and polarizability –different kinds of polarization –Internal electric field in a dielectric-Clausius-Mossotti equation- dielectric loss- Dielectric breakdown-ferroelectric–types and models of ferroelectric transition–structural phase transitions – displacive transitions-electrets and their applications–piezoelectric and pyroelectric materials.

UNIT III SEMICONDUCTORS 9

Classification - Intrinsic and Extrinsic Semiconductor – Temperature dependence of conductivity-Effective mass of the electron-Carrier concentration in N type and P type Semiconductors-Carrier transport in Semiconductors-Theory of generation and recombination of charge carriers-Diffusion and conduction equations and Random motion-Continuity Equation-Schottky Junction-Ohmic contact and thermoelectric coolers-Optical absorption-Hall effect-Measurement of Hall coefficient-Application of Hall effect.

UNIT IV OPTICAL PROPERTIES 9

Optical absorption in insulators, semiconductors and metals – band to band absorption –Light scattering in materials-luminescence - Phosphor and super luminescent- LED principles-Heterojunction high intensity-LED characteristics-LED materials - liquid crystals - properties and structure - liquid crystal displays (LCD)-comparison between LED and LCD displays.

UNIT V ADVANCED MATERIALS 9

Metallic glasses - preparation, properties and applications - shape memory alloys – CCD device materials and applications - solar cell -Series and shunt Resistance-Solar cell materials Device and efficiencies - surface acoustic wave and sonar transducer materials and applications -

TOTAL: 45 PERIOD

PHYSICS OF MATERIALS LAB

Any **FIVE** experiments:

1. Hall effect - Determination of Hall co-efficient, charge carrier density and mobility
2. Creep characteristics of a metallic wire.
3. I-V characteristics of Solar cell, Photodiode
4. LED Characteristics.
5. Dielectric constant
6. Seebeck coefficient measurement
7. Electro optic effect

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After completing the course, the students should be able to

- Would have gained knowledge on various mechanical tests and plastic deformation mechanisms
- The students have gained knowledge on various properties of dielectric materials and their applications
- Make use of the fundamentals on semiconducting materials and their applications
- To gain knowledge on the properties of optical materials and their applications.
- Understood the basic knowledge of about advanced materials, preparation methods for nanomaterials and their properties and NLO materials

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1. V.Raghavan, Materials Science and Engineering: A First Course. PHIL earning,2013.
2. S.O.Kasap. Principles of Electronic Materials and Devices. Tata McGraw-Hill, New Delhi, 2007.
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5. N.W.Aschroft and N.D.Mermin, Solid State Physics, Rhinehart and Winton, New York.
6. J.S.Blakemore,1974,Solid state Physics, 2nd Edition, W.B.Saunder, Philadelphia.

Attested

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	2
CO2	2	1	3	2	1	2
CO3	2	1	2	2	2	2
CO4	2	1	2	3	2	2
CO5	2	1	2	3	1	2
Avg.	2.2	1	2.4	2.4	1.6	2

High – 3, Medium-2, Low -1

MC3211 **MATERIALS SCIENCE LAB–II** **L T P C**
0 0 6 3

OBJECTIVES:

- To make the students gain knowledge on the electrical conductivity of metals and alloys
- To make the students understand the semiconducting and magnetic properties of materials
- To make the students aware about the various techniques for growing single crystals.
- To expose the students to various types of mechanical behavior of materials
- To inculcate the students to apply their knowledge on various properties of materials

LIST OF EXPERIMENTS

Any ten experiments: **45**

1. Magnetic susceptibility - Quincke's method
2. Crystal Growth – Solution technique
3. Crystal Growth - Gel technique
4. Determination of melt flow index of polymers
5. Particle size determination using laser –
6. Determination of wavelength of He-Ne laser-Diffraction method
7. Ultrasonic interferometer – ultrasonic velocity in liquids
8. Ferromagnetism – Hysteresis loop - coercivity, retentivity and saturation magnetization
9. Fraunhofer diffraction - using laser

Strength of Materials Laboratory **45**

1. Tensile test on mild steel rod
2. Compression test on wood
3. Torsion test on mild steel rod
4. Impact test
5. Compression test on helical spring

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6. Deflection test on Carriage spring
7. Double shear test
8. Hardness shear test
9. Deflection test on metal beams
10. Tension test on helical spring

TOTAL: 90 PERIODS

COURSE OUTCOMES:

- The students will gain knowledge on the electrical conductivity of metals and alloys
- The students will acquire knowledge on the semiconducting and magnetic properties of materials
- The students will learn to grow single crystals using various techniques
- The students will be exposed to various mechanical behavior of materials
- The students will be able to analyse and apply their knowledge on various properties of materials

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	2	3	2	3	2
CO3	3	2	2	3	3	2
CO4	3	2	3	3	3	3
CO5	2	3	3	3	3	3
Avg.	2.6	2.2	2.6	2.8	2.8	2.4

High – 3, Medium-2, Low -1

MC3301 CRYSTALLOGRAPHY AND CRYSTAL GROWTH **L T P C**
4 0 0 4

OBJECTIVES:

- To introduce the basics of crystal symmetry and important crystal structures.
- To introduce the knowledge of X-ray production, optics, detection and fundamentals of X-ray diffraction.
- To familiarize with the instrumentation and interpretation of single crystal/powder diffractometry.
- To impact knowledge on basic theories of crystal growth.
- To gain knowledge on various crystal growth techniques.

UNIT I CRYSTAL SYMMETRY AND STRUCTURES 12

Symmetry operations, elements - translational symmetries - point groups - space groups - equivalent positions – close packed structures - voids - important crystal structures – Pauling's rules - defects in crystals – polymorphism and twinning.

UNIT II X-RAY DIFFRACTION 12

Generation of X-rays - laboratory sources – X-ray absorption – X-ray monochromators - X-ray detectors (principles only) - diffraction by X-rays - Bragg's law - reciprocal lattice concept - Laue conditions - Ewald and limiting spheres - atomic scattering factor - anomalous scattering - neutron and electron diffraction (qualitative only)

UNIT III SINGLE CRYSTAL AND POWDER DIFFRACTION 12

Laue, rotation/oscillation methods - interpretation of diffraction patterns - cell parameter determination – indexing – systematic absences - space group determination (qualitative only). Powder diffraction: Debye-Scherrer method – uses.

UNIT IV CRYSTAL GROWTH THEORY 12

Introduction to crystal growth - nucleation – Gibbs-Thomson equation - kinetic theory of nucleation - limitations of classical nucleation theory - homogeneous and heterogeneous nucleation – different shapes of nuclei – spherical, cap, cylindrical and orthorhombic – Temkins model – physical modeling of BCF theory.

UNIT V CRYSTAL GROWTH TECHNIQUES 12

Bridgman technique - Czochralski method - Verneuil technique - zone melting – gel growth – solution growth methods – low and high temperature solution growth methods – vapour growth - epitaxial growth techniques- LPE – MOCVD - MPE

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- The student can understand the basics of various crystal symmetries and their importance in crystal structures.
- Gain the understandings of phenomenon of X-ray diffraction.
- The students attain basic knowledge in crystallographic techniques and analyzing the data.
- The students gain in-depth knowledge on thermodynamic and other kinetic theories of crystal growth.
- The students can understand basic principles involved in the traditional crystal growth techniques.

REFERENCES

1. H.E.Buckley. Crystal growth. John Wiely& sons, NewYork,1981.
2. D.Elwell and H.J.Scheel. Crystal growth from high temperature solution. Academic Press, New York,1995.
3. R.A.Laudise. The growth of single crystals. Prentice Hall, Englewood,1970.
4. P.Ramasamy and P.Santhanaraghavan. Crystal growth processes and methods.
5. KRU Publications, 2000. L.V.Azaroff. Elements of X-ray crystallography. Techbooks,1992.
6. J.A.K.Tareen and T.R.N.Kutty. A Basic course in Crystallography. University Press, 2001.
7. C.Hammond. The Basics of Crystallography and Diffraction, IUCr-Oxford University Press, 2009.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	2
CO5	3	2	2	2	3	3
Avg.	3	2	2.4	2	2.6	2.4

High – 3, Medium-2, Low -1

MC3302 **POLYMER AND COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce polymers, their synthesis and polymerization techniques.
- To impart knowledge on the various properties of polymers.
- To gain knowledge of various polymer processing techniques, and applications.
- To introduce the fundamentals of composites and their mechanical behavior.
- To impart knowledge on the fabrication of different types of composites.

UNIT I INTRODUCTION TO POLYMERS 9

Classification of polymers – copolymers – tacticity – geometric isomerism – molecular weight distribution and averages –Measurement of molecular weight – synthesis of polymers – step growth polymerisation – chain growth polymerisation – polymerisation techniques.

UNIT II PROPERTIES OF POLYMERS 9

Polymer conformation and chain dimensions – Freely jointed chains- amorphous state – glass transition temperature – the crystalline state – ordering of polymer chains – crystalline melting temperature – techniques to determine crystallinity – Mechanical properties – Introduction to viscoelasticity – dynamic mechanical analysis – mechanical models of viscoelastic behaviour – Boltzmann superposition principle

UNIT III POLYMER PROCESSING, RHEOLOGY AND APPLICATIONS 9

Basic processing operations – extrusion, injection molding, blow molding, compression molding of Thermoplastics, calendaring, coating – Introduction to polymer rheology – non-Newtonian flow – analysis of simple flows – rheometry – capillary rheometer, Couette rheometer, cone and plate rheometer - applications-conducting polymers-biopolymers -liquid crystal polymers-photonic polymers-high temperature polymers.

UNIT IV INTRODUCTION TO COMPOSITES 9

Classification of composite materials – the concept of load transfer - matrix materials - polymers, metals and ceramics - fibers - glass, boron, carbon, organic and metallic fibers-fiber packing arrangements - particle reinforced composites - fibre reinforced composites – interface region –bonding mechanisms – mechanical behavior of composites.

UNIT V FABRICATION OF COMPOSITES 9

Polymer matrix composites – liquid resin impregnation routes, pressurized consolidation of resin pre-pregs, consolidation of resin moulding compounds– metal composites – squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, physical vapour deposition – ceramic composites – powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to understand

- the basics properties of polymers, their synthesis and various polymerization techniques
- the conformation, glass transition temperature, crystallinity and mechanical behaviour of polymers
- different polymer processing methods, and various applications of polymers
- classification of composites, matrix and reinforcement, and mechanical behavior of composites
- fabrication techniques of composites and apply them in practice.

REFERENCES

1. Joel R.Fried. Polymer Science and Technology. Pearson Prentice Hall, 2014.
2. V.R. Gowarikar, N.V.Viswanathan & J.Sreedhar. Polymer Science. New Age International, 2019.
3. R.J.Crawford. Plastics Engineering. Elsevier India, 2014.
4. D.Hull & T.W.Clyne. An Introduction to Composite Materials. Cambridge University Press, 2008.
5. P.K.Mallick. Fiber-Reinforced Composites: Materials, Manufacturing and Design. CRC Press,Boca Raton, 2008.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	3	3
CO2	2	3	2	3	3	3
CO3	3	2	2	3	2	3
CO4	3	2	2	3	2	3
CO5	2	2	3	3	3	2
Avg.	2.4	2.2	2.4	3	2.6	2.8

High – 3, Medium-2, Low -1

MC3303 PHYSICAL METALLURGY L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of phase diagrams.
- To impart knowledge about iron carbon phase equilibrium diagram and alloys.
- To expose the students to various heat treatment processes those are employed.
- To make the students to understand about various phase transformations.
- To introduce various engineering alloys and their applications.

UNIT I PHASE DIAGRAMS 9

The phase rule - Types of Binary Diagrams, – invariant reactions- eutectic, eutectoid, peritectic and peritectoid reactions – Microstructural changes during cooling- Thermodynamics, Solution theory - free energy composition curves for Binary systems – Experimental determination of equilibrium diagram-grain size analysis, grain size measurement - effect of grain size on properties of metals and alloys Iron- Carbon phase equilibrium diagram

UNIT II SOLID SOLUTION AND PHASE TRANSFORMATIONS 9

Types of solid solution – solid solution factors governing substitutional solubility – Hume-Rothery rules - intermediate phases -solid solution alloys – Vegards law – Lever rule - mechanical mixtures- Types of phase changes – Driving forces, N-G aspects, diffusion in solids – solidification – pearlitic transformations – martensitic transformations – kinetics of transformation - precipitation and age hardening.

UNIT III HEAT TREATMENT 9

Recovery, recrystallisation and grain growth: property changes, annealing twins, textures in cold worked and annealed alloys, – Effect of alloying elements- TTT diagrams – CCT diagrams – heat-treatment processes –annealing, normalising, quenching and tempering – baths used in heat treatment – hardenability – Jominy's end quench test – martempering and austempering – case hardening – induction, flame, laser - carburising, cyaniding, nitriding, carbo nitriding.

UNIT IV CORROSION AND ITS PREVENTION 9

Galvanic cell - Types of corrosion cells - Electrode potentials - standard electrode potentials - Nernst equation - Pourbaix diagrams - Galvanic series in sea water - Polarization - Passivation - Pitting - General methods for corrosion prevention - cathodic protection - coatings - metallic and non metallic - corrosion prevention by alloying - stress corrosion cracking - mechanisms of crack growth.

UNIT V ENGINEERING ALLOYS 9

Low carbon steels – mild steels –Micro alloyed steels - Applications - Medium carbon steels - high strength structural steels – tool materials – stainless steels – super alloys – light alloys – Aluminum alloys – Copper alloys - shape memory alloys – applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students would be able to construct phase diagrams.
- The students would have gained knowledge on Iron-Carbon phase equilibrium diagram.
- Students would be able to apply the various heat treatment processes.
- Students would gain knowledge on phase transformations.
- To analyze the various properties of engineering alloys and apply them.

REFERENCES

1. V.Raghavan, Physical Metallurgy: Principles and Practice. PHI Learning Private Limited, NewDelhi, 2015.
2. A.G.Guy and J.Hren, Elements of Physical Metallurgy. Oxford Univ. Press, 1984.
3. S.H.Avner, Introduction to Physical Metallurgy. Mc Graw Hill Education, 2017.
4. Robert E.Reed, -Hill Physical Metallurgy Principles. Affiliated East-West Press, 2008.
5. I.S.Polmear, Light Alloys. Metallurgy and Materials Science, 1995
6. W.F.Smith, Structural Properties of Engineering Alloys, McGraw Hill Education, 2014.
7. Y.Lakhtin, Engineering Physical Metallurgy. CBS Publishers & Distributors, 2005.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	1	2
CO3	2	2	3	2	2	1
CO4	2	2	2	2	3	3
CO5	2	2	2	2	3	2
Avg.	2.4	2	2.6	2	2.2	2

High – 3, Medium-2, Low -1

MC3311 MATERIALS SCIENCE LAB - III AND MINI PROJECT

L	T	P	C
0	0	6	3

OBJECTIVES:

- To understand the basic property measurements governing fundamental physics
- To train the students in hands-on experience with various sophisticated materials characterization techniques.
- To make the students to visualize the experimental data and interpretation of results.
- To expose the students about the introductory concepts of computational materials science.
- To train the students to do independent research and ability to write and present the technical report.

LIST OF EXPERIMENTS

Any Ten experiments

1. Density measurements – organic materials and polymers
2. NDT – Ultrasonic flaw detector
3. Faraday effect
4. X-ray powder method – indexing, cell determination and identification of unknown elements
5. Charge density, atomic scattering factor calculations.
6. Laser coherence, divergence measurement.
7. Optical Fibre – Measurement of numerical aperture and bending loss.
8. Preparation of buffer solutions and pH measurements.
9. Laser Raman - sample preparation, recording and analysis
10. Etch pattern of single crystals.
11. MATLAB/SCILAB/MATERIALS STUDIO – simple programs and plots.
12. Synthesis of Nanomaterials.
13. X Crys Den – Crystal Structure Tool.
14. VESTA – Molecular Structure Tool.

TOTAL: 45+45 = 90 PERIODS

B. MINI PROJECT

COURSE OUTCOMES:

- The students can have familiarity about the basic property measurements governing fundamental physics.
- The students can attain the higher knowledge on hands-on experience with various sophisticated materials characterization techniques.
- The students can have knowledge on visualizing the experimental data and interpretation of results.
- The students can gain knowledge on the computational materials science by utilizing suitable computer suites.
- The students will get insight in doing independent research and consolidating the technical report.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	2
CO2	3	2	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg.	3	2.4	3	3	2.8	2.8

High – 3, Medium-2, Low -1

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MC3001 SEMICONDUCTOR MATERIALS AND DEVICES **L T P C**
3 0 0 3

OBJECTIVES:

- To give theoretical fundamental understanding on the Physics of semiconductors
- To make the students to understand transport properties of charge carriers in semiconductors.
- To familiarize the students with the materials used for making semiconductor devices
- To educate the students about making of semiconductor junctions and transistors
- To give an overview on the applications of semiconductors devices in various fields.

UNIT I INTRODUCTION: FORMATION OF ENERGY BANDS & BAND-GAP 9

Drude theory – Quantum state and degeneracy – Crystal structure and properties - Electrons in periodic potential, Bloch's theorem in one dimension, Fundamentals of band structure: Formation of energy bands in solids, classification of materials on the basis of the band structure, Origin of the energy gap (qualitative discussions). Reciprocal space - Brillouin zone, concept of effective mass and holes, Intrinsic carrier statistics - Temperature dependence of carrier concentration.

UNIT II DOPING AND TRANSPORT PROPERTIES IN SEMICONDUCTORS 9

Direct and indirect band gaps – Electron and holes –Types of defects – Doping - Influence of intrinsic defects and dopants on the electrical properties –Temperature-dependent carrier concentration profile in extrinsic semiconductors- High doping effects and incomplete ionization – Types of recombination- Carrier scattering and mobility - Low-field and high-field transport, drift and diffusion - Current continuity equation–Characterizing defects: Hall-effect measurement.

UNIT III SEMICONDUCTOR MATERIALS 9

Elemental semiconductors - Compound (III - V and II – VI) semiconductors and their Examples – Types of semiconductors: Magnetic semiconductors, Polarized Semiconductors – Oxide Semiconductors –Organic Semiconductors – Wide-band-gap semiconductors and their applications –Intermediate band-gap semiconductors –Heterostructures – Lattice matching and band bending– Charge transport at the interface.

UNIT IV SEMICONDUCTOR JUNCTIONS AND TRANSISTORS 9

Introduction to p-n junction – p-n junction under bias –Formation of diodes -Schottky junction under equilibrium and bias – Ohmic contacts- p-n, n+-n, p+-p junctions – Transistors: Bipolar Junction transistors (BJT) - Working of Junction Field-Effect Transistors (JFET)- Basics and working of Metal-Oxide Semiconductor FET (MOSFET) – Basics and working of Metal-Semiconductor FET – Transistors for power electronics.

UNIT V SEMICONDUCTOR DEVICES 9

Optical absorption in semiconductors– band to band absorption –luminescence – Photoconductivity- Semiconductors in sensors - Light emitting diodes (LED) and the LED materials –Semiconductor lasers - Solar cells – Semiconductors in photocatalysis - Optically Stimulated Luminescence for radiation detection – Semiconductors in novel healthcare technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Understand the theoretical background of electronic band formation in semiconductors.
- Appreciate different types of defects and influence of dopants on semiconductors
- Gain knowledge on various types of semiconductor materials.
- Get a fundamental understanding on junctions and various junction devices.
- Understand the different application areas of semiconductors.

Attested

REFERENCES:
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2. Charles Kittel. Introduction to Solid State Physics. Wiley, 2021.
3. M. Ali Omar. Elementary Solid-State Physics. Pearson Education, 2002.
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5. A.J Dekker. Solid State Physics. Macmillan India, 2000.
6. The Physics of Semiconductors – Marius Grundmann – Springer 3rd Edition 2016.
7. The Physics of Solids- Essentials and Beyond – Eleftherios N. Economou, Springer 2010.

Additional Books:
1. H.P. Myers, Introductory Solid-State Physics, 2nd edition, Viva Books Pvt. Ltd (1998)
2. S. O. Pillai, "Solid State Physics", New age International Pvt Ltd, 6th edition, 2005.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	1
CO2	2	2	2	1	1	1
CO3	2	2	2	1	1	1
CO4	2	2	2	1	1	1
CO5	2	2	2	1	1	1
Avg.	2	2	2	1	1	1

High – 3, Medium-2, Low -1

MC3002 PYTHON PROGRAMMING **L T P C**
3 0 0 3

OBJECTIVES:
- To introduce the concepts of algorithms and developing them.
- To make the students to understand different types of data, expressions and statements in Python environment.
- To elucidate the aspects of control flow and functions in Python environment.
- To introduce the concepts of lists, tuples and dictionaries in Python environment.
- To make the students to use files, modules and packages.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

Attested

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNITV FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completing this course, the students should able to

- Develop algorithms.
- understand different types of data, expressions and statements in Python environment.
- Make use of control flow and functions in Python environment.
- Use lists, tuples and dictionaries in Python environment.
- use files, modules and packages Python programming environment.

REFERENCES

1. Kenneth Lambert. Fundamentals of Python: First Programms. Cengage Learning,2012.
2. Mark Lutz. Learning Python. O'Reilly Media,2013.
3. Eric Matthes. Python Crash Course. No Starch Press,2015.
4. R.Nageswara Rao. Core Python Programming. Dreamtech Press,2018.
5. Yuxi Liu. Python Machine Learning by Example. Packt Publishing Ltd.,2017.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	2	2	3	2	2	2
CO3	3	1	2	2	3	1
CO4	2	2	2	2	2	2
CO5	2	2	2	2	1	3
Avg.	2.4	1.8	2.4	2	2	2

Attested

High – 3, Medium-2, Low -1

MC3003 **MATERIALS PROCESSING** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basics of manufacturing processes.
- To impart the knowledge about surface treatment processes.
- Teaching the students about various processes of welding.
- To teach the students about mechanical working of metals.
- To understand the knowledge about powder metallurgical processes.

UNIT I BASIC MANUFACTURING PROCESSES 9

Fundamental analysis of Manufacturing processes, casting, casting processes, forging, methods of forging, extrusion, rolling, spinning, turning, planning and shaping, milling, grinding.

UNIT II SURFACETREATMENT PROCESSES 9

Necessity for surface modification, surface cladding, surface alloying, hard facing, shock hardening, conventional methods, carburising, nitriding, cyaniding, advantages of laser surface treatment over conventional methods, typical laser variables used in surface alloying, laser cladding, experimental setup.

UNIT III WELDING PROCESSES 9

Various processes of welding, fusion welding, pressure welding, oxyacetelene welding, resistance welding, spot welding, thermit welding, hermetic welding, projection welding, seam welding, butt welding, thermal effects of welding, effects on grain size and microstructure, internal stresses effect, corrosion effect, high energy beam welding, laser beam and electron beam welding, key hole effect.

UNIT IV MECHANICAL WORKING OF METALS 9

Hot working, cold working, normalising, full annealing, tempering, theory of tempering, effect of tempering temperature on mechanical properties of carbon steels, different tempering process, deformation of metals, elastic deformation, plastic deformation, slip, twinning – assessment of processed materials.

UNIT V POWDER METALLURGICAL PROCESS 9

Production of powders, powder mixing, compacting, types of presses, sintering, soaking, finishing process, limitations and advantages of powder metallurgy, applications , production of cemented carbide cutting tools, self lubricating bearings, magnets, cermets, ultrasonic ceramic transducers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will gain the knowledge about the basics of various manufacturing processes.
- The students will learn the various surface treatment processes.
- The students will understand the different welding techniques.
- The students will have better knowledge with mechanical working of metals.
- The students will get clear understanding of powder metallurgical process.

REFERENCES

1. T.V.Rajan, C.P.Sharma and A. Sharma. Heat Treatment: Principles and Techniques. Prentice Hall India Learning Private Limited,2010.
2. M.K.Muralidhara. Materials Science and Processes. Dhanpat Rai Publishing Co., New Delhi, 1998.
3. Rykalin, Uglov A, Kokona, A Laser and Electron beam material processing hand book, MIR Publishers, 1987.
4. R.B.Gupta. Materials Science and Processes. Satya Prakashan, New Delhi,1995.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	2	2	3	2	2	2
CO4	3	2	3	2	3	2
CO5	3	2	2	2	3	2
Avg.	2.8	2	2.8	2	2.4	2

High – 3, Medium-2, Low -1

MC3004 LASER AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

To introduce knowledge on basics of lasers and its application

- To make the students understand about theoretical studies on laser systems.
- To impact the basic knowledge on laser system compound.
- To introduce the knowledge about various laser systems.
- The students will be able to know about laser system used for materials processing.
- To impact knowledge on the laser applications.

UNIT I PRINCIPLES OF LASERS 9

Spontaneous emission, Stimulated emission, Einstein coefficients, ratio of rates of stimulated and spontaneous emission – Threshold condition for laser action – Rate equations – Population inversion in three level and four level systems.

UNIT II OPTICAL RESONATORS 9

Resonant cavities, Gaussian beam characteristics, resonator modes, spot size – Types of resonators, geometries, quality factor of an optical resonator – Q-switching and Mode locking concepts and techniques.

UNIT III LASER SYSTEMS 9

Gas lasers: He-Ne laser, Carbon dioxide gas laser, Nitrogen gas laser, Argon ion gas laser – Solid state lasers: Ruby laser, Nd-YAG laser, fiber laser, Ti-Sapphire- Semiconductor Laser– homojunction and heterojunction lasers- Liquid Lasers: Dye lasers – Femto-second laser.

UNIT IV MATERIALS PROCESSING 9

Laser power density – heat affected zone - Welding - Fusion depth and welding geometry - Welding speeds - Advantages and uses of laser welding - Drilling hole geometry - Advantages and uses of laser drilling - resistor trimming - Capacitor height adjustment and fabrication, Scribing – Controlled fracturing.

Attested

UNIT V APPLICATIONS **9**

Metrology - interferrometric techniques - Laser ranging and tracking - Laser Doppler velocimetry - Ring laser and rotation sensing - Pollution monitoring - Holography and speckle in displacement and deformation measurements – ions – Medical applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of course, the students should be able to

- Understood the principle involved in Einstein coefficient and laser action.
- Gained knowledge on laser compound and Q switching mode focusing concepts.
- Understand the basic knowledge about various laser systems working methods.
- The students have gained knowledge on various laser processing methods and advantages.
- The students would have known the laser applications on industrial and medical fields.

REFERENCES

1. D.C.O'Shea, W.R.Callen and W.T.Rhodes. An Introduction to Lasers and their Applications. Pearson,1977.
2. J.T. Verdeyen. Laser Electronics. Prentice Hall,1990.
3. S.S. Charchan. Lasers in Industry. Van Nostrand Reinhold Co.,1975.
4. B.B.Laud. Lasers and Non-Linear Optics. New Age International (P) Ltd.2011
5. M.Steen William. Laser Material Processing. Springer,2010.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	2
CO5	3	2	2	2	3	3
Avg.	3	2	2.4	2	2.6	2.4

High – 3, Medium-2, Low -1

MC3005 NON-DESTRUCTIVE TESTING **L T P C**
3 0 0 3

- To introduce the students to liquid penetrant and magnetic particle inspection.
- To make the students understand the principle, working and uses of radiographic testing.
- To impart knowledge about the ultrasonic testing.
- To make the students understand the principle, working and application of eddy current technique.
- To expose the thermal and optical methods used in NDT.

UNIT I INTRODUCTION AND SURFACE NDT METHODS **9**

Definition of terms, discontinuities and defects/flaws – fracture mechanics concept of design and the role of NDT – life extension and life prediction – penetrant testing and magnetic particle testing, basic principle of penetrant testing – limitations and advantages – basic principle involved in magnetic particle testing – development and detection of large flux – longitudinal and circular magnetization – demagnetization.

UNIT II RADIOGRAPHIC TESTING 9

Properties of X-rays and gamma rays – attenuation and differential attenuation – interaction of radiation with matter – Principle of radiographic testing and recording medium – films and fluorescent screens – non imaging detectors – film radiography – calculation of exposure for X-ray and gamma rays – quality factors – Image quality indications and their use in radiography – neutron radiography.

UNIT III ULTRASONIC TESTING 9

Ultrasonic waves – velocity, period, frequency and wavelength – reflection and transmission – near and far field effects and attenuation – generation – piezoelectric and magnetostriction methods – normal and angle probes – methods of Ultrasonic testing – Principle of pulse echo method – Equipment – examples – rail road inspection, wall thickness measurement – range and choice of frequency.

UNIT IV EDDY CURRENT TESTING 9

Introduction – Principles of eddy current inspection – conductivity of a material – magnetic properties – coil impedance – lift off factor and edge effects – skin effect – inspection frequency – coil arrangements – inspection probes – types of circuit – Reference pieces – phase analysis – display methods – typical applications of eddy current techniques.

UNIT V THERMAL AND OPTICAL METHODS 9

Imaging – principle and applications – testing of composites – acoustic emission testing – application of AET – on-line monitoring or continuous surveillance and applications in materials science – Optical methods of NDT – photo elasticity – evaluation procedure – Holographic NDT procedure – speckle phenomenon – speckle interferometry – speckle shear interferometry – Fourier optics – Fourier filtering techniques for non-destructive testing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will learn about liquid penetrant and magnetic particle inspection.
- The students will understand the principle, working and uses of radiographic testing.
- The students will gain knowledge on ultrasonic testing.
- The students will be able to apply their knowledge on eddy current technique.
- The students would be able to analyse the thermal and optical methods used in NDT.

REFERENCES

1. B.Hull and V.John. Non-Destructive Testing. Springer-Verlag New York Inc,2012.
2. Metals Hand Book, Vol.2, 8th Edition, ASTM, Metals Park,Ohio.
3. J.C.Dainty. Laser Speckle & Related Phenomena, Springer-Verlag, New York,1984.
4. W.J.McGonnagle. Non-Destructive Testing Methods, Mc Graw Hill Co., NY,1961.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	1
CO2	2	1	3	3	3	1
CO3	2	1	2	2	3	1
CO4	2	1	2	3	3	1
CO5	2	1	2	2	3	1
Avg.	2	1.2	2.4	2.6	3	1

Attested

High – 3, Medium-2, Low -1

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MC3006 **BIOMATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the response of biomaterials to host environment, and host response to biomaterials
- To introduce various materials used in bone and joint replacement
- To gain knowledge about materials used in cardiovascular implants
- To know about dental materials and dental implants
- To impart knowledge on soft tissue and drug delivery materials.

UNIT I BIOLOGICAL PERFORMANCE OF MATERIALS 9
Biocompatibility- introduction to the biological environment – material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process - coagulation and hemolysis- approaches to thrombo- resistant materials development

UNIT II ORTHOPAEDIC MATERIALS 9
Bone composition and properties - temporary fixation devices - joint replacement – biomaterials used in bone and joint replacement: metals and alloys – stainless steel, cobalt based alloys, titanium based materials – ceramics: carbon, alumina, zirconia, bioactive calcium phosphates, bio glass and glass ceramics – polymers: PMMA, UHMWPE/HDPE, PTFE – bone cement – composites.

UNIT III CARDIOVASCULAR MATERIALS 9
Blood clotting – blood rheology – blood vessels – the heart – aorta and valves – geometry of blood circulation – the lungs - vascular implants: vascular graft, cardiac valve prostheses, cardiac pacemakers – blood substitutes – extracorporeal blood circulation devices

UNIT IV DENTAL MATERIALS 9
Teeth composition and mechanical properties – impression materials – bases, liners and varnishes for cavities – fillings and restoration materials – materials for oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives

UNIT V SOFT TISSUE MATERIALS 9
Biomaterials in ophthalmology – viscoelastic solutions, contact lenses, intraocular lens materials – tissue grafts – skin grafts – connective tissue grafts - suture materials – tissue adhesives – drug delivery: methods and materials – selection, performance and adhesion of polymeric encapsulants for implantable sensors

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the students should able to

- understand the response of biomaterials to host environment, and host response to biomaterials
- know and prepare various materials used in bone and joint replacement
- gain knowledge on materials used in synthetic blood vessels, pacemakers and in other cardiovascular implants
- to prepare impression materials and dental cements, and know about dental implants
- to gain knowledge on soft tissue replacement and drug delivery materials.

REFERENCES

1. Sujata V. Bhat. Biomaterials. Springer,2014.
2. J.Park&R.S.Lakes. Biomaterials: An Introduction. Springer,2010.
3. J. Black. Biological Performance of Materials: Fundamentals of Biocompatibility. Marcel Dekker Inc, New York,1992.
4. D.F.Williams(editor). Materials Science and Technology: A Comprehensive treatment, Volume 14. Medical and Dental Materials. VCH Publishers Inc, New York,1992.
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6. B.D.Ratner, A.S.Hoffman, F.J.Schoen & J.E.Lemons. Biomaterials Science: An Introduction to Materials in Medicine. Academic Press, 2004.

Attested

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	2	2	3	3	3	2
CO3	2	2	3	3	3	2
CO4	2	2	2	3	3	2
CO5	2	3	2	2	3	2
Avg.	2.2	2.2	2.4	2.8	3	2

High – 3, Medium-2, Low -1

MC3007 NONLINEAR OPTICAL MATERIALS

L T P C
3 0 0 3

OBJECTIVES:

- To make the students aware of the various characterization techniques based on non-linear optics
- To educate the students about the important properties of Non-linear optical materials
- To make the students aware of the various Inorganic Non-linear materials
- To educate the students about various Organic Non-linear materials
- To make the students aware of the various applications of Non-linear Materials

UNIT I INTRODUCTION TO NON-LINEAR MATERIALS 9

Second harmonic generation –Optical Kerr Effect-electro optic co-efficient-chemical inertness - Nonlinear Birefringence - Pulse Shaping- Nonlinear Phase Shift-Velocity Dispersion - Nonlinear wave propagation-Nonlinear refraction- Fibre Modes- Soliton characteristics

UNIT II INORGANIC NON-LINEAR MATERIALS 9

Potassium di hydrogen phosphate (KDP) - potassium titany1 phosphate (KTP) - ammonium dihydrogen phosphate (NH4H2PO4) 3-4, potassium dihydrogen phosphate (KH2PO4), Lithium formate monohydrate, potassium niobate (KNbO3) and barium titanate (BaTiO3) potassium pentaborate (KB5O84H2O and ammonium pentaborate (NH4B54H2O) urea, potassium titanyl phosphate, beta barium borate and lithium borate

UNIT III ORGANIC NON-LINEAR MATERIALS 9

Nonlinear optical (NLO) response in organic molecules -Semiorganic Non-linear materials- alkynes- heterocycles- dyes- ferrocenes-spiranes- porphyrins- nonlinear optical fullerenes

UNIT IV NLO CHARACTERIZATION TECHNIQUES 9

Raman/Brillouin gain measurement techniques -Second-order wave mixing- Third-order parametric wave mixing- Third-order polarization rotation- Beam distortion/absorption- Nonlinear interferometry- Third-order nonlinear imaging

UNIT V APPLICATIONS OF NON-LINEAR MATERIALS 9

Harmonic generation and up-conversion-optical parametric oscillator- frequency conversion of ultrashort pulses- frequency conversion of high average power sources- frequency conversion of low average power sources - laser fusion- Fibre Interferometers -Fibre Gratings- organic photovoltaics (OPVs) and organic thin-film transistors (OTFTs)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Students will gain knowledge about the various characterization techniques based on non-linear optics like Nonlinear interferometry- Third-order nonlinear imaging etc.
- Students will be educated about the important properties of Non-linear optical materials Like Velocity Dispersion-Non linear wave propagation-Non linear refraction-Fibre Modes-Soliton characteristics etc.
- Students will be aware of the various Inorganic Non-linear materials.
- Students will learn about various Organic Non-linear materials.
- Students will acquire knowledge of the applications of Non-linear Materials in Fibre Gratings - organic photovoltaics (OPVs) and organic thin-film transistors (OTFTs) etc.

REFERENCES

1. G P Agrawal, Nonlinear fiber optics (Academic, San Diego, 1989)
2. G. New, Introduction to Nonlinear Optics, Cambridge University Press, New Delhi, 2011.
3. G P Agrawal, Nonlinear fiber optics (Academic Press) 2012.
4. G.P. Agrawal “” Applications of Nonlinear Optics”, Academic Press 2013
5. Y.V.G.S. Murti and C. Vijayan. Essentials of Nonlinear Optics.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	2
CO5	3	2	2	2	3	3
Avg.	3	2	2.4	2	2.6	2.4

High – 3, Medium-2, Low -1

MC3008 SUPERCONDUCTING MATERIALS AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic experimental aspects of the superconductivity.
- To know about superconducting materials and its alloys.
- To make the students to understand the experimental studies of superconducting materials.
- To inspire the theoretical aspects of superconductivity.
- To progress the students with various application in superconductivity.

UNIT I INTRODUCTION TO SUPERCONDUCTIVITY 9

Zero electrical resistance – Meissner effect – a.c. diamagnetic susceptibility – heat capacity – optical absorption by superconductor – entropy change –thermal conductivity – destruction of superconductivity by external magnetic fields – type I and type II materials – superconducting behaviour under high pressures –flux quantisation – normal and Josephson tunneling.

UNIT II SUPER CONDUCTING MATERIALS 9

Elemental superconductors – superconducting compounds and its alloys – A-I5 compounds – chevral phase compounds

UNIT III THEORY OF SUPERCONDUCTIVITY 9

Isotope effect – BCS theory – Role of electrons and phonons – applications of electron band structure results to calculate electron-phonon coupling constant McMillan's formula – GLAG theory-recent theories on high Tc materials, Coherence length, expression for critical temperature Tc, critical field Hc, critical current Jc – heavy fermion superconductivity.

UNIT IV HIGH TEMPERATURESUPERCONDUCTORS 9

La-Ba-Cu-O,Y-Ba-cu-O, Bi-Sr-Ca-Cu-O and new systems and their crystal structures – Experimental studies on the new materials – organic superconductors –fullerenes.

UNIT V APPLICATIONS 9

Superconducting magnets – power generators, motors, transformers, power storage, power transmission – Josephson junction devices – IR sensors – SQUIDS –SLUGS – magnetically leviated trains – computer storage elements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will understand the basic concepts of superconductivity.
- Gain knowledge in superconducting materials.
- Crack the experimental studies of superconducting materials.
- Apply the theoretical aspects of superconductivity.
- The students will able to understand various technological application of the super conductivity.

REFERENCES

1. A.V.Narlikar and Ekbote. Introduction to Superconductivity. South Asia publishers,1983.
2. D.R.Tilley and Tilley. Superfluidity and Superconductivity. Adam Hilger,1986.
3. H.S.Kowk and D.T.Shaw (Eds.). Superconductivity and its Applications. Elsevier Science Publishing, 1988.
4. A.V.Narlikar. Studies on High temperature superconductors- Advances in research and applications. Nova Scientific, New Delhi,1990.
5. M.Tinkham. Introduction to Superconductivity. CBS Publishers & Distributors, New Delhi, 2008.
6. S.Blundell. Superconductivity: A Very Short Introduction. Oxford University Press,2009.
7. J.R.Schrieffer, Theory of Superconductivity, Levant Books,2009.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	3	3	2
CO2	2	2	2	3	2	2
CO3	2	1	2	2	2	2
CO4	2	2	2	3	2	2
CO5	2	1	2	2	2	2
Avg.	2	1.4	2	2.6	2.2	2

High – 3, Medium-2, Low -1

Attested

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MC3009 MECHANICAL PROPERTIES OF MATERIALS

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To explain principles behind elasticity, viscoelasticity and rubber elasticity.
- To provide insights into plastic deformation under tension and compression, and hardness testing methods.
- To explain macroscopic aspects of fracture in the context of microscopic mechanisms, and various fracture testing methods.
- To explain the mechanisms of creep and development of heat resistant materials.
- To impart understanding of fatigue mechanisms and fatigue tests.

UNIT I ELASTICITY AND VISCOELASTICITY 9

Longitudinal stress and strain - strain energy density- shear stress and strain - poisson's ratio - complex states of stress - graphical solution of a biaxial state of stress: the Mohr circle - pure shear: relationship between G and E - anisotropic effects - elastic properties of polycrystals- elastic properties of metals, ceramics and polymers - elastic constants of unidirectional fiber reinforced composite – viscoelasticity - storage and loss moduli - rubber elasticity – Mooney-Rivlin equation.

UNIT II PLASTICITY 9

Plastic deformation in tension: tensile curve parameters, necking, strain rate effects - plastic deformation in compression testing - the Bauschunger effect- plastic deformation of polymers: stress - strain curves, glassy polymers, semicrystalline polymers, viscous flow-plastic deformation of glasses: microscopic deformation mechanism - temperature dependence and viscosity - flow, yield, and failure criteria – hardness: macroindentation tests - microindentation tests - nanoindentation.

UNIT III FRACTURE 9

Macroscopic aspects: theoretical tensile strength, stress concentration and Griffith criterion of fracture, crack propagation with plasticity, linear elastic fracture mechanics, fracture toughness - microscopic aspects: fracture in metals, fracture in ceramics, fracture in polymers - fracture testing: impact testing, plane-strain fracture toughness test, crack opening displacement testing, j-integral testing, flexure test (three-point bend test, four-point bending), fracture toughness testing of brittle materials (Chevron notch test , indentation methods for determining toughness).

UNIT IV CREEP 9

Fundamental mechanisms responsible for creep - diffusion creep - dislocation creep-dislocation glide - grain-boundary sliding - deformation-mechanism (Weertman-Ashby) maps - creep-induced fracture - heat resistant materials -creep in polymers – super plasticity.

UNIT V FATIGUE 9

Fatigue parameters and S-N curves - fatigue strength - effect of mean stress on fatigue life - effect of frequency - mechanisms of fatigue: fatigue crack nucleation, fatigue crack propagation - linear elastic fracture mechanics applied to fatigue - environmental effects in fatigue - fatigue testing: conventional fatigue tests, rotating bending machine, nonconventional fatigue testing, low-cycle fatigue tests, fatigue crack propagation testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the subject, the student should be able to:

- understand elastic and viscoelastic behavior of materials.
- understand the mechanism of plastic deformation and origin of materials strength.
- design and select engineering components based on the principles of fracture mechanics.
- understand high temperature mechanical behavior of materials and be able to select the materials for high temperature applications.
- improve materials resistance to fatigue fracture.

REFERENCES
1. M.A.Meyers and K.K.Chawla. Mechanical Behavior of Materials. Cambridge University Press,2009.
2. Norman E. Dowling. Mechanical Behavior of Materials. Pearson Education, 2017.
3. Thomas H. Courtney. Mechanical Behavior of Materials. McGraw Hill Education,2017.
4. J.Roesler, H.Harders & M.Baeker. Mechanical Behaviour of Engineering Materials: Metals, Ceramics, Polymers, and Composites. Springer,2010.
5. William F. Hosford. Mechanical Behavior Of Materials. Cambridge University Press, 2012.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	2
CO2	3	1	2	2	3	2
CO3	2	1	2	2	3	2
CO4	2	1	2	3	3	2
CO5	2	1	2	2	3	2
Avg.	2.4	1.2	2	2.2	3	2

High – 3, Medium-2, Low -1

MC3010 INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY **L T P C**
3 0 0 3

OBJECTIVES:
- To make the students understand the structure and properties of nanomaterials.
- To educate students about the various synthesis methods of nanostructure materials
- To introduce the students about quantum dots.
- To give awareness about characterization of materials like crystallite size analysis, scanning etc.,
- To inspire the nanotechnology applications.

UNIT I NANOSCALE SYSTEMS 9

Length, energy, and time scales - Quantum confinement in 3D, 2D, 1D and zero dimensional structures - Quantum confinement of electrons in semiconductor nanostructures- Size effect and properties of nanostructures- Top down and Bottom-up approach.

UNIT II SYNTHESIS OF NANOSTRUCTURE MATERIALS 9

Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – laser ablation- Sol-Gel- Ball milling –Electro deposition- electroless deposition – spray pyrolysis – plasma-based synthesis process (PSP) - hydrothermal synthesis – carbon nanotubes and graphene synthesis.

UNIT III QUANTUM DOTS 9

Excitons and excitonic Bohr radius – nanoparticles and quantum dots - Preparation through colloidal methods - Epitaxial methods- MOCVD and MBE growth of quantum dots - Absorption and emission spectra - photo luminescence spectrum - optical spectroscopy – linear and nonlinear optical spectroscopy.

Attested

UNIT IV CHARACTERIZATION 9

Crystallite size analysis using Scherrer formula - Particle size measurement using DLS and HRTEM - Atomic Force Microscopy (AFM) and Scanning tunneling microscopy (STM) - applications to nanostructures – Nanomechanical characterization – Nanoindentation – femotosecond laser.

UNIT V NANOTECHNOLOGY APPLICATIONS 9

Applications of nanoparticles, quantum dots, nanotubes and nanowires for nanodevice fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of dip pen lithography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Plan and develop the application of semiconductor nanomaterials
- Familiar with various synthesizing methods.
- Workout various quantum dot synthesis.
- Advance the applications of nanostructures and nanomechanical characterization.
- The students can understand the importance of nanoscience and technology with the fundamental concepts behind size reduction.

REFERENCES

1. G. Timp. Nanotechnology.AIP press, Springer-Verlag, New York, 1999.
2. Hari Singh Nalwa. Nanostructured materials and nanotechnology. Academic Press, USA, 2002.
3. Hari Singh Nalwa. Hand book of Nanostructured Materials and Technology. Vol.1-5. Academic Press, USA, 2000.
4. Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series), Kluwer Publishers, 2002.
5. C.J. Brinker and G.W. Scherrer. Sol-Gel Science. Academic Press, Boston, 1994.
6. N John Dinardo. Nanoscale Characterization of Surfaces &Interfaces.Weinheim Cambridge: Wiley-VCH, 2000.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	2	1
CO2	2	1	3	2	2	1
CO3	3	2	2	2	1	1
CO4	2	1	2	2	1	1
CO5	1	2	2	2	2	1
Avg.	2	1.6	2.4	2	1.6	1

High – 3, Medium-2, Low -1

MC3011 CORROSION SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students to corrosion process and corrosion control.
- To make the students understand the methods used for testing corrosion.
- To introduce the different methods used for coating.
- To impart knowledge on various types of corrosion with respect to corrosion.
- To expose the students to various application of coating.

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UNIT I CORROSION PROCESSES 9

Basic principles of electrochemistry and aqueous corrosion processes - Electrochemical Thermodynamics and Electrode Potential - Electrochemical Kinetics of Corrosion Cathodic and anodic behavior - Faraday's Law - Nernst equation; standard potentials Pourbaix diagram - Tafel equations, corrosion rate - Evans diagram - pitting, crevice and exfoliation corrosion; influence of deposits and anaerobic conditions; corrosion control; high temperature oxidation and hot corrosion; corrosion/mechanical property interactions.

UNIT II CORROSION TESTING 9

Materials and specimens – surface preparation – measuring and weighing – linear polarization – AC impedance – *in vivo* corrosion – paint tests – seawater tests.

UNIT III COATING MANUFACTURE 9

Electrodeposition; flame and plasma spraying; thermal, HV of detonation gun, physical vapour deposition; chemical vapour deposition; HIP surface treatments.

UNIT IV CORROSION IN SELECTED ENVIRONMENTS 9

Atmospheric Corrosion, Corrosion in Automobiles, Corrosion in Soils, Corrosion of Steel in Concrete, Corrosion in Water, Microbiologically Induced Corrosion, Corrosion in the Body, Corrosion in the Petroleum Industry, Corrosion in the Aircraft Industry, Corrosion in the Microelectronics Industry

UNIT V COATING APPLICATIONS 9

Abrasive, erosive and sliding wear. The interaction between wear and corrosion. Coating systems for corrosion and wear protection; new coating concepts including multi-layer structures, functionally gradient materials, intermetallic barrier coatings and thermal barrier coatings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students would have learnt various corrosion process and corrosion control.
- The students would have understood the methods used for testing corrosion.
- They analyze and apply the different methods for coating.
- The students would have gained knowledge on corrosion type with respect to environment.
- The students would have learnt about the various concepts and applications of coating.

REFERENCES

1. Denny A.Jones. Principles and Prevention of Corrosion. Pearson,2013.
2. J.O.M.Bockris, B.E.Conway, E.Yeager and White. Electrochemical Materials Science in Comprehensive Treatise of Electrochemistry, Volume 4. Plenum press,2001.
3. M.G.Fontana. Corrosion Engineering, McGraw Hill Education,2017.
4. I.Hutchings and Philip Shipwar. Tribology: Friction and Wear of Engineering Materials. Butterworth-Heinemann,2017.
5. D.O. Sprowds. Corrosion Testing and Evaluation. Corrosion Metals Hand book, Vol. 13, 1986.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	3	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	1	2	3	3	2
CO5	2	1	2	2	2	2
Avg.	2	1.6	2	2.2	2.4	2

Attested

High – 3, Medium-2, Low -1

MC3012 **NANOELECTRONICS AND PHOTONICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To expose the students to the introductory concepts of nanoelectronics and nanophotonics.
- To explain the electron transport in semiconductors & nanostructures.
- To make the students recognize the concept of electromigration.
- To make the students acquire the knowledge in the theory of low-dimensional structures and nanodevices science of molecular electronic devices.
- To accomplish nanophotonics and basic properties of electromagnetic effects in periodic media.

UNIT I MATERIALS FOR NANOELECTRONICS 9

Introduction – semiconductors – crystal lattices: bonding in crystals – electron energy bands – semiconductor heterostructures – organic semiconductors – carbon nanomaterials: graphene, nanotubes, and fullerenes.

UNIT II ELECTRON TRANSPORT IN SEMICONDUCTORS & NANOSTRUCTURES 9

Introduction – time and length scales of the electron in solids – statistics of the electrons in solids and nanostructures – density of states of electrons in nanostructures – electron transport in nanostructures.

UNIT III ELECTROMIGRATION 9

Introduction – electro-migration (EM) – wire morphology – electron wind – EM induced stress in nanodevice – current-induced heating in nanowire device – diffusion of material – importance of surfaces – failure of wires – wire heating – EM consequences for nanoelectronics.

UNIT IV LOW-DIMENSIONAL STRUCTURES AND NANODEVICES 9

Introduction – Quantum confinement: Quantum wells, wires and dots – Uses of quantum structures – band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade – uncertainty - resonant-tunneling diodes – field-effect transistors – single-electron transfer devices. Molecular electronic devices.

UNIT V NANOPHOTONICS 9

Light-matter interaction: Review of Maxwell's equations – dispersion in materials – optical properties of insulators, semiconductors and metals – electromagnetic properties of molecules, microscopic and nano particles – photonic crystals: introduction – basic properties of electromagnetic effects in periodic media – photonic crystal waveguides – photonic devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Utilize the ideas with materials for nanoelectronics carbon nanomaterials: graphene, nanotubes, and fullerenes.
- Gain knowledge on the density of states of electrons in nanostructures and electron transport in nanostructures.
- Apply ideas of electromigration consequences for nanoelectronics.
- Design the Molecular electronic devices.
- The students will gain knowledge on the basics of nanoelectronics, nanoelectronic devices and nanophotonics.

REFERENCES

1. G.W. Hanson. Fundamentals of Nanoelectronics. Pearson, New Delhi, 2009.
2. C.Durkan. Current at the Nanoscale. Imperial College Press, London, Second edtion, 2013.
3. V.V. Mitin, V. A. Kochelap and M.A. Stroscio, Introduction to Nanoelectronics. Cambridge University Press, 2012.
4. Supriyo Datta. Quantum Transport: Atom to transistor. Cambridge University Press, Cambridge, 2023.

5. B. Rogers, S. Pennathur, and J. Adams. Nanotechnology: Understanding small systems. CRC Press, Boca Raton, 2017.
6. Sergey V. Gaponenko and Hilmi Volkan Demir, Applied Nanophotonics, Cambridge University Press, 2018.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	2	2
CO3	3	2	2	3	2	2
CO4	3	3	3	3	2	2
CO5	3	2	2	3	2	2
Avg.	3	2.2	2.2	3	2.2	2

High – 3, Medium-2, Low -1

MC3013 CARBON MATERIALS **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the different types of Carbon materials
- To impart knowledge about the various processing methods
- To expose the students to various applications of Carbon materials
- To make the students to understand carbon and graphite fibers
- To make the students understand about carbon composites

UNIT I INTRODUCTION 9

Graphite – Phase diagram of carbon - Diamond – Fullerene - Carbon nano tubes – Structure of single walled and multiwalled carbon nanotubes – Euler's theorem in cylindrical and defective nanotubes- intercalated graphite-graphite oxide - exfoliated graphite –flexible graphite – graphene – structure of grapheme - activated carbon- carbon black- carbon-carbon composite.

UNIT II PROCESSING OF CARBON MATERIALS 9

Physical methods and chemical methods : Carbon nanotubes – laser ablation – electric arc discharge – CVD- hydrothermal - graphene- micromechanical exfoliation-arc discharge method-fullerene- pyrolysis- partial combustion – graphene oxide – Hummers method.

UNIT III APPLICATIONS 9

Applications of fullerene – Carbon nano tube – Graphene – Graphite - other carbon materials-Mechanical-Thermal-Electronic-semicondcutor and related industry-Biological –Drug Delivery-Energy storage-fuel cell- photovoltaic- Light weight applications.

UNIT IV CARBON AND GRAPHITE FIBRES 9

Carbon fibres: salient features – Classifications - Raw materials- Rayon/cellulose, Pitch, and Poly acrylo nitrile - Tensile properties: Low modulus, Standard modulus, Intermediate modulus, High modulus, and Ultra high modulus - Functional carbon fibre: Compressive strength, Thermal conductivity, and Electrical conductivity, Low-cost carbon fibres and Niche grade carbon fibres - Carbon fibre manufacturing processes (PAN based- Rayan based), precursors and their characteristics, typical carbon fibre properties - Applications: carbon reinforced forms, Continuous filaments, Chops, Mills, Flame resisted Panox fibres

UNIT V CARBON COMPOSITES 9

Textile preforms – classification, woven, multi-directional reinforced preforms. Structural geometry of 2D and 3D fabrics; Carbon matrix precursors - Thermosetting resin matrix precursors, Thermoplastic matrix precursor; Fabrication methods of C_f/C composites - Liquid phase infiltration (atmospheric and high pressure), Gas phase infiltration techniques - Properties of C_f/C composites – Microstructures, Interface in Carbon-Carbon. Mechanical & Thermal properties, Electromagnetic properties; Oxidation & Oxidation protection - High temperature coatings on carbon fibres and C_f/C composites; Application of C_f/C composites.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course the students will be able to

- Gain Knowledge on the basics and types of carbon structures
- Have knowledge about the preparation of various carbon related materials
- Know various fields and applications of carbon-based materials.
- Better understanding about carbon and graphite fibers
- Have gained knowledge about various carbon composites with their applications

REFERENCES

1. A Kelly, Carl H Zweben, "Comprehensive Carbon Materials", Elsevier Publishing, 1st edition, 2000.
2. Jenkins, G. M. & Kawamura, K. Polymeric carbons--carbon fibre, glass (Cambridge University Press, 1976).
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5. G Savage, "Carbon Carbon Composites", Springer Publishing, , 1st Edition, 1993.
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CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	3	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	2	2
CO4	2	1	2	3	3	2
CO5	2	1	2	2	2	2
Avg.	2	1	2	2.2	2.4	2

High – 3, Medium-2, Low -1

MC3014 THIN FILM SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To introduce about mechanical pumps, production of high vacuum and thin film coating unit
- To expose the various methods for preparation of thin films.
- To make the students understand the characterization methods used for thickness measurement.
- To make the students gain knowledge on the nucleation theories and thin films tructures.
- To impact knowledge on the various properties of thin films.

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UNIT I HIGH VACUUM PRODUCTION 9

Mechanical pumps - Diffusion pump - measurement of vacuum - gauges - production of ultra high vacuum - thin film vacuum coating unit.

UNIT II PREPARATION METHODS 9

Physical methods: thermal evaporation - vapour sources - Wire, crucible and electron beam gun - sputtering mechanism and methods - Pulsed laser deposition (PLD), photochemical deposition (PCD) - Chemical methods: chemical vapour deposition and chemical solution deposition techniques - spray pyrolysis - laser ablation.

UNIT III THICKNESS MEASUREMENT AND MONITORING 9

Multiple beam interference - quartz crystal - ellipsometric - stylus techniques. Characterization: X-ray diffraction - electron microscopy - high and low energy electron diffraction.

UNIT IV GROWTH AND STRUCTURE OF FILMS 9

General features - Nucleation theories - Post-nucleation growth – Thin film structures- Structural defects.

UNIT V PROPERTIES OF THIN FILMS 9

Optical - reflection and anti-reflection coatings - interference filters - thin film solar cells - electrophotography. Electrical and dielectric behaviour of thin films - components - thin film diode and transistor - strain gauges and gas sensors. Anisotropy in magnetic films - domains in films - computer memories - superconducting thin films - SQUID - mechanical properties: testing methods adhesion - surface and tribological coatings

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students would have gained knowledge on production of high vacuum and thin film coating unit.
- The students would apply the various methods for the preparation of thin films.
- The students know the methods of characterization of thin films and thickness measurement.
- Gained knowledge on nucleation theories and thin film structures.
- Gained knowledge on properties of thin films.

REFERENCES

1. M. Ohring. Materials Science of Thin Films. Academic Press,2001.
2. D. L.Smith. Thin-Film Deposition: Principles and Practice. McGraw-Hill,1995.
3. K.L. Chopra.Thin Film Phenomena. Krieger Pub Co ,1979.
4. K.L. Chopra and I.Kaur. Thin Film Device Applications. Springer-Verlag New York Inc,2011.
5. L.I. Maissel and R. Glang (Eds.). Handbook of Thin film Technology. McGraw- Hill,1970.
6. R.W. Berry, P.M. Hall and M.T. Harris. Thin Film Technology. VonNostrand,1968.
7. George Hass. Physics of Thin Films: Volumes 1 -12. Academic Press,1963.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	2	3	3	2
CO4	3	2	2	3	2	2
CO5	3	3	2	1	2	2
Avg.	3	2.8	2.4	2.6	2.2	2

High – 3, Medium-2, Low -1

Attested

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MC3015 **ADVANCES IN CRYSTAL GROWTH** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the concepts of nucleation and types of nucleation.
- To explain about the theories related to crystal growth.
- To expose the various methods of melt growth.
- To impact knowledge on the growth of crystals by solution growth.
- To make the students understand various methods of growing crystals from vapour phase.

UNIT I NUCLEATION 9

Nucleation concept – Homogeneous, heterogeneous nucleation – classical theory – Energy of formation of nucleus – kinetic theory of nucleation – statistical theory of nucleation – nucleation rate – induction period.

UNIT II THEORIES OF CRYSTAL GROWTH 9

Two dimensional nucleation theory – Temkins model of crystal growth – limitations of Temkins model – BCF surface diffusion theory – solution of BCF surface diffusion equation. Atmospheric nucleation

UNIT III MELT GROWTH 9

Temperature measurement and control – Starting materials and purification – conservative and non-conservative process – Bridgman method – Czochralski method – Verneuil method – Zone melting – Fluid flow analysis in melt growth – theory and experiment.

UNIT IV SOLUTION GROWTH 9

Measurement of supersaturation – Low temperature solution growth – High temperature solution growth – Accelerated crucible rotation technique (ACRT) – Electro crystallization – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique – Sol-gel growth

UNIT V VAPOUR GROWTH 9

Physical vapour transport –chemical vapor transport. Epitaxial growth techniques – Liquid phase epitaxy - vapour phase epitaxy: chloride, hydride, metalorganic - molecular beam epitaxy - chemical beam epitaxy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will understand the concepts of nucleation and types of nucleation.
- The students would have learnt the theories related to crystal growth.
- Students would have known the various methods of melt growth.
- Students would have gained knowledge on solution growth.
- Students would have gained knowledge on growth of crystals from vapour phase.

REFERENCES

1. A.C.Zxettlemoyer. Nucleation. Marcel-Dekker Publishers,1969.
2. M.Ohara and R.C.Reid. Modelling Crystal Growth Rates from Solution,1973.
3. J.C.Brice. Crystal Growth Processes. John Wiley and sons, New York,1986.
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5. P.M.Dryburgh, B.Cockayane and K.G.Barraclough. Advance Crystal Growth. Prentice Hall, London, 1986.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	2	2
CO2	2	2	1	2	1	3
CO3	3	2	2	2	2	1
CO4	2	2	2	3	2	1
CO5	2	2	2	3	2	2
Avg.	2.2	2	2	2.4	1.8	1.8

High – 3, Medium-2, Low -1

MC3016 **HIGH PRESSURE SCIENCE AND TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the aspects of High pressure science and technology.
- To expertise the measurements of high pressure.
- To familiarize high pressure devices for various properties and applications.
- To inspire physical properties of high pressure and spectroscopy studies.
- To insight mechanical properties under pressure.

UNIT I METHODS OF PRODUCING HIGH PRESSURE 9

Definition of pressure – Hydrostaticity – generation of static pressure, pressure units – piston cylinder – Bridgmann Anvil – Multi-anvil devices – Diamond anvil cell.

UNIT II MEASUREMENT OF HIGH PRESSURE 9

Primary gauge – Secondary gauge – Merits and demerits – Thermocouple pressure gauge – Resistance gauge – fixed point pressure scale – Ruby fluorescence – Equation of state.

UNIT III HIGH PRESSURE DEVICES FOR VARIOUS APPLICATIONS 9

X-Ray diffraction, Neutron diffraction – Optical studies – Electrical studies – Magnetic studies – High and low temperature applications – Ultra high pressure anvil devices.

UNIT IV HIGH PRESSURE PHYSICAL PROPERTIES 9

PVT Relation in fluids – Compressibility of solids – properties of gases under pressure - Melting phenomena – viscosity – thermo emf – thermal conductivity. Electrical conductivity – phase transitions phonons superconductivity – Electronic structure of metals and semiconductors – NMR and magnetic properties. Liquid crystals – spectroscopy studies –Infrared, Raman Optical absorption – EXAFS.

UNIT V MECHANICAL PROPERTIES UNDER PRESSURE 9

Elastic constants–Measurements–mechanical properties–Tension and compression – Fatigue – Creep – Hydrostatic extrusion. Material synthesis – Super hard materials – Diamond – Oxides and other compounds – waterjet.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Establish the operation of anvil and Multi-anvil devices.
- Crack the gauge operations.
- Design various anvil device applications.
- Apply ideas of Electronic structure of metals and semiconductors.
- After completing this course the students will be able to understand the basic concepts of the high pressure and various technological applications of high pressure.

REFERENCES

1. P.W. Bridgmann. The Physics of High Pressure. G. Bell and SONS Ltd., London,1931.
2. B.Vodar and Ph. Marteam. High Pressure Science and Technology, Vol.I and II. Pergamon Press,Oxford,1980
3. H. Li and D. Pugh. Mechanical Behaviour of Materials under Pressure. Elsevier Publishing Co., Ltd., New York,1970.
4. M.I. Eremets. High pressure Experimental methods. New York,1996.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	3	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	2	2
CO4	2	1	2	3	3	2
CO5	2	1	2	2	2	2
Avg.	2	1	2	2.2	2.4	2

High – 3, Medium-2, Low -1

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MC3017	CERAMIC MATERIALS	L T P C 3 0 0 3

OBJECTIVES:

- To introduce the students to structural ceramics and familiarize them with their properties.
- To impact knowledge to the students on various electronic ceramics, magnetic ceramics, superconducting materials and fuel cells
- To expose the students to various processing techniques used for ceramic materials..
- To introduce the students about various types of refractories.
- To make the students understand about various glass forming processes, types of glass and their applications.

UNIT I STRUCTURAL CERAMICS 9

Oxide ceramics – zirconia, alumina, silica, mullite, magnesia and titania – carbides – silicon carbide, boron carbide, tungsten carbide, titanium carbide – nitrides – silicon nitride, boron nitride, titanium nitride, borides, silicides, - sialon – bio ceramics

UNIT II ELECTRONIC CERAMICS 9

Ceramic insulators and capacitors – ferroelectric ceramics – barium titanate, PZT, PLZT materials – properties and applications of electronic ceramics - magnetic ceramics – spinel ferrites, zinc ferrites – applications - garnets – superconducting ceramics – varistors – oxides and non-oxide varistors and fuel cells.

UNIT III CERAMIC PROCESSING 9

Powder processing – precipitation, spray drying, freeze drying, sol-gel, CVD – milling techniques – forming – die pressing, slip casting, injection moulding, doctor blade processing – sintering techniques – standard pressure sintering, hot pressing, HIP, reaction bonded sintering, microwave sintering – surface finishing techniques.

UNIT IV REFRACTORY CERAMICS 9

Refractories – types of refractories - special refractories - silica, alumina, mullite, zirconia, cordierite - carbide based and nitride-based refractories – Fusion cast refractories – ceramic fibers – high temperature applications.

UNIT V GLASS CERAMICS 9

Glass forming processes – Glass transition – Glass transformation range - Heat treatment schedule, crystal nucleation in glass, nucleation agent – high purity silica glass, laser glasses, fiber glasses, optical glasses and non-oxide glasses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completing the course, the students

- would have gained knowledge on various structural ceramic materials and their applications.
- would have known the applications of electronic ceramics and magnetic ceramics and also
- will analyze and apply the various processing techniques they have studied.
- they would know about the functioning of varistors and fuel cells.
- would have gained knowledge on refractories and their applications.
- would be familiar with various glass forming methods, types of glasses and their applications.

REFERENCES

1. D.W. Richerson & W.E. Lee. Modern Ceramic Engineering: Properties, Processing and Use in design. CRC Press, 2018.
2. J.S. Reed. Principles of Ceramic Processing. Wiley-Interscience, 2008.
3. M.H. Lewis. Glasses and Glass Ceramics. Springer, 2011.
4. M. Cable and J.M. Parker. High Performance Glasses. Chapman and Hall, London, 1992.
5. J.H. Chester. Refractories, Production and Properties. Iron and Steel Institute, London, 1992.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	2	3	2	2	2
CO3	2	1	2	2	2	2
CO4	2	2	2	2	1	2
CO5	2	1	2	2	2	2
Avg.	2	1.4	2.4	2	1.8	2

High – 3, Medium-2, Low -1

MC3018 SMART MATERIALS AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide fundamental understanding on smart and intelligent materials.
- To provide the students with knowledge about multifunctional smart materials
- To expose the students to electro-rheological smart materials
- To enhance students' understanding on the structure-property relationship.
- To enable students, appreciate novel materials and their usage in current cutting-edge technologies.

UNIT I BASICS OF SMART MATERIALS AND STRUCTURES 9

Evolution of mankind with materials -Classification of materials– Intelligent /Smart materials – components and classification of smart structures. Requirements of Smart Materials – Functions: Sensor, Memory, Processor, Actuator –Examples of intelligent materials, – Intelligent biological materials – Smart polymers: Technological applications in drug delivery, tissue engineering. Bio-mimetics and bio-inspiration.

UNIT II MULTI FUNCTIONAL SMART MATERIALS 9

Introduction - Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Piezoelectric materials as sensors, actuators and bimorphs - Piezoelectric materials in Energy Harvesting systems: Regenerative braking - Transparent Conducting Materials –Solar cells, Touch screen, etc.

UNIT III ELECTRO-RHEOLOGICAL (FLUIDS) SMART MATERIALS 9

Suspensions and electro-rheological fluids – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electrorheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheological fluids.

UNIT IV SHAPE – MEMORY SMART MATERIALS 9

Introduction to structure types, Structure-property relationships, Shape memory effect (SME), One way and two-way SME, Shape memory alloys (SMAs), Intelligence in the form of SMA - Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA in Thermal-storage, and aerospace materials. Shape-memory polymers, and their applications.

UNIT V MULTIFERROIC AND SMART OPTICAL MATERIALS **9**

Multiferroism: Ferromagnetism and ferroelasticity, Magneto-electricity –Magnetostrictive smart materials – Magneto-caloric materials for emission-less refrigeration - Magneto-Optic Materials: Examples (Heusler alloys, double perovskites) and Applications - Smart optical materials for modifying spectral shift and refractive index shift - Chromogenic Materials – Types: Photochromic, Thermochromic, Electrochromic - Devices and Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- understand the working principle of smart materials
- get an overview on various types of smart materials and their application areas.
- Gain knowledge in electro-rheological smart materials
- get motivated to find novel applications of these multifunctional materials in new technologies.
- understand the importance and structure of smart materials.

REFERENCES:

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
2. M. Addington, D.L. Schodek, Smart Materials and New Technologies, Elsevier 2005.
3. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.
4. M.V. Gandhi, B. S. Thompson, Smart Materials and Structures, Springer, 1992.
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7. Ed.: Peter L. Reece, Smart Materials and Structures: New Research, Nova Science 2007.
8. Ian Baker, Fifty Materials that Make the World, Springer, 2018.
9. Ed.: Mel Schwartz, Smart Materials, CRC Press, 2008.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	2	1	3	2	2	2
CO3	3	1	2	2	2	2
CO4	3	2	3	2	3	2
CO5	2	1	2	3	2	2
Avg.	2.6	1.4	2.6	2.2	2.4	2

High – 3, Medium-2, Low -1

MC3019 **ADVANCES IN X-RAY ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the knowledge on X-ray sources, optics and detection.
- To impat the basics of single crystal X-ray methods with their physical concepts.
- The students will be able to understand traditional and advanced methods for crystal structure determination from powder crystal techniques.
- To familiarize various applications of X-ray in determining physical parameters.
- To expose the other characterization techniques using X-rays.

Attested

UNIT I EXPERIMENTAL METHODS 9

X-ray sources – synchrotron radiation – monochromatization, collimation and focusing – X-ray detectors – point, linear and area detectors – X-ray optics - physical and geometrical factors affecting X-ray intensities.

UNIT II SINGLE CRYSTAL METHODS 9

Single crystal diffractometers – geometries and scan modes - structure factors - systematic absences and space group determination – electron density – phase problem - structure solution – direct method (basics only) - Patterson function and heavy atom method. Structure refinement – Least-squares method - difference Fourier synthesis - R factor - structure interpretation – geometric calculations - computer program packages (qualitativeonly).

UNIT III POWDER METHODS 9

Powder cameras: Seeman-Bohlin, Back-reflecton and Guinier cameras - Bragg-Brentano geometry - sample preparation and step data collection – indexing – phase indentification - ICDD powder diffraction file – quantitative phase analysis: external and internal standard methods, direct comparison method. The Rietveld method – fundamentals - peak shapes – profile fitting - structure refinement procedures – R factors – structure determination from powder data – computer packages.

UNIT IV APPLICATIONS 9

Orientation and quality of single crystals: transmission and back-reflection methods – defect analysis: X-ray topographic methods – crystallite size analysis: grain and particle size – strain and line width – texture studies: fiber and sheet textures - residual stress analysis: uniaxial and biaxial.

UNIT V OTHER STUDIES 9

Wide-angle diffraction, small angle scattering (qualitative study) - Wavelength dispersion and energy dispersion – spectrometers – intensity and resolution - X-ray fluorescence – applications - high pressure diffraction methods – high and low temperature diffraction methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students can have basic idea on how the X-rays are produced and detected.
- The students attain knowledge on prediction of crystal structure from single crystal methods.
- The students can understand the advances in powder diffraction analysis.
- Get insight knowledge on utilizing X-ray as a tool for determining physical parameters.
- The students will understand the qualitative study on other X-ray characterization techniques.

REFERENCES

1. G.H.Stout and L.Jensen. X‐ray Structure Determination: A Practical Guide, Macmillan, New York,1989.
2. M.M.Woolfson. An introduction to X-ray crystallography. Cambridge Univ. Press, New York, 1997.
3. M.F.C.Ladd and R.A.Palmer. Structure Determination by X-ray Crystallography. Springer, 2003.
4. B.D.Cullilty and S.R.Stock. Elements of X-ray diffraction, Pearson Education Ltd.,2013.
5. R.A.Young. The Rietveld method, IUCR-Oxford University Press,1995.
6. C.Giacovazzo. Fundamentals of Crystallography, IUCR-Oxford University Press,2002.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	2	3	2	1	2
CO3	1	1	2	2	2	2
CO4	2	2	2	2	1	2
CO5	1	1	2	2	1	2
Avg.	1.6	1.4	2.4	2	1.4	2

High – 3, Medium-2, Low -1

MC3020 COMPUTATIONAL MATERIAL SCIENCE **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students understand theoretical background of condensed media.
- To teach students to the density functional theory methods.
- To teach the students exchange correlation functionals
- To introduce students to plane wave methods.
- To introduce the students augmented plane wave methods.

UNIT I INTRODUCTION AND OVERVIEW 9

Introduction and Basic concepts, Theoretical Background, Basic equations for interacting electrons and nuclei, Coulomb interaction in condensed matter, independent electron approximations, Exchange and correlation, Periodic solids and electron bands, Structures of crystals: lattice + basis, The reciprocal lattice and Brillouin zone, Excitations and the Bloch theorem

UNIT II INTRODUCTION TO QUANTUM MECHANICAL MODELING 9

Time reversal and inversion symmetries, Integration over the Brillouin zone and special points Density of states - Uniform electron gas and simple metals. Non-interacting and Hartree-Fock approximation, The correlation hole and energy. Density functional theory: foundations, Thomas-Fermi-Dirac approximations: example of a functional. The Hohenberg-Kohn theorems - The Kohn-Sham ansatz. Replacing one problem with another: The Kohn-Sham variational equations Exc, Vxc and the exchange correlation hole meaning of the eigenvalue.

UNIT III FUNCTIONALS FOR EXCHANGE AND COORELATION 9

Functionals for exchange and correlation, The local spin density approximation (LSDA), Generalized-gradient approximation (GGAs) , LDA and GGA expressions for the potential Vxc(r), Non-collinear spin density, Non-local density formulations: ADA and WDA, Orbital dependent functionals I: SIC and LDA+U. Orbital dependent functional II: OEP and EXX, Hybrid functionals , Self-consistent coupled Kohn.Sham equations - Total energy functionals, Achieving self-consistency – Numerical mixing schemes, Force and stress.

UNIT IV DETERMINATION OF ELECTORNIC STRUCTURE 9

Determination of electronic structure – Atomic sphere approximation in solids, Plane waves and grids: basics - The independent particle Schrodinger equation in a plane wave basis. The Bloch theorem and electron bands - Nearly free-electron-approximation - Form factors and structure factors. Plane-wave method - ‘Ab initio’ pseudopotential method - Projector augmented waves (PAWs) - Examples of bands: semiconductors and transition metals - Electronic states of nanotubes.

UNIT V AUGMENTED PLANE WAVES AND MUFFIN-TINS 9

Augmented plane waves (APW's) and 'muffin-tins' – Solving APW equations: examples Muffin-tin orbitals (MTOs). Linearized augmented plane waves (LAPWs) - Applications of the LAPW method - Linear muffin-tin orbital (LMTO) method - Applications of the LMTO method - Full potential in augmented methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

- understand the underlying interactions in condensed matter
- apply suitable approximations and methods to model the materials and obtain energy values.
- Apply suitable exchange correlation functional for the materials of interest.
- Determine electronic structures of the materials.
- perform theoretical studies, analyses and calculations with applications in materials science

REFERENCES

1. H. Skriver, The LMTO Methods, Springer 1984.
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3. Ellad b. Tadmor, Modeling Materials Continuum, Atomistic and Multiscale Techniques, Cambridge University Press, 2012.
4. Efthimios Kaxiras, Atomic and Electronic Structure of Solids, Cambridge University Press 2003.
5. Richard Dronskowski, Computational Chemistry of Solid State Materials, WILEY-VCH , 2005.
6. Mizutani U. Introduction to the Electron Theory of Metals, CUP,2001.
7. Roessler U. Solid State Theory. An Introduction, 2ed., Springer, 2009.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	2	3	2	1	2	2
CO3	2	2	3	1	2	2
CO4	3	3	2	2	2	1
CO5	2	2	2	1	2	2
Avg.	2.2	2.4	2.2	1.6	2	1.8

High – 3, Medium-2, Low -1

MC3021 SOLID STATE IONICS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic aspects of solid state physics.
- To impart knowledge on solid state ionics, hydrogen storage and nano-ionic materials.
- To introduce the students to micro batteries, fuel cells, super capacitors and their applications.
- To familiarize the students to various characterization techniques for new cathode materials.
- To expose the students to the various application of ionic materials.

UNIT I BASIC ASPECTS OF SOLID STATE PHYSICS 9

Types of bonding in solids-Fundamentals of Crystallography-Simple Crystal structures-BCC, FCC, HCP - X-ray diffraction-band structures of metals, semiconductors and insulators-Ionic and electronic conductivities.

UNIT II SOLID STATE IONICS 9

Concept of solid state ionics- Importance of super-ionic materials and structures-Classification of Superionic solids- crystalline anionic and cationic conductors, mixed ionic and electronic conductors-structural factors responsible for high ionic conductivity - Experimental probes pertaining to solid state ionics- Theoretical models of fast ion transport- Applications of fast ionic solids-Nano-ionic materials.

UNIT III MICRO BATTERIES AND APPLICATION 9

Concept of a thin film solid state battery- electrolyte thin films- flash evaporation technique-pulsed laser deposition technique-applications-electromotive force-reversible cells-free energy changes-capacity of a cell-power and energy density of a cell-polymer electrolytes-application of polymer electrolytes in micro batteries, Fuel cells-solid state battery-super capacitors.

UNIT IV CHARACTERIZATION OF NEW CATHODE MATERIALS 9

Phase identification- Thermal analysis-DTA-DSC-TG- Energy dispersive X-ray fluorescence spectroscopy (EDX)-X-ray and neutron scattering-Rutherford Back scattering spectroscopy-X-ray photoelectron spectroscopy-Structural characterization-XRD-Electron microscopy, local environment studies-Extended X-ray absorption fine structure-FTIR-Transport measurements-Electrical transport-transient transport.

UNIT V APPLICATIONS OF IONIC MATERIALS 9

Primary lithium batteries- thermodynamics and mass transport in solid state batteries, battery performance and electrode kinetics-Secondary lithium batteries-Li-ion electrode materials-preparation and fabrication- -characterization of Li-ion cells- Comparison of Li-iodine and NiCd cells in CMOS-RAM applications. Applications of Lithium batteries in electronic devices, electric vehicle, fuel cells, sensors -Solar energy conversion devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students would have learnt the basic aspects of solid state physics.
- Gained knowledge on solid state ionics, hydrogen storage.
- Learnt about micro batteries, fuel cells, super capacitors.
- Learnt about the various characterization techniques available for cathode materials.
- The students are familiar with various applications of ionic materials

REFERENCES

1. H.V.Keer. Principles of the Solid State. New Age International Private Limited,2017.
2. S.Chandra. Superionic Solids-Principles and applications. North Holland Amsterdam,1981.
3. Clive D.S.Tuck, Modern Battery Technology, Elis Horwood Publishers,1991.
4. T.R.Crompton. Battery Reference Book, Newnes,2000.
5. Geoffrey A.Ozin& Andre C Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry,2008.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	1	3	2	2	2
CO3	2	2	2	2	1	2
CO4	2	1	2	2	1	2
CO5	2	1	2	2	2	2
Avg.	2	1.2	2.4	2	1.6	2

High – 3, Medium-2, Low -1

Attested

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MC3022 PREPARATION AND FABRICATION OF NANOSCALE MATERIALS **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basic aspects of preparation of nanomaterials and nanoscale fabrication related characterization techniques.
- To expose the different types of clean room and its importance.
- To study the synthesis and purification Single walled and Multi walled Nanotubes (SWNT and MWNT) and impart the concepts behind one dimensional nanowires and nanofibers.
- To inculcate characterization of materials with various techniques and to progress the nano-fabrication for biomedical applications.
- To inspire the knowledge of nanodevices for magnetic storage and know about applications and devices and mechanics for micro- and nano-systems.

UNIT I PROPERTIES OF NANOPARTICLES AND NANOSCALING LAWS 9

Size effect and properties of nanoparticles - particle size - particle shape - melting point, surface tension, wettability - specific surface area and pore size – Reason for change in optical properties, electrical properties, and mechanical properties – advantages - Heat conduction in micro- and nano- systems: heat conduction equation, Newton's cooling law, Quantum phenomena in nano-systems: photonic band gap structure, quantum states in nano-sized structures, quantum transport.

UNIT II CLEAN ROOM 9

Clean room and its importance – Types of clean rooms – maintenance of different types of cleanrooms – standardization – peripherals - oxidization and metallization- masking and patterning.

UNIT III PREPARATION OF NANOTUBES, NANOWIRES AND NANOFIBERS 9

Single walled and Multi walled Nanotubes (SWNT and MWNT) - synthesis and purification - synthesis of carbon nanotubes by pyrolysis techniques - arc-discharge method – CVD - nanotube properties – Nanowires – methods of preparation of nanowires –Semiconductor and Oxide nanowires – preparation –template method (qualitative) – nanofibers – electro spinning technique

UNIT IV CHARACTERIZATION AND NANO-FABRICATION 9

Absorption and emission spectra – PL spectrum - single nanoparticle characterization –Scanning capacitance microscopy – capillary electrophoresis- laser induced fluorescence (CE-LIF)-Etching technologies - wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography - strain-induced self-assembly for Nanofabrication of quantum dots and molecular architectures - Polymer processing for biomedical applications

UNIT V NANODEVICES APPLICATIONS 9

Mechanics for micro- and nano-systems: fluid flow in submicron and nanoscale, MEMS, field emission display devices, nano diodes, nano switches, molecular switches, nano-logic elements-Super hard nanocomposite coatings and applications in tooling-high density quantized magnetic disks - magnetic super lattices – MRAMS - MTJs using nano scale tunneling junctions - Millipede for storage – nano-material sensors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Familiarize the properties of nanoparticles and Grow up and promote scaling laws.
- The students should be able to utilize types of clean rooms.
- The students apply ideas on enlightenment of Nanowires and gain the idea of one dimensional nanostructure.
- The students will be able to gain the keen idea of biomedical applications and its characterization.
- The students will understand the principle involved in preparation and characterization of
- nanostructures and fabrication of nanodevices and characterization techniques.

Attested

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2. Hari Singh Nalwa (Editor). Hand book of Nanostructured Materials and Technology, Vol.1- Academic Press, USA, 2000.
3. T.W. Ebbesen (Editor). Carbon nanotubes: preparation and properties. CRC Press, USA, 1997.
4. B. Bhushan. Springer Handbook of Nanotechnology. Springer-Verlag, 2004.
5. J.A. Pelesko and D.H. Bernstein. Modeling MEMS and NEMS. Boca Raton, Chapman &Hall/CRC, 2003.
6. T.R. Hsu. MEMS & Microsystems Design and Manufacture. McGraw Hill, 2002.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	2	2
CO2	2	2	3	2	2	2
CO3	2	1	2	2	1	2
CO4	2	2	2	2	1	1
CO5	2	2	2	2	2	1
Avg.	2	1.8	2.4	2	1.6	1.6

High – 3, Medium-2, Low -1

MC3023 ENERGY CONVERSION AND ENERGY STORAGE DEVICES **L T P C**
3 0 0 3

OBJECTIVES:
- To familiarize the students about the energy conversion devices (Thermoelectric application)
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Super capacitors and the materials used.

UNIT I THERMOELECTRIC 9

Basics of thermoelectricity - Seebeck effect- Peltier effect-Thomson effect - Analysis of Electrical Conductivity, Seebeck Coefficient, Thermal Conductivity, Electronic Thermal Conductivity, Lattice Thermal Conductivity-Wiedmann Franz law- Figure of Merit- Two Probe and Four Probe Method of Measuring Electrical Resistivity,- Hall measurements- Laser pulse method- Thermal conductivity - Nanostructuring of Thermoelectric material- Charge Impurity Scattering, Grain Boundary Scattering, Point Defect- Applications – Exhaust of Automobiles, Refrigerators, Industries, Space Programs (RTG)

UNIT II ELECTROCHEMICAL DEVICES 9

Electrochemical Energy – Cells & Batteries - direct and rechargeable - Electrochemical sensors- Mass Transfer- Electric and Hybrid Vehicles - Linear Kinetics and Tafel equation - Gibbs Energy and Equilibrium - Battery V-I - Types of Batteries - Primary battery (Alkaline battery, Zinc-Carbon battery) - Secondary battery (Li-ion battery, Sodium-ion battery) —, $LiFePO_4$, $LiMn_2O_4$ – Electrolytes for Lithium-ion battery.

UNIT III FUEL CELLS 9

Principle of operation of fuel cells – electrochemical kinetics of fuel cells - mass transfer effects - Fuel cell performance characteristics - voltage efficiency and power density -types of fuel cells

(Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates)- Fuel cells for automotive applications

UNIT IV PHOTOVOLTAICS 9

Fundamentals of photoelectric conversion - Photovoltaic cell - I-V and P-V characteristics - Physics of the solar cell – Solar Cell Parameters- Efficiency of Solar Cell - Design methodology for SPV system - types of solar cells – dye sensitized solar cells – Perovskite solar cells – two dimensional Graphene - organic based solar cells materials.

UNIT V SUPERCAPACITORS 9

Fundamentals of electrochemical energy storage- supercapacitor – type of supercapacitors- Electrode and electrolyte interfaces- cyclic voltammetry- charge- discharge characteristics – energy and power density - design of supercapacitor- Faradaic and non - Faradaic capacitance- various type of electrode materials - Different types of nanocomposites for the SC electrodes - Two-Dimensional (2D) Electrode Materials - Application of super capacitors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
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6. Electrode Materials for Supercapacitors: A Review of Recent Advances, ParniaForouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and Venkataraman Thangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	3	2	2	3
CO4	3	3	3	2	2	3
CO5	2	2	2	2	3	3
Avg.	2.8	2.4	2.4	2.4	2.6	3

High – 3, Medium-2, Low -1

Attested

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MC3024 NUCLEAR PHYSICS AND REACTOR MATERIALS **L T P C**
3 0 0 3

OBJECTIVES:
- To introduce the students to nuclear structure and radioactivity.
- To expose the students about nuclear models, exchange forces and elementary particles.
- To make the students understand about nuclear fission, fusion and controlled thermo nuclear reaction.
- To make the students understand about neutron and reactor physics.
- To impart knowledge on the reactor design, materials and radioactive waste disposal.

UNIT I NUCLEAR STRUCTURE AND RADIOACTIVITY 9
Nuclear charge, mass, spin, magnetic moment, electric quadrupole moment, Binding energy, Semi-empirical mass formula – mass parabola – applications – Radioactivity – Soddy-Fajans law – Successive disintegration – transient and secular equilibrium.

UNIT II NUCLEAR MODELS, FORCES AND ELEMENTARY PARTICLES 9
Liquid drop model – shell model-compound nucleus model – Breit-wigner formula – Mesion theory– ground state of deutron – exchange forces – n-p, p-p scattering-spin dependence – classification of elementary particles – conservation laws – elementary idea about quarks, gluons and quantum chromodynamics.

UNIT III NUCLEAR FISSION AND FUSION 9
Types of fission-distribution of fission products – fissile and fertile materials – neutron emission in fission – spontaneous fission – Bohr – Wheeler theory – chain reaction – four factor formula – criticalitycondition–fusion-energyreleased–stellarenergy–controlledthermonuclearreaction – Plasma confinement.

UNIT IV NEUTRON AND REACTOR PHYSICS 9
Nuclear transmutation, Q value – exoenergic – endoenergic reactions – Nuclear cross sections – neutron sources – classification of neutrons – the malisation – average logarithmic decrement – thermal neutron diffusion – Fermi age equation.

UNIT V REACTOR DESIGN AND MATERIALS 9
Fuels, moderator, coolants, shielding – reactor size – radioactive waste disposal – radiation detection and measurement – film badge – TLD pocket dosimetry – application of radio isotopes – irradiation technology – radiation protection – units and dosage.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- The students will learn about nuclear structure and radioactivity.
- The students would have gained knowledge about nuclear models exchange forces and elementary particles.
- The students would have understood about nuclear fission, fusion and controlled thermo nuclear reaction.
- The students would have understood about neutron and reactor physics.
- The students would learn about reactor design, materials and radioactive waste disposal.

REFERENCES

1. Evans. Atomic Physics. Tata McGraw Hill, New Delhi,1986.
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3. R.R.Roy and B.P.Nigam. Nuclear Physics. Wiley Easter, New Delhi,1985.
4. D.S.Tayal. Nuclear Physics. Himalaya Publishers, Bombay, 1998.

CO-PO MAPPING

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	2	2
CO2	2	1	3	2	2	2
CO3	2	2	2	2	1	2
CO4	2	1	2	2	1	2
CO5	2	1	2	2	2	2
Avg.	2	1.2	2.4	2	1.6	2

High – 3, Medium-2, Low -1

MC3025 NON-LINEAR ELECTRONICS **L T P C**
3 0 0 3

OBJECTIVES:

- To prepare the students for understanding the concepts of nonlinear circuits
- To introduce the concept of nonlinear network theory and its importance
- To equip the students for designing chaotic circuits
- To apply the knowledge of nonlinear dynamics in power electronic systems
- To understand the implication of nonlinear transmission line in the generation of electrical solitons

UNIT I LINEAR AND NONLINEAR CIRCUITS 9

Linear circuit elements – nonlinear circuit elements – circuits with linear elements – circuits with nonlinear elements – LC, RLC and forced RLC circuits - importance of nonlinearity – rectification and clipping - low and higher order electronic circuits with nonlinearity – relaxation oscillator - Op-amp: Mathematical operations.

UNIT II NONLINEAR NETWORKS 9

Properties of linear and nonlinear resistive circuits: Superposition theorem, Thevenin-Norton theorem, Passivity, monotonicity. Dynamic nonlinear networks: Order of complexity, principles of duality – time domain and frequency domain analysis – memristive devices and networks – reciprocity – synthesis of higher order circuit elements – Negative impedance converter - limit cycles.

UNIT III CHAOTIC CIRCUITS 9

Chaos theory – autonomous chaotic circuits: Chua's diode, Chua's circuit, Chua's Wien-bridge oscillator based chaotic circuit – Colpitts chaotic oscillator – negative resistance based chaotic circuits – LC oscillator based chaotic circuits. Non-autonomous chaotic circuits: RL-diode circuit, driven Chua's circuit - Murali-Lakshmanan-Chua (MLC) circuit, Lindberg-Murali-Tamasevicius (LMT) oscillator. Stochastic resonance circuit. Analog simulation circuits: Duffing oscillator, van-der Pol oscillator – Lorenz system – Rossler system – Threshold-controller based circuits – higher order chaotic circuits.

UNIT IV POWER ELECTRONIC SYSTEMS 9

Overview – switching power converters – voltage mode control, current mode control, complexity of operation – modeling strategies of switching converters – bifurcation behavior in switching power converters – nonlinear dynamics of Cuk Boost, and Buck converters – Intermittent chaotic operations.

UNIT V ELECTRICAL SOLITONS 9

The linear transmission line – nonlinear transmission line (NLTL) – NLTL characterization - Toda lattice – NLTL lattice – KdV approximation of the NLTL – lossy NLTL – NLTL soliton oscillator – chaotic solitons.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should able to

- Understand the importance of nonlinearity in electronic circuit design.
- Apply the knowledge of nonlinear network theory in circuit design.
- Design different types of chaotic circuits.
- Apply the knowledge of nonlinear dynamics in power electronic systems.
- Design electrical soliton generators.

REFERENCES

1. M. Lakshmanan and K. Murali. Chaos in nonlinear oscillators: Controlling and synchronization. World Scientific, 1996.
2. L.O. Chua, C.A. Desoer and E.S. Kuh. Linear and nonlinear circuits. McGraw-Hill, 1991.
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5. D.S. Ricketts and D.Ham. Electrical solitons: Theory, design and applications. CRC Press, 2018.
6. Julien Clinton Sprott and Wesley Joo-chen Thio, Elegant Circuits: Simple Chaotic Oscillators, World Scientific Publishing Co Pte Ltd, Singapore, 2022.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	2	2
CO3	3	2	2	3	2	2
CO4	3	3	3	3	2	2
CO5	3	2	2	3	2	2
Avg.	3	2.2	2.2	3	2.2	2

High – 3, Medium-2, Low -1

MC3026 COMPOSITE MATERIALS AND STRUCTURES

L T P C
3 0 0 3

OBJECTIVES:

- To introduce about the properties of fibers and matrices.
- To make the students to understand the interface region and their testing.
- To impart knowledge on the fabrication techniques of composites.
- To expose the students to various micro and macro mechanics involved.
- To impart knowledge on the various mechanical properties of composites.

UNIT I FIBERS AND MATRICES 9

Types of composite materials – the concept of load transfer - fibers – glass, boron, carbon, organic, ceramic and metallic fibers – the strength of reinforcements – volume fraction and weight fraction- fiber packing arrangements – long fibers – laminates, woven, braided and knitted fiber arrays – short fibers – fiber orientation and length distributions – matrix materials – polymers, metals and ceramic matrices.

UNIT II INTERFACE REGION 9

Bonding mechanisms – adsorption and wetting, interdiffusion and chemical reaction, electrostatic attraction, mechanical keying – experimental measurements of bond strength – single fiber pull out, push-out and push-down tests – three-point bend test - control of bond strength – coupling agents, toughness reducing coatings, diffusion barrier coatings, interfacial chemical reaction, the inter phase region.

UNIT III FABRICATION 9

Polymer matrix composites – liquid resin impregnation routes, pressurized consolidation of resin pre-pregs, consolidation of resin moulding compounds, injection moulding of thermoplastics, hot press moulding of thermoplastics – metal composites – squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, physical vapour deposition – ceramic composites – powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites.

UNIT IV MICROMECHANICS AND MACROMECHANICS 9

Prediction of elastic constants – micromechanical approach - Halpin Tsai equations – transverse stresses – mechanics of load transfer from matrix to fiber – macro mechanics – elastic constants of an isotropic material – elastic constants of a lamina – Analysis of laminated composites.

UNITV STRENGTH AND TOUGHNESS OF COMPOSITES 9

Failure modes of long fiber composites axial and transverse tensile failure, shear and compression failure – strength of laminates – fracture mechanics – contributions to work of fracture – sub-critical crack growth – Applications of composite materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students would have gained knowledge about various fibers and matrices.
- The students would gain knowledge about the interface region and chemical reactions.
- To apply the fabrication methods they have learnt.
- Understood the micromechanics and macro mechanics involved.
- Learnt the various mechanical properties and applications of composites.

REFERENCES

1. D.Hull and T.W.Clyne. An Introduction to Composite Materials. Cambridge University Press, 2008.
2. K.K.Chawla. Composite Materials: Science and Engineering. Springer India,2015.
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6. R.M.Jones. Mechanics of Composite Materials. Taylor and Francis,2015.

CO-PO MAPPING

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	2	1	3	2	2	2
CO3	3	1	2	2	2	2
CO4	3	2	3	2	3	2
CO5	2	1	2	3	2	2
Avg.	2.6	1.4	2.6	2.2	2.4	2

High – 3, Medium-2, Low -1

Attested

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