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. The Department shall provide an outstanding experience in teaching, research and consultancy. The Department shall 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. The Department of Physics promotes high quality academic and research programmes and providing extension services in cutting edge technologies in materials science and laser engineering. The Department of Physics 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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Centre for Academic Courses
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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.Sc. MATERIALS SCIENCE (2 YEARS)

REGULATIONS 2019

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.

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of the Materials Science program the student will have following Program specific outcomes.

1. To select materials as per needs and specifications and process them.
2. To develop new materials for specific applications and characterize them.
3. To develop new materials with required physical properties.
4. To analyze the functioning of devices made with novel materials.

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4. PEO / PO Mapping:

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

5. Mapping of Course Outcome and Programme Outcome

		Course Name	PO01	PO02	PO03	PO04	PO05	PO06
YEAR 1	Semester 1	Mathematical Physics	✓	✓	✓	✓		
		Classical Mechanics and Statistical Thermodynamics	✓	✓	✓	✓		
		Electronics and Instrumentation	✓	✓	✓	✓	✓	
		Solid State Physics	✓	✓	✓	✓	✓	
		Electromagnetic Theory and Optics	✓	✓	✓	✓	✓	
		Audit Course – I (one from list of Audit courses)					✓	✓
		Materials Science Lab - I	✓	✓	✓	✓	✓	
	Semester 2	Numerical Methods for Materials Science	✓	✓	✓	✓	✓	
		Crystallography and Crystal Growth	✓	✓	✓	✓	✓	
		Characterization of Materials	✓	✓	✓	✓	✓	
		Quantum Mechanics	✓	✓	✓	✓	✓	
		Physics of Materials	✓	✓	✓	✓	✓	
		Program Elective I (one from list of electives I)	✓	✓	✓	✓	✓	
		Audit Course –II (one from list of Audit courses)						✓
		Materials Science Lab - II	✓	✓	✓	✓	✓	
	Semester 3	Introduction to Nanoscience and Technology	✓	✓	✓	✓	✓	
		Polymer and Composite Materials	✓	✓	✓	✓	✓	
		Physical Metallurgy	✓	✓	✓	✓	✓	
		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	✓	✓	✓	✓	✓	
		Technical Seminar	✓	✓	✓	✓	✓	✓

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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)	✓	✓	✓	✓	✓	
		Open Elective (one from list of courses)	✓	✓	✓	✓	✓	
		Dissertation	✓	✓	✓	✓	✓	

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.Sc. MATERIALS SCIENCE (2 YEARS)

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MC5101	Mathematical Physics	FC	4	0	0	4	4
2.	MC5102	Classical Mechanics and Statistical Thermodynamics	PCC	3	0	0	3	3
3.	MC5103	Electronics and Instrumentation	PCC	3	0	0	3	3
4.	MC5104	Solid State Physics	PCC	3	0	0	3	3
5.	MC5105	Electromagnetic Theory and Optics	PCC	3	0	0	3	3
6.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
7.	MC5111	Materials Science Lab - I	PCC	0	0	6	6	3
			TOTAL	**18**	**0**	**6**	**24**	**19**

*** Audit Course is Optional**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MC5201	Numerical Methods for Materials Science	RMC	4	0	0	4	4
2.	MC5202	Crystallography and Crystal Growth	PCC	3	0	0	3	3
3.	MC5203	Characterization of Materials	PCC	3	0	0	3	3
4.	MC5204	Quantum Mechanics	PCC	3	0	0	3	3
5.	MC5205	Physics of Materials	PCC	3	0	0	3	3
6.		Program Elective I	PEC	3	0	0	3	3
7.		Audit Course –II*	AC	2	0	0	2	0
PRACTICAL								
8.	MC5211	Materials Science Lab - II	PCC	0	0	6	6	3
			TOTAL	**21**	**0**	**6**	**27**	**22**

*** Audit Course is Optional**

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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.	MC5301	Introduction to Nanoscience and Technology	PCC	3	0	0	3	3
2.	MC5302	Polymer and Composite Materials	PCC	3	0	0	3	3
3.	MC5303	Physical Metallurgy	PCC	3	0	0	3	3
4.		Program Elective II	PEC	3	0	0	3	3
5.		Program Elective III	PEC	3	0	0	3	3
PRACTICAL								
6.	MC5311	Materials Science Lab-III and Mini Project	EEC	0	0	6	6	3
7.	MC5312	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**15**	**0**	**8**	**23**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	MC5411	Dissertation	EEC	0	0	24	24	12
			TOTAL	**9**	**0**	**24**	**33**	**21**

Total No. of Credits : 81

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MC5101	Mathematical Physics	4	0	0	4	1
					Total Credits	4	

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PROGRAM CORE COURSES (PCC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MC5102	Classical Mechanics and Statistical Thermodynamics	3	0	0	3	1
2.	MC5103	Electronics and Instrumentation	3	0	0	3	1
3.	MC5104	Solid State Physics	3	0	0	3	1
4.	MC5105	Electromagnetic Theory and Optics	3	0	0	3	1
5.	MC5111	Materials Science Lab - I	0	0	6	3	1
6.	MC5202	Crystallography and Crystal Growth	3	0	0	3	2
7.	MC5203	Characterization of Materials	3	0	0	3	2
8.	MC5204	Quantum Mechanics	3	0	0	3	2
9.	MC5205	Physics of Materials	3	0	0	3	2
10.	MC5211	Materials Science Lab - II	0	0	6	3	2
11.	MC5301	Introduction to Nanoscience and Technology	3	0	0	3	3
12.	MC5302	Polymer and Composite Materials	3	0	0	3	3
13.	MC5303	Physical Metallurgy	3	0	0	3	3
					Total Credits	**26**	

PROGRAM ELECTIVE COURSES (PEC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	GROUP
			Lecture	Tutorial	Practical		
1.	MC5001	Ceramic Materials	3	0	0	3	1
2.	MC5002	Non-Destructive Testing	3	0	0	3	1
3.	MC5003	Nonlinear Optics and Materials	3	0	0	3	1
4.	MC5004	Laser and Applications	3	0	0	3	1
5.	MC5005	Python Programming	3	0	0	3	1
6.	MC5006	Advances in X-ray Analysis	3	0	0	3	2
7.	MC5007	Semiconductor Materials and Devices	3	0	0	3	2
8.	MC5008	Superconducting Materials and Applications	3	0	0	3	2
9.	MC5009	Advances in Crystal Growth	3	0	0	3	2
10.	MC5010	Nonlinear Science	3	0	0	3	2
11.	MC5011	Materials Processing	3	0	0	3	3
12.	MC5012	Nanoelectronics and Photonics	3	0	0	3	3
13.	MC5013	Corrosion Science and Engineering	3	0	0	3	3
14.	MC5014	Solid State Ionics	3	0	0	3	3

15.	MC5015	Mechanical Properties of Materials	3	0	0	3	3
16.	MC5016	Thin Film Science and Technology	3	0	0	3	4
17.	MC5017	Nanomaterials Preparation and Characterization	3	0	0	3	4
18.	MC5018	Nanoscale Fabrication and Techniques	3	0	0	3	4
19.	MC5019	High Pressure Science and Technology	3	0	0	3	4
20.	MC5020	Optical Materials	3	0	0	3	4
21.	MC5021	Biomaterials	3	0	0	3	5
22.	MC5022	Composite Materials and Structures	3	0	0	3	5
23.	MC5023	Nuclear Physics and Reactor Materials	3	0	0	3	5
24.	MC5024	Smart Materials and Structures	3	0	0	3	5
25.	MC5025	Non-linear Electronics	3	0	0	3	5

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	MC5201	Numerical Methods for Materials Science	4	0	0	4	2
					Total Credits:	**4**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	MC5311	Materials Science Lab-III and Mini Project	0	0	6	3	3
2	MC5312	Technical Seminar	0	0	2	1	3
3	MC5411	Dissertation	0	0	24	12	4
					Total Credits:	**16**	

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OPEN ELECTIVE COURSES (OEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP5491	Nuclear Energy in Health Care and Industry	OEC	3	0	0	3	3
2.	MP5492	Smart Materials for Energy and Environment Applications	OEC	3	0	0	3	3
3.	EA5491	Climate Journalism	OEC	3	0	0	3	3
4.	EA5492	Digital Photography	OEC	3	0	0	3	3
5.	AC5491	Green Chemistry	OEC	3	0	0	3	3
6.	AC5492	Food Chemistry	OEC	3	0	0	3	3
7.	AG5491	Natural Hazards and Management	OEC	3	0	0	3	3
8.	AG5492	Ocean Resources and Exploration Techniques	OEC	3	0	0	3	3
9.	MC5491	Basic Crystallography and Crystal Growth	OEC	3	0	0	3	3
10.	MC5492	Nonlinear Science	OEC	3	0	0	3	3
11.	MT5491	Statistical Methods	OEC	3	0	0	3	3
12.	HS5491	Professional Email Communication	OEC	3	0	0	3	3
13.	HS5492	Project Report Writing	OEC	3	0	0	3	3
14.	HS5493	Basic Presentation Skills	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
					Total Credits:	0	

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SUMMARY

	M.Sc. MATERIALS SCIENCE (FT)					
	Subject Area	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	**FC**	04	00	00	00	**04**
2.	**PCC**	15	15	09	00	**39**
3.	**PEC**	00	03	06	06	**15**
4.	**RMC**	00	04	00	00	**04**
5.	**OEC**	00	00	00	03	**03**
6.	**EEC**	00	00	04	12	**16**
7.	Non Credit/Audit course	✓	✓	00	00	
	Total Credit	**19**	**22**	**19**	**21**	**81**

MC5101 **MATHEMATICAL PHYSICS** **L T P C**
4 0 0 4

OBJECTIVE

- 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

OUTCOME

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

- Apply ideas of vector calculus and matrices to physics problems.
- Crack the physics problems with special formula.
- Make use of complex variable to solve integrals.
- Use integral transform in physics and optics.
- 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.

MC5102	CLASSICAL MECHANICS AND STATISTICAL THERMODYNAMICS	L T P C 3 0 0 3

OBJECTIVE

- To develop familiarity with mechanical aspects of systems and mathematical methods of Classical Mechanics.
- To make the students understand the concepts laws of thermodynamics its applications and phase equilibria.
- To make the students understand the statistical mechanics of systems, probability distribution laws.
- To enable the students to understand the applications of statistical thermo dynamical methods in solid state physics.
- To make the students understand the basic concepts of heat and mass transfer and its application in hydrodynamics.

UNIT I CLASSICAL MECHANICS 9

Virtual work - Generalised coordinates — d'Alembert's principle – Lagranges equation of motion – Cyclic co-ordinates and conservation laws - Euler Lagrange equation - Hamiltonian dynamics – Hamilton's equations of motion – Principle of least action – Canonical transformation – Poisson brackets.

UNIT II THERMODYNAMICS 9

Laws of thermodynamics- internal energy- Enthalpy- Entropy- Helmholtz and Gibbs free energies – Thermodynamic relations – Euler equation – Maxwell's relations and applications – Chemical Potential- Gibbs phase rule – phase equilibria (single and multicomponent systems) - Clausius – Clayperon equation – law of mass action – first order phase transition in single component systems – Second order phase transition.

UNIT III CLASSICAL AND QUANTUM STATISTICS 9

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 STATISTICS 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

OUTCOME

- Students have gained knowledge in mathematical methods of classical mechanics, namely Newtonian mechanics, Lagrangian and Hamiltonian dynamics.
- Students have learned the laws of thermodynamics, thermodynamic relations, its applications, phase equilibria and phase transitions.
- Students have understood the concepts of ensembles and learned to derive the statistical distribution laws.
- Students have learned to apply the statistical distribution laws to problems in solid state physics.
- Students have understood the basic concepts of heat and mass transfer, the equations governing them and its application in hydrodynamics.

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REFERENCES

1. M.C.Gupta. Statistical Thermodynamics. Wiley Eastern Ltd., 1993.
2. T.Engel and P.Reid. Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, 2007.
3. H.B.Callen. Thermodynamics. John Wiley and Sons,1966.
4. H.Goldstein, C.P.Poole and J.Safko. Classical Mechanics. Pearson Education, Inc. 2017.
5. J.P.Holman. Heat transfer. Tata McGraw Hill, 2008.
6. F.Reif. Fundamentals of Statistical and Thermal Physics. Waveland Press, 2010.
7. N.C.Rana and P.S.Joag. Classical Mechanics. McGraw Hill Education, 2017.

MC5103 ELECTRONICS AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVE

- To make the students to understand the concept of analog electronics.
- To introduce the advanced concepts of digital electronics.
- To educate the students on the concepts of optoelectronics.
- To equip the students for designing electronic instruments.
- To introduce the concepts of nanoelectronics and physics aspects to the students.

UNIT I ANALOG ELECTRONICS 9

Operational amplifiers: Introduction – differential amplifier – op-amp parameters – feedback-comparators – mathematical operations – analog simulation circuits - oscillators – active filters – instrumentation amplifiers – isolation amplifiers – active diode circuits – OTAs – sample & hold circuits. Voltage regulators: Principles and operations – Nonlinear electronics: Ideas, implications and applications. ‘.

UNIT II DIGITAL ELECTRONICS 9

Introduction – overview of logic functions and logic gates – combinational logic – flip-flops and related circuits – sequential logic – registers, counters, shift-registers and memory – microprocessor architecture – A/D and D/A conversion – DSP fundamentals.

UNIT III OPTOELECTRONICS 9

LEDs – semiconductor lasers – photodiodes – solar cells – photodetectors – optical fibers – communication – optoelectronic modulation and switching devices – optocoupler – optical data storage devices – display devices.

UNIT IV ELECTRONIC INSTRUMENTATION 9

Basics of instrumentation system – transducers – types of transducers – strain gauges – RTDs – LVDT – piezoelectric transducers – load cell – flow meters – signal conditioning – data acquisition and conversion – data transmission – digital signal processing.

UNIT V NANOELECTRONICS 9

MOSFETs - ‘electron transport in nanostructures - resonant tunneling diodes – single electron transfer devices – molecular switches and memory storage – nano-electromechanical systems - quantum dot cellular automata.

TOTAL: 45 PERIODS

OUTCOME

After completing this course, the students should able to

- To design analog electronic circuits.
- To design digital electronic circuits.
- To design optoelectronic circuits.
- To design electronic instruments.
- To gain knowledge on nanoelectronic devices.

REFERENCES

1. A.P.Malvino. Electronic principles. Tata McGraw-Hill, 2011.
2. T.L. Floyd. Electronic devices. Pearson Education, 2015.
3. P.Horowitz and W.Hill. Art of electronics. Cambridge Univ.Press, 2006.
4. L.O.Chua, C.A.Desoer and E.S.Kuh. Linear and Nonlinear Circuits. McGraw-Hill, 1997.
5. M.Lakshmanan and K.Murali. Chaos in Nonlinear Oscillators. World Scientific, 1996.
6. P.Bhattacharya. Semiconductor Optoelectronic Devices. Pearson Education, 2017.
7. H.S.Kalsi. Electronic Instrumentation. McGraw Hill Education, 2017.
8. W.D.Cooper. Electronic Instrumentation and Measurement Techniques. Prentice Hall of India, 1991.
9. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education Inc., 2009.

MC5104 SOLID STATE PHYSICS L T P C
3 0 0 3

OBJECTIVE

- To understand the basic crystal structures, bonding of solids and the lattice energy calculations.
- To explain electrical and thermal conduction in metals and Fermi distribution function.
- To discuss how our understanding of lattice dynamics is formulated in terms of travelling waves, together with the role of the interatomic forces.
- To understand the electrons in solid move under the influence of a periodic potential due to ions arranged along a periodic lattice. The energ**y** spectrum of such electrons consists of allowed and forbidden energy bands and the theory developed on the basis of this model.
- To study the properties of different Semiconducting 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 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.

UNIT III 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 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.

UNIT V PHYSICS OF SEMICONDUCTORS AND SUPERCONDUCTIVITY 9

Semiconductors – direct and indirect gaps – carrier statistics (intrinsic and extrinsic) – law of mass action– electrical conductivity and its temperature variation - III - V and II – VI compound semiconductors. Superconductivity – critical parameters – anomalous characteristics – isotope effect, Meissner effect – type I and II superconductors - BCS theory (elementary) - Josephson junctions and tunneling – SQUID - High temperature superconductors - applications.

TOTAL: 45 PERIODS

OUTCOME

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

- Make use of fundamental concepts of various crystal systems, types of bonding and calculate the cohesive energy.
- Understand the basics concepts of free electron theory and Boltzmann transport theory.
- To gain knowledge on atomic lattice vibrations, phonon-phonon interactions and Einstein and Debye models.
- The students would have gained knowledge on periodic potentials and Fermi surface studies.
- Would have known the applications and various properties of semiconductors and superconductive materials.

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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.

MC5105 ELECTROMAGNETIC THEORY AND OPTICS L T P C

3 0 0 3

OBJECTIVE

- Fundamentals of Maxwell's equations are their applications in different situations.
- Insight on fundamental laws of optics and how they can be derived from Maxwell's Equations.
- Introduction to novel calculus of tensors and illustrate their usage in different Material properties.
- An overview on various optical activities and their applications in material characterization.
- Basics of non-linear optical effects and non-linear optical materials.

UNIT I MAXWELL'S EQUATIONS 9

Review of Gauss's law in electrostatics and magnetism - Ampere's law - Faraday's law - displacement current - Maxwell's equations - differential and integral forms - scalar and vector potentials and applications - Potential due to a uniformly charged sphere - magnetic induction due to a current carrying wire.

UNIT II ELECTROMAGNETIC WAVE PROPAGATION 9

Plane electromagnetic waves in free surface - Poynting vector - characteristic impedance - wave equation in an isotropic medium - wave equation in insulators and conductors - reflection by a perfect conductor - normal and oblique incidence - Fresnel equations for parallel and perpendicular polarisation - Hollow rectangular wave guide.

UNIT III CRYSTAL OPTICS 9

Crystal symmetry-Light propagation in anisotropic media – Maxwell's equations: the constitutive relation -Index ellipsoid – wave plates – Biaxial media: Optic axes – positive and negative crystals - Electrical conductivity tensor- - stress optic tensors - third rank tensors – Linear Electro-optic effect - Fourth rank tensors: third order susceptibility tensor.

UNIT IV OPTICAL ACTIVITY 9

Optical Polarization – Magneto-optical effects – Magneto-optical Kerr and Faraday effect - Kerr and Pockel effect - applications - Harmonics and sum & frequency generation - stimulated Brillouin scattering (SBS) - stimulated Raman scattering (SRS) – applications of SBS and SRS for material characterization – examples.

UNIT V NONLINEAR OPTICS 9

Theory and applications of non-linear effects - frequency conversion - optical switching - phase conjugation - optical bistability - nonlinear optical materials - NLO crystals, properties and applications.

TOTAL: 45 PERIODS

OUTCOME

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:

- Derive Maxwell's equations and apply them to study the electrostatics and magnetostatics
- Understand boundary conditions between different materials and reflection and refraction of light based on Maxwell's equations
- Appreciate the use of tensors in determining crystal symmetry and in explaining advanced properties of materials like elastic properties, piezoelectric effect, eletro-optic effect etc.
- Elucidate how optical activities occur in materials and how they can be used to further characterize materials
- Apprehend the fundamentals of Non-linear optical effects, the nature of materials exhibiting such properties, and their applications.

REFERENCES

1. J.F.Nye. Physical Properties of Crystals. Oxford University Press, 1997.
2. E.C.Jordan and K.G.Balmain. Electromagnetic Waves and Radiating Systems. Pearson Education, 2015.
3. D.Corson and P.Lorrain, Introduction to Electromagnetic Fields and Waves, Literary Licensing, LLC, 2013.
4. A.Yariv and P.Yeh. Photonics. Oxford University Press, 2007
5. G. New, Introduction to Nonlinear Optics, Cambridge University Press, 2014.
6. D.J.Griffiths. Introduction to Electrodynamics. Pearson Education, 2015.
7. D.Fleisch. A student's Guide to Maxwell's Equations. Cambridge University Press, 2008.

MC5111 MATERIALS SCIENCE LAB – I L T P C
0 0 6 3

LIST OF EXPERIMENTS

Any Fifteen experiments

1. Band gap determination
2. Determination of elastic constants – Hyperbolic fringes
3. Determination of elastic constants – Elliptical fringes
4. Determination of dielectric constant
5. Ultrasonic diffractometer - Ultrasonic velocity in liquids
6. Magnetostriction measurements
7. Study of crystal lattices
8. Strain gauge meter – Determination of Young's modulus of a metallic wire

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9. Conductivity of ionic crystals
10. Instrumentation Amplifier
11. Regulated power supply
12. 555 Timer – Astable multivibrator
13. Operational amplifier - characteristics and applications.
14. Active filter
15. RC Phase Shift Oscillator (FET)
16. AD/DA convertor
17. Viscosity of liquid - Meyer's disc

TOTAL: 90 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS:

1. X-Y translation microscope
2. Thermostats
3. Ultrasonic generator
4. Multimeters
5. IC's transistors and resistors

MC5201 NUMERICAL METHODS FOR MATERIALS SCIENCE L T P C
4 0 0 4

OBJECTIVE

To improve and enhance the analytical ability in problem solving skills of students using numerical methods.

- To demonstrate the understanding of numerical methods using Mat Lab.
- To solve the large system of linear equations and find the roots of non-linear equations.
- To familiarize interpretation 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.

UNIT I MATLAB/SCILAB PROGRAMMING 12

Overview of Matlab – data types and variables – operators – flow control – functions – input-output – array manipulation – writing and running programs – plotting – overview of simulink environment.

UNIT II 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.

UNIT III INTERPOLATION & CURVE FITTING AND ERROR ANALYSIS 12

Polynomial interpolation theory - Newton's forward and backward interpolation formulae - Lagrange's method - Lagrange's inverse interpolation – piecewise linear interpolation – interpolation with cubic spline – least-squares line - curve fitting – Fourier series and trigonometric polynomials.

UNIT IV NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Numerical differentiation: Finite difference approximations – Richardson extrapolation – derivatives by interpolation. Numerical integration: introduction to quadrature – composite Trapezoidal and Simpson's rule – recursive rules and Romberg integration – Gaussian integration.

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UNIT V DIFFERENTIAL EQUATIONS SOLVING AND STATISTICS 12

Initial value problems: Euler method - Taylor series method – Runge-Kutta methods – stability and stiffness – adaptive Runge-Kutta method – Predictor- corrector method – system of differential equations – phase-plane analysis: chaotic 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. Generating random numbers – Monte Carlo integration.

TOTAL: 60 PERIODS

OUTCOME

At the end of each unit the students will be able to

- Write efficient mat lab code, analyze and interpret numerical results.
- Solve large system of linear equation and find the roots of non-linear equations.
- Construct approximate polynomial of given data and also apply numerical methods for curve fitting.
- Numerically differentiate and evaluate complicated integrals.
- Understand the basic concepts in numerical methods to estimate the solutions to ordinary differential equations and also get expose to use of statistics.

REFERENCES

1. A. 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. C. 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.

MC5202 CRYSTALLOGRAPHY AND CRYSTAL GROWTH L T P C
3 0 0 3

OBJECTIVE

- 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 9

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 9

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 9

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 9

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 9

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: 45 PERIODS

OUTCOME

- 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, New York,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. KRU Publications, 2000.
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7. C.Hammond. The Basics of Crystallography and Diffraction, IUCr-Oxford University Press, 2009.

MC5203 CHARACTERISATON OF MATERIALS L T P C
3 0 0 3

OBJECTIVE

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 – 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,- HRTEM: 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 – electrochemical C-V profiling – limitations - Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

UNIT V SPECTROSCOPY 9

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

TOTAL: 45 PERIODS

OUTCOME

- 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, Electrochemical, 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.
4. D.Kealey & P.J.Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. C.N.Banwell and E.M.McCash. Fundamentals of Molecular Spectroscopy. McGraw-Hill Education, 2017.

MC5204 **QUANTUM MECHANICS** **L T P C**
3 0 0 3

OBJECTIVE

- 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 -Eigenvalues and Eigenfunctions, 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

OUTCOME

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.

MC5205 **PHYSICS OF MATERIALS** **L T P C**
3 0 0 3

OBJECTIVE

To impart knowledge on various properties of materials

- To introduce the concepts of various 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 magnetic materials and their properties. The various applications used in magnetic materials.
- To study the properties of various optical materials, LED and LCD and their applications.
- To make the students understand about various properties of smart materials, shape memory alloys CCD and nanomaterials and their applications.

UNIT I MECHANICAL PROPERTIES **9**

Plastic deformation by slip – the shear strength of perfect and real crystals -dislocation movement – methods of strengthening against plastic yield – Creep – mechanisms – fracture – ductile fracture – brittle fracture – Griffith criterion – fracture toughness – fatigue fracture - mechanical tests - tensile, hardness and creep tests.

UNIT II DIELECTRIC PROPERTIES **9**

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

UNIT III MAGNETIC PROPERTIES **9**

Classification of magnetic materials- origin of magnetism – Langevin and Weiss theories - exchange interaction - magnetic anisotropy - magnetic domains - molecular theory – hysterisis - hard and soft magnetic materials - ferrite structure and uses - magnetic bubbles - magnetoresistance - GMR materials - dilute magnetic semiconductor (DMS) materials.

UNIT IV OPTICAL PROPERTIES **9**

Optical absorption in insulators, semiconductors and metals – band to band absorption – luminescence - photoconductivity. Injection luminescence and LEDs - LED materials - superluminescent LED materials - liquid crystals - properties and structure - liquid crystal displays- comparison between LED and LC displays.

UNIT V ADVANCED MATERIALS **9**

Metallic glasses - preparation, properties and applications - SMART materials - piezoelectric, magnetostrictive, electrostrictive materials - shape memory alloys - rheological fluids - CCD device materials and applications - solar cell materials (single crystalline, amorphous and thin films) - surface acoustic wave and sonar transducer materials and applications - introduction to nanoscale materials and their properties.

TOTAL: 45 PERIODS

OUTCOME

After completing the course the students should be able to:

- The students have gained knowledge in mechanical tests and plastic deformation mechanism.
- Would have known the application and various properties of dielectric materials.
- Make use of fundamental on magnetic materials properties and their application.
- To gain knowledge on optical materials properties and their applications.
- Understand the basic knowledge about advanced materials and preparation methods for nanomaterials and their properties.

REFERENCES

1. V.Raghavan, Materials Science and Engineering: A First Course. PHI Learning, 2015.
2. S.O.Kasap. Principles of Electronic Materials and Devices. McGraw-Hill Education, 2017.
3. C.Suryanarayana and A.Inoue. Bulk Metallic Glasses, CRC Press, 2017.
4. K.Otsuka and C.M.Wayman. Shape Memory Materials, Cambridge University Press, 1998.

MC5211	MATERIALS SCIENCE LAB – II	L T P C 0 0 6 3

LIST OF EXPERIMENTS
Any ten experiments: 45

1. Electrical conductivity of metals and alloys with temperature-four probe method
2. Hall effect - Determination of Hall co-efficient, charge carrier density and mobility.
3. Magnetic susceptibility-Quincke's method
4. Crystal Growth-Solution technique
5. Crystal Growth-Gel technique
6. Determination of melt flow index of polymers
7. Creep characteristics of a metallic wire
8. Particle size determination-laser - Determination of wave length of He-Ne laser-Diffraction method
9. Ultrasonic interferometer – ultrasonic velocity in liquids
10. Ferroelectricity – Hysteresis loop - coercivity, retentivity and saturation magnetisation.
11. 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
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

Laboratory equipments requirements:

1. Four probe
2. Electromagnet
3. Laser source
4. Melt flow index device
5. Ultrasonic interferometer
6. Universal testing machine

MC5301	INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY	L T P C 3 0 0 3

OBJECTIVE

- 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.

Attested

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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.

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

OUTCOME

- 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.

MC5302 POLYMER AND COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVE

- 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.

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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, molding, 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, 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.

TOTAL: 45 PERIODS

OUTCOME

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.
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5. P.K.Mallick. Fiber-Reinforced Composites: Materials, Manufacturing and Design. CRC Press, Boca Raton, 2008.

MC5303 **PHYSICAL METALLURGY** **L T P C**
3 0 0 3

OBJECTIVE

- To introduce the concepts of phase diagrams.
- To impact 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

Composition and classification of pig iron and cast iron – iron ores - manufacture of wrought iron and steel - The phase rule - Types of Binary Diagrams,– invariant reactions- eutectic, eutectoid, peritectic and peritectoid reactions – Thermodynamics, Solution theory - free energy composition curves – Experimental determination of equilibrium diagram-grain size analysis, grain size measurement - effect of grain size on properties of metals and alloys

UNIT II SOLID SOLUTION 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- - Iron-Carbon equilibrium diagram – Aluminum alloys – Copper alloys – Effect of alloying elements

UNIT III HEAT TREATMENT 9

Recovery, recrystallisation and grain growth: property changes, annealing twins, textures in cold worked and annealed alloys,-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 PHASE TRANSFORMATIONS 9

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 V ENGINEERING ALLOYS 9

Low carbon steels – mild steels – high strength structural steels – tool materials – stainless steels – super alloys – light alloys – shape memory alloys – applications

TOTAL: 45 PERIODS

OUTCOME

- 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.

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1. V.Raghavan. Physical Metallurgy: Principles and Practice. PHI Learning Private Limited, New Delhi, 2015.
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6. W.F.Smith. Structural Properties of Engineering Alloys, McGraw Hill Education, 2014.
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MC5311 MATERIALS SCIENCE LAB - III AND MINI PROJECT L T P C
0 0 6 3

A. MATERIALS SCIENCE LABORATORY – III

LIST OF EXPERIMENTS

Any Ten experiments

1. Density measurements – organic materials and polymers
2. NDT – Ultrasonic flaw detector
3. TGA – Measurement and interpretation of results
4. Faraday effect
5. X-ray powder method – indexing, cell determination and identification of unknown elements
6. Charge density, atomic scattering factor calculations.
7. Kerr effect
8. Laser coherence, divergence measurement.
9. Optical Fibre – Measurement of numerical aperture and bending loss.
10. Optical absorption – spectrophotometer
11. Identification of phases using metallurgical microscope.
12. Preparation of buffer solutions and pH measurements.
13. Laser Raman - sample preparation, recording and analysis
14. FTIR studies - sample preparation, recording and analysis
15. Etch pattern of single crystals.
16. MATLAB/SCILAB/MATERIALS STUDIO – simple programs and plots.
17. Synthesis of Nanomaterials.

B. MINI PROJECT

TOTAL: 45+45 = 90 PERIODS

MC5001 CERAMIC MATERIALS L T P C
3 0 0 3

OBJECTIVE

- To expose the students to various processing techniques used for ceramic materials.
- 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 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 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 II 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 III 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 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

OUTCOME

After completing the course, the students

- will analyze and apply the various processing techniques they have studied.
- 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 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.

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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.
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MC5002 NON-DESTRUCTIVE TESTING L T P C

3 0 0 3

OBJECTIVE

- 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 – nonimaging 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

OUTCOME

- 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

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2. Metals Hand Book, Vol.2, 8th Edition, ASTM, Metals Park, Ohio.
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4. W.J.Mc Gonnagle. Non-Destructive Testing Methods, Mc Graw Hill Co., NY, 1961.

MC5003 NONLINEAR OPTICS AND MATERIALS L T P C
3 0 0 3

OBJECTIVE

- To introduces the concepts of electromagnetic theory and refractive index of materials
- To expose the students the concept of optical susceptibility
- To make the students to understanding the concept of second order non linearity
- To introduce the processes of third order nonlinear optical effects
- To make the students to understand the properties of non linear optical materials

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UNIT I ELECTROMAGNETIC THEORY 9

Maxwell equations – wave equations in various media and its propagation – origin of complex refractive index – classical theory of optical absorption (electron oscillator model) and dispersion (Lorenz oscillator model) – classical theory of anharmonic oscillators.

UNIT II OPTICAL SUSCEPTIBILITIES 9

Wave equation description of nonlinear optical susceptibilities – quantum mechanical treatment of nonlinear optical susceptibilities – frequency and intensity dependence of polarization – and dielectric susceptibility – first and higher order susceptibilities.

UNIT III SECOND-ORDER NONLINEARITIES 9

Second harmonic generation – sum and difference frequency generation – parametric processes – simple theory and calculations of nonlinear polarization – various phase matching techniques in second harmonic generation (SHG).

UNIT IV THIRD-ORDER NONLINEARITIES 9

Third harmonic generation – four-wave mixing – Kerr nonlinearity – intensity dependent effect – self-phase modulation – cross-phase modulation. Stimulated Raman scattering – stimulated Brillioun scattering. Parametric gain – parametric amplification and oscillation -. Applications of frequency mixing and up-conversion – difference frequency generation – optical phase conjugation: theory and applications – Photorefractive effect and applications – solitons: theory and applications – optical bistability.

UNIT V NONLINEAR OPTICAL MATERIALS 9

Nonlinear optics of organic materials and polymers – liquid crystals – photorefractive materials – organic doped glasses – rare earth doped glasses and crystals – semiconductors – optical fibers and photonic crystal fibers – ferroelectric materials and other novel optical materials.

TOTAL: 45 PERIODS

OUTCOME

After the completion of the course the students able to

- Understand the concept of electromagnetic theory
- Appreciate the importance of optical susceptibility
- Reveal the origin of second harmonic generation and other second nonlinear optical processes
- Understand the important third order optical nonlinearities.
- Gain knowledge on the properties of non linear optical materials.

REFERENCES

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3. Y.V.G.S.Murti and C.Vijayan. Essentials of Nonlinear Optics. Wiley, 2014.
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MC5004 LASERS AND APPLICATIONS L T P C

3 0 0 3

OBJECTIVE

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 Modelocking 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.

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

OUTCOME

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

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5. M.Steen William. Laser Material Processing. Springer, 2010.

MC5005 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.

Attested

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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.

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, mergesort, histogram.

UNIT V 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

OUTCOME

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.

MC5006 ADVANCES IN X-RAY ANALYSIS L T P C
3 0 0 3

OBJECTIVE

- 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.

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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 (qualitative only).

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

OUTCOME

- 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.

MC5007 SEMICONDUCTOR MATERIALS AND DEVICES L T P C
3 0 0 3

OBJECTIVE

- To introduce the basic aspects of electronic energy band structures.
- To make the students to understand optical properties of materials.
- To aid the students to understand transport properties of charges in materials.
- To expose the students on the aspects of fabrication of semiconductor devices.
- To make the students to understand fabrication of optoelectronic devices.

UNIT I INTRODUCTION 9

Introduction: Properties of semiconductors - Free electron Theory - Transport properties. Bonds and Bands in Semiconductor: - Electronic band structure - Junction Properties of semiconductors - Recombination mechanism - Electron, Hole recombination through traps - Junction properties of p-n, n+-n, p+-p junctions - Surface recombination - Recombination with donors and acceptors at low temperatures - Quantum theory of junction devices - Generation of recombination processes in junction devices

UNIT II OPTICAL PROPERTIES 9

Optical properties of semiconductors - Optical constants - Light absorption spectrum - Light absorption edge - Effect of free charge carriers on the absorption edge - Fundamentals of absorption and reflection - Electron transport phenomena: Theory of electron transport in crystalline semiconductors - Boltzmann's transport equation for Bloch states - relaxation time - relaxation time approximation to the low field transport coefficients - scattering mechanism - Thermal effects in Semiconductors: Thermal conductivity - Thermo-electric power - Thermomagnetic effects - condition of degeneracy - strong magnetic fields - relative magnitudes of the magnetic effects. Optical and High frequency effects in Semiconductor.

UNIT III TRANSPORT PROPERTIES 9

Basic Process in Semiconductor Devices: Equilibrium properties - electrons and holes - impurities in semiconductors - carrier concentration as a function of temperature - High doping effects - Non-equilibrium phenomena - carrier transport - Transport properties in high fields - recombination and generation processes - breakdown mechanism - Basic equations for Semiconductor devices - equations for the interior of devices - boundary conditions - Systems, Material preparation - Material Characterisation - important processes for optoelectronic devices - Hetero junctions and Heterostructures.

UNIT IV FABRICATION OF TRANSISTORS AND THYRISTORS 9

Unipolar devices: Metal-Semiconductor contacts - Energy - Band Relation - Schottky Effect - Characterization of Barrier Height - Device Structure - Ohmic Contact - JFET and MESFET - basic device characteristic - general characteristic - Microwave performance - related field-effect devices - MIS diode - Si-SiO2 MOS diode - Charge-Coupled Device - MOSFET - basic device characteristic - Nonuniform doping and buried-channel devices - short-channel effect - MOSFET Structures - Nonvolatile memory devices. Bipolar transistor - Static characteristics - microwave transistor - power transistor - switching transistor - related device structures - Thyristors - basic characteristics - Schottky diode - Three terminal thyristor - related power thyristor - Unijunction transistor and trigger thyristor - Field-controlled thyristor.

UNIT V FABRICATION OF LED'S AND SENSORS 9

Photonic Devices: Light Emitting diodes - LED for fiber optics - LED performance - reliability - Semiconductor Laser - Lasers for optical communication system - future trends in Fiber optic communications - Photodetectors - Photoconductor - Photodiode - Avalanche Photodiode - Phototransistor - Solar cells - Thin film solar cells - solid state sensors, optical Sensors - optoelectronic components.

TOTAL: 45 PERIODS

OUTCOME

After the completion of the course the students able to

- Gain knowledge on energy band structures.
- Understand the optical properties of materials.
- Understand the transport materials in properties.
- Gain knowledge on fabrication of semiconductor devices.
- Understand different fabrication steps involved in optoelectronic devices.

REFERENCES

1. S.M.Sze and K.K.Ng. Physics of Semiconductor devices. Wiley India, New Delhi, 2008.
2. S.P.Keller. Handbook on Semiconductors, Vol. 1-4. T.S. Moss, Ed., North-Holland, Amsterdam, 1980.
3. C.M.Wolfe, J.R.N.Holonyak and G.E.Stillman. Physical Properties of Semiconductors. Prentice Hall International Inc., London, 1989.

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8. P. Gise & R. Blanchard. Modern Semiconductor Fabrication Technology. Prentice-Hall, New Jersey, 1986

MC5008 SUPERCONDUCTING MATERIALS AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVE

- 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 BASIC EXPERIMENTAL ASPECTS 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 SUPERCONDUCTING MATERIALS 9

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

UNIT III HIGH TEMPERATURE SUPERCONDUCTORS 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 IV THEORETICAL ASPECTS 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 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

OUTCOME

- 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 superconductivity.

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REFERENCES

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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.
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7. J.R.Schrieffer, Theory of Superconductivity, Levant Books, 2009.

MC5009 ADVANCES IN CRYSTAL GROWTH L T P C
3 0 0 3

OBJECTIVE

- 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) – Electrocrystallization – 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

OUTCOME

- 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.
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MC5010 NONLINEAR SCIENCE L T P C
3 0 0 3

OBJECTIVE
- To introduce the concept of dynamical systems, phase-space and equilibrium points.
- To make the students to understand the importance of nonlinearity and bifurcations.
- To show the occurrence of chaos in discrete systems and applications.
- To elucidate the notion of fractals and pattern formation in dynamical systems.
- To introduce the concept of solitons in simple nonlinear dynamical systems.

UNIT I DYNAMICAL SYSTEMS 9
Linear and nonlinear differential equations - Autonomous and nonautonomous systems - Phase trajectories, phase-space, flows and limit sets – Linear systems and linearity principle – Second-order linear equations – Trace-Determinant plane - Classification of equilibrium points in planar systems – Periodic orbits, limit cycles, Poincaré-Bendixson theorem.

UNIT II BIFURCATIONS AND CHAOS 9
Equilibria in nonlinear systems - bifurcations – Local and global bifurcations - Three dimensional autonomous systems and chaos, Lyapunov exponents -– Torus – quasi-periodic attractor – Poincaré map – Period doubling cascades – Feigenbaum number – characterization – Homoclinic orbits, heteroclinic orbits – Strange attractor and strange non-chaotic attractor.

UNIT III DISCRETE DYNAMICAL SYSTEMS 9
Linear and nonlinear discrete dynamics systems – complex iterated maps – Logistic map – Linear stability – Period doubling phenomena and chaos – Lyapunov exponents – Chaos synchronization – Synchronization manifold and stability properties – Controlling of Chaos – applications.

UNIT IV FRACTALS, CELLULAR AUTOMATA AND PATTERN FORMATION 9
Dimension of regular and chaotic attractors – Fractals – Koch curve – Cantor set – Sierpinski set – Julia and Mandelbrot sets – Cellular automata – Self organized criticality – Stochastic resonance – pattern formation – Time series analysis.

UNIT V INTEGRABLE SYSTEMS AND SOLITONS 9
Finite dimensional integrable systems - Linear and nonlinear dispersive systems – solitary waves - The Scott Russel phenomenon and derivation of Korteweg-de Vries (KdV) equation – Fermi – Pasta – Ulam (FPU) numerical problem – FPU recurrence phenomenon – Numerical experiments of Zabusky and Kruskal – Explicit soliton solutions: one-, two- and N- soliton solutions of KdV equation – Hirota's bilinear method.

TOTAL: 45 PERIODS

OUTCOME
After completion of this course, the students should able to
- Understand the concept of dynamical systems, phase-space and equilibrium points.
- appreciate the importance of nonlinearity and bifurcations in dynamical systems.
- Investigate the chaotic dynamics in discrete systems.
- Know the aspect of fractals and pattern formation in dynamical systems.
- Analyse the requirements needed to observe solitons in simple nonlinear dynamical systems.

Attested

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REFERENCES

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MC5011 MATERIALS PROCESSING L T P C
3 0 0 3

OBJECTIVE

- 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, planing and shaping, milling, grinding.

UNIT II SURFACE TREATMENT 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 set up.

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

OUTCOME

- 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.

Attested

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MC5012 NANOELECTRONICS AND PHOTONICS L T P C
3 0 0 3

OBJECTIVE

- 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

OUTCOME

- 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.

Attested

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MC5013 CORROSION SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVE

- 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.

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

OUTCOME

- 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.

Attested

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MC5014 SOLID STATE IONICS L T P C
3 0 0 3

OBJECTIVE

- 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

OUTCOME

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

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MC5015 MECHANICAL PROPERTIES OF MATERIALS L T P C
3 0 0 3

OBJECTIVE

- 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 - superplasticity.

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

OUTCOME

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

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MC5016 THIN FILM SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

- 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 film structures.
- To impact knowledge on the various properties of thin films.

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

OUTCOME

- 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.

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MC5017 NANOMATERIALS PREPARATION AND CHARACTERIZATION L T P C
3 0 0 3

OBJECTIVE

- To introduce the basic aspects of preparation of nanomaterials and their related characterization techniques.
- To study the synthesis and purification Single walled and Multi walled Nanotubes (SWNT and MWNT).
- To impart the concepts behind 1 dimensional nanowires and nanofibers.
- To inculcate characterization of materials with various techniques.
- To inspire the knowledge of nanodevices for magnetic storage.

UNIT I BASIC PROPERTIES OF NANOPARTICLES 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

UNIT II NANOTUBES 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 –VLS mechanism

UNIT III NANOWIRES AND NANOFIBERS 9

Semiconductor and oxide nanowires –preparation –solvothermal – electrochemical –PVD –Pulse laser deposition – template method (qualitative)- nanofibers –electro spinning technique

UNIT IV CHARACTERIZATION 9

FESEM - near-field Scanning Optical Microscopy - High-resolution Transmission Electron Microscopy (HRTEM)- Absorption and emission spectra – PL spectrum - single nanoparticle characterization –Scanning capacitance microscopy – capillary electrophoresis- laser induced fluorescence (CE-LIF)

UNIT V NANODEVICES **9**

Magnetic storage: - magnetic quantum well; magnetic dots - magnetic date storage - high density quantized magnetic disks - magnetic super lattices – MRAMS - MTJs using nanoscale tunneling junctions - Millipede for storage – nano-material sensors

TOTAL: 45 PERIODS

OUTCOME

- Familiarize the properties of nanoparticles and its advantages.
- The students apply ideas on enlightenment of Nanowires.
- Gain the idea of ID nanostructures.
- The students will be able to crack its application.
- The students will understand the principle involved in preparation and characterization of nanostructures and fabrication of nanodevices.

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2. A.S.Edelstein (Editor). Nanomaterials Synthesis, properties and applications. IOP Publishing, UK, 1996.
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MC5018 NANOSCALE FABRICATION AND TECHNIQUES **L T P C**
3 0 0 3

OBJECTIVE

- To introduce the various aspects of nanoscale fabrication techniques.
- To expose the different types of clean room and its importance.
- To make the students to understand the preparation techniques.
- To progress the nano-fabrication for biomedical applications.
- To know about applications and devices and mechanics for micro- and nano-systems.

UNIT I SCALING LAWS IN MINIATURIZATION **9**

Heat conduction in micro- and nano- systems: heat conduction equation, Newton's cooling law, heat conduction in multilayered thin films, heat conduction in submicron scale - 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 clean rooms – standardization – peripherals - oxidization and metallization- masking and patterning

UNIT III PREPARATION TECHNIQUES **9**

Basic micro- and nano-fabrication techniques: thin film deposition, ion implantation, diffusion, oxidation - surface micromachining, LIGA process -Packaging: die preparation, surface bonding, wire bonding, sealing, assembly Measurement techniques : scanning tunneling microscope, atomic force microscope, focused ion beam technique.

UNIT IV NANO-FABRICATION 9

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 APPLICATIONS AND DEVICES 9

Mechanics for micro- and nano-systems: bending of membrane and cantilever, resonance vibration, fracture, stress, nano Tribology -Fluid dynamics for micro- and nano- systems: surface tension, viscosity, continuity equation -laminar fluid flow, fluid flow in submicron and nanoscale- Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, nanodiodes, nanoswitches, molecular switches, nano-logic elements- Super hard nanocomposite coatings and applications in tooling- Biochemistry and medical applications: lab-on-a-chip systems.

TOTAL: 45 PERIODS

OUTCOME

- Grow up and promote scaling laws in miniaturization.
- The students should be able to utilize types of clean rooms.
- Apply the measurement techniques and focused ion beam technique.
- Gain the keen idea of biomedical applications.
- The students will understand the basic aspects of various lithographic techniques and the importance of clean room facility. They also understand various device characterization techniques.

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MC5019 HIGH PRESSURE SCIENCE AND TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE

- To introduce the aspects of High pressure science and the 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 – Superhard materials – Diamond – Oxides and other compounds – water jet.

TOTAL: 45 PERIODS

OUTCOME

- 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.

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MC5020 OPTICAL MATERIALS L T P C
3 0 0 3

OBJECTIVE

- To explain the optical properties of conducting materials.
- To make the students to understand the optical properties of semiconductors.
- To elucidate the concepts of optical properties in insulating materials.
- To elucidate the notion of optical gain the different types of lasers.
- To introduce the concept of nonlinear optical processes.

UNIT I OPTICAL PROPERTIES OF CONDUCTORS 9

Atomistic view: Drude model – plasma frequency – band structure in metals – density of states – coloration in metals – coloration by means of small metal particles – optical properties of superconductors – photoacoustic absorption spectroscopy – differential reflection spectroscopy.

UNIT II OPTICAL PROPERTIES OF SEMICONDUCTORS 9

Free electron gas – nearly free electron model – band structure – impurity states and lattice imperfections – carrier densities – absorption and photoluminescence – measurements: polarized light, absorption, photoluminescence, differential reflection spectroscopy. Optical materials and properties: Fabrication and growth – color – band gap energies – contact potentials.

UNIT III OPTICAL PROPERTIES OF INSULATORS 9

Propagation of light through insulators – reflection and transmission – optical attenuation – optical scattering – refractometers – thin films – glasses, crystals and birefringence – photochromic and electrochromic behavior – oxides, chalcogenides and halides – optical plastics – sources of color.

UNIT IV OPTICAL GAIN AND LASERS 9

Spontaneous emission – line shapes – stimulated emission and absorption – absorption and amplification – characteristics of lasers – cavity dynamics – laser systems – semiconductor lasers: p-n junctions, homo and hetero junction lasers.

UNIT V NONLINEAR OPTICAL PROCESSES 9

Linear materials – nonlinear processes – second-order optical nonlinearity – second-order susceptibility – materials – second harmonic generation – optical parametric oscillation – third-order susceptibility – materials – photorefraction – z-scan measurement – third harmonic generation.

TOTAL: 45 PERIODS

OUTCOME

After completion of this course, the students should able to

- Explain the optical properties of conducting materials.
- Understand the optical properties of semiconductors.
- Understand the optical properties in insulating materials.
- Understand the optical gain properties of materials and functioning of different types of lasers.
- Explain different nonlinear optical processes.

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MC5021 BIOMATERIALS L T P C
3 0 0 3

OBJECTIVE

- 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, bioglass and glass ceramics – polymers: PMMA, UHMWPE/HDPE, PTFE – bone cement – composites.

UNIT III CARDIO VASCULAR 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

OUTCOME

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.

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MC5022 COMPOSITE MATERIALS AND STRUCTURES **L T P C**
3 0 0 3

OBJECTIVE

- 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 interphase 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 – macromechanics – elastic constants of an isotropic material – elastic constants of a lamina – Analysis of laminated composites.

UNIT V 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

OUTCOME

- 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.

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5. B.D.Agarwal, L.J.Broutman & K.Chandrashekhara. Analysis and Performance of Fibre Composites. Wiley, 2012.
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MC5023 NUCLEAR PHYSICS AND REACTOR MATERIALS L T P C
3 0 0 3

OBJECTIVE

- 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 – criticality condition – fusion- energy released – stellar energy – controlled thermo nuclear reaction – plasma confinement.

UNIT IV NEUTRON AND REACTOR PHYSICS 9

Nuclear transmutation, Q value – exoenergic – endoenergic reactions – Nuclear cross sections – neutron sources – classification of neutrons – themalisation – 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

OUTCOME

- 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.
2. S.Glasstone. Principles of Nuclear Reactor Engineering. Van Nostrand Co, Inc., New York, 1985.
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.

MC5024 SMART MATERIALS AND STRUCTURES L T P C
3 0 0 3

OBJECTIVE

- To introduce the students to various intelligent, structural and biocompatible material.
- To introduce the concept of hybrid smart materials and structural systems.
- To make the students understand the principle, working and application of electro-rheological fluids.
- To expose the students to industrial piezo-electric materials and their properties.
- To impart knowledge on shape memory alloys, their properties and applications.

UNIT I INTRODUCTION 9

Classification of materials and their uses – Intelligent /Smart materials – Evaluation of materials Science – Structural material – Functional materials – Polyfunctional materials – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Intelligent inherent in materials – Examples of intelligent materials, structural materials, Electrical materials, bio-compatible materials etc. – Intelligent biological materials – Biomimetics – Wolff's law – Technological applications of Intelligent materials.

UNIT II SMART MATERIALS AND STRUCTURAL SYSTEMS 9

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures–Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

UNIT III ELECTRO-RHEOLOGICAL (FLUIDS) SMART MATERIALS 9

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

UNIT IV PIEZOELECTRIC SMART MATERIALS 9

Background – Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.

UNIT V SHAPE – MEMORY SMART MATERIALS 9

Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorisation process- SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary molding – Potential applications of SMA plastics.

TOTAL: 45 PERIODS

OUTCOME

- The students would gain knowledge on the intelligent, structural and biocompatible materials**.**
- The students would learn the concepts of hybrid smart materials and structural systems.
- The students will understand the principle, working and application of electro-rheological fluids.
- The students would be able to implement the knowledge gained on industrial piezo-electric materials.
- The students would have gained knowledge on shape memory alloys, their properties and applications.

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2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman. Engineering aspects of Shape Memory alloys. Butterworth –Heinemann, 1990
3. C.A.Rogers. Smart Materials, Structures and Mathematical issues. Technomic Publising Co., USA, 1989.

MC5025 NONLINEAR 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 stratergies 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

OUTCOME

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, 1987.
3. C.K.Tse. Complex behavior of switching power converters. CRC Press, 2005.
4. B.Muthuswamy and S.Banerjee. Introduction to nonlinear circuits and networks. Springer, 2019.
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OPEN ELECTIVE COURSES (OEC)

MP5491 NUCLEAR ENERGY IN HEALTH CARE AND INDUSTRY L T P C
3 0 0 3

OBJECTIVES

- To provide the student about the action of radiation on living cells and the response.
- To make the student to understand the basic nuclear medicine physics and newer technology systems.
- To enable the students to understand the diagnostic and therapeutic nuclear medicine techniques.
- To provide a broad knowledge in radiation hazard evaluation and control

UNIT I BASICS OF NUCLEAR SCIENCE AND RADIATION EFFECTS 9

Radioactivity, nuclear reactions and interaction of ionizing radiation with matter, with emphasis on radiation detection, radiation shielding - photoelectric - Compton effect and pair production - biological effects on human health - Action of radiation on living cells -direct and indirect physical damage- cell response to radiation - somatic and genetic radiation effects -Radiation side effects - Acute and chronic effects of low dose effects.

UNIT II DIAGNOSTIC APPLICATIONS OF NUCLEAR ENERGY 9

Production of X rays and its applications X-ray radiography - CT scan -contrast studies in x ray imaging - fluoroscopic applications -Mammography - physics of nuclear medicine and nuclear imaging - radio isotopes in diagnosis of nuclear imaging - Tc-99m extraction - radiopharmaceuticals - scanning instruments and techniques.

UNIT III THERAPEUTIC APPLICATION OF NUCLEAR ENERGY 9

Production of nuclear radiations- alpha, beta and gamma rays and X-rays - External radiation therapy -telecobalt unit and linear accelerators - and internal radiation therapy - Iridium -192 HDR brachtherapy unit- therapeutic nuclear medicine.

UNIT IV INDUSTRIAL APPLICATIONS OF NUCLEAR ENERGY 9

Industrial applications — Non destructive testing - industrial radiography - tracing, gauging, Radiation sterilization of medical equipments - food preservation and other applications.

UNIT V NUCLEAR RADIATION SAFETY MEASURES 9

Basic concepts of radiation protection standards - ICRP recommendations - systems of radiological protection - Optimization of protection and individual dos limits - Radiation dose to individuals from natural radioactivity in the environment and man- made sources - Evaluation of external and internal radiation hazards - effect of time, distance and shielding - radioactive waste disposal and transport of radioactive nuclides.

TOTAL: 45 PERIODS

OUTCOMES

After successful completion of the course

- students will be able to handle radioactive source carefully for treatment purpose.
- will develop competence in radioactive waste disposal management
- Will be develop competency to face radiation emergency
- students will develop critical thinking skills in radiation safety and protection.
- will be able to safe guard the radioactive sources used in hospitals.

REFERENCE BOOKS

1. W. R. Handee, Medical Radiation Physics, Year Book Medical Publishers Inc., London, 2003.
2. E. J. Hall, Radiobiology for Radiologists, J. B. Lippincott Co., Philadelphia, 2000.
3. W. N. Wagner, Principles of Nuclear Medicine, W. B. Saunders Co., London, 1990.
4. R. F. Mold, Radiation Protection in Hospitals, Adam Hilger Ltd., Bristol, 1985.
5. Fred A Mettler and Milton J Guiberteau, The essentials of nuclear Medicine imaging, 2011.

MP5492 SMART MATERIALS FOR ENERGY AND ENVIRONMENT APPLICATIONS **L T P C 3 0 0 3**

OBJECTIVES

- To provide fundamental understanding on smart and intelligent 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

Introduction - components and classification of smart structures, Requirements of Intelligent Materials – Functions: Sensor, Memory, Processor, Actuator - Common smart materials - Applications of smart systems – Energy Harvesting systems: Regenerative braking - Smart polymers: Applications in drug delivery, tissue engineering. Biomimetics and bio-inspiration.

UNIT II INTELLIGENT MATERIALS FOR ENERGY GENERATION 9

Artificial Intelligence in Materials, Ferrolectricity: Introduction - Piezoelectric effect, Piezoelectric materials as sensors, Actuators and bimorphs - Transparent Conducting Materials – Band-gap and electrical conductivity, Conditions for transparency – role of defects on conductivity - Applications: Solar cells, Touch screen, etc.

UNIT III SHAPE MEMORY MATERIALS FOR ENERGY STORAGE 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, Functional properties of SMAs. Thermal-storage, and aerospace materials. Shape-memory polymers, and their applications.

UNIT IV MULTIFERROIC MATERIALS FOR NOVEL REFRIGERATION 9

Ferromagnetism and ferroelasticity, Magneto-electric materials: Types of magnetic ordering phenomena, Conditions for multiferroicity– Applications of multiferroic materials. Magnetostrictive smart materials – Magneto-caloric materials for emission-less refrigeration - Magneto-Optic (MO) Materials: Examples (Heusler alloys, double perovskites) and Applications.

UNIT V INTELLIGENT OPTICAL MATERIALS FOR ENVIRONMENT 9

Smart optical materials for modifying spectral shift and refractive index shift. Electro-optic and Acousto-optic materials: Definitions, examples and applications –Chromogenic Materials – Types: Photochromic, Thermochromic, Electrochromic - Devices and Applications:Radiation absorption.

TOTAL: 45 PERIODS

OUTCOMES

- The student will understand the working principle of smart materials
- The student will get an overview on various types of smart materials and their application areas.
- The student will get ideas to use smart materials in green energy and environment applications
- The student will get motivated to find novel applications of these multifunctional materials in new technologies.
- The student will get an idea on different synthesis and characterization techniques

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.
5. P. Ball,Made to Measure: Materials for the 21st Century, Princeton University Press, 1997.
6. Ed. M. R. Aguilar and J.S. Roman, Smart Polymers and their Applications, Elsevier 2014.
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.

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EA5491 **CLIMATE JOURNALISM** **L T P C**
3 0 0 3

OBJECTIVES

- To offer a comprehensive approach to reporting of climate change.
- To impart knowledge about political, economic, and ethical questions raised by the need for transformative change of societies in the wake of climate change.
- To reflect over the development of climate change as a nature and a society issue.
- To synthesize knowledge from different areas related to climate change.
- To reflect on the norms and values of journalism in the context of climate change.

UNIT I HUMAN INFLUENCES **9**

Anthropocene Era (anthropo: man, and cene: new) - Freshwater scarcity - The decline of our oceans, fish, and wildlife - Environmental health - Sustainable energy, agriculture, and food systems – Role and responsibility of journalists – Making climate change relevant as a society issue – Politics and economics of climate change – Environmental ethics – Human health – Species migration.

UNIT II PUBLIC NARRATIVES **9**

Complex science and uncertainty - Public apathy and politics - Well-funded counter-narratives - Zealous stakeholders - What can (incorrectly) appear due to a lack of news hook for stories - Two centuries of CO_2emissions.

UNIT III JOURNALISTIC CHALLENGES **9**

Environmental Journalism as a craft - Roles and differences between journalism and communications – Finding the most accurate, credible and timeliest information on science and issues – Essentials of environmental reporting – Discerning uncompromised expert sources – Using human narratives and descriptive storytelling to relate real-world impact – Tapping the databases, records and other tools commonly used by environmental reporters.

UNIT IV CLIMATE ISSUES **9**

The lack of diversity in environmental journalism – “Junk science” – Battling climate denial - Covering GMOs – The problem of doomsday climate reporting – Digital security for journalists and researchers etc.

UNIT V JOURNALISTIC SKILLS **9**

Hands-on journalistic series – Reporting, developing, funding, crafting and publishing environmental stories – Writing diverse stories on environmental history, a wildlife or ocean story, a clam-aquaculture story, a work of nature writing, etc. – A polished, fact-checked, final story with questions answered and edits made from the first draft and at least two added elements such as photos, audio or video clips, graphics, timelines or others to draw people in.

TOTAL: 45 PERIODS

OUTCOMES

- Students will understand the importance of climate issues.
- Students will understand the various aspects of climate change and its effect in society.
- Students will learn to cover the climate change issues.
- Students will understand the need of journalistic skills for covering climate issues.
- Students will learn the various strategies, approaches on covering climate issues in various media.

REFERENCES

1. Lakoff, G., Why it matters how we frame the environment. In Environmental Communication, 2010.
2. Vetlesen, A. J., Nature, technology and environmental crisis. In Bhaskar, R., Næss, P., Høyer, K.G. (eds.), Eco philosophy in a World of Crisis. Critical Realism and the Nordic Contributions. London: Routledge, 2012.
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6. Stoknes, P.E., What We Think About When We Try Not to Think About Global Warming: Toward a New Psychology of Climate Action. Vermont: Chelsea Green, 2015.

EA5492 DIGITAL PHOTOGRAPHY L T P C
3 0 0 3

OBJECTIVES

- To create opportunities for professional and creative expression through the practice and art of photography.
- To inculcate aesthetic sense involved in creativity.
- To get to know the genres of photography

UNIT I CAMERA 9

Different camera formats, working of an SLR, DSLR and Mirrorless Cameras. Features and functions of SLR and DSLR Cameras. Various camera controls. Anseladams Zone system. Exposure. Image sensors. Different storage formats.

UNIT II LENS AND ELEMENTS OF PHOTOGRAPHY 9

Different type of Lenses - Basic Shots and Camera Angles, Photographic Composition - View point and Camera angle-Eye Level, Low and High, Balance- Aspects of Balancing, Shapes and Lines, Pattern, Volume, Lighting, Texture, Tone, Contrast- and Colour, Framing, various Perspectives.

UNIT III COLOUR AND LIGHTING 9

Colour Theory, Colour Temperature, Electromagnetic spectrum, Lighting Philosophies – Basic styles of Lighting – Properties of Light – Additive and Subtractive Light – Contrast and Lighting Ratios – Direct and Indirect Light – Three point and Five Point Lighting – Light Sources. Light meters and filters

UNIT IV PEOPLE AND PORTRAIT PHOTOGRAPHY 9

Indoor and outdoor lighting techniques for portraits, the Casual Portrait, Environmental Portraits, Group Portraits, Familiar Subjects, Hands and Other Details.

UNIT V GENRES OF PHOTOGRAPHY 9

Basic shooting and Lighting Techniques and Equipments required for different genres of Photography like Black and White, Landscape, Cityscape, Architecture, Advertising, Table top photography Fashion, Food, Automobile, Sports, Travel, Children, Portrait, wild life, Still Life, Event, Silhouette, Festival and Themes.

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to utilize the principles of good composition in photography.
- Students will be able to develop an individual style in representing the society through photographs.
- Students will have a thorough understanding of how to create visual variety
- Students will understand the foundation principles of design
- Students will gain understanding in Depth of field
- Students will understand the different genres of photography

REFERENCES

1. Ansel Adams, The Negative, Bulfinch press, Fourteenth Edition, 2008.
2. BalakrishnaAiyer, Digital Photojournalism, Authors press, 2005
3. Ben long, Complete Digital Photography, Charles River Media, Third Edition, 2005

4. Fil Hunter, Steven Biver, Paul Fuqua, Light - Science & Magic: an Introduction to Photographic Lighting, Focal Press,2007
5. Langford Bilissi,Langford's Advanced Photography, focal press, Seventh Edition, 2008.
6. Scott Kelby, The Digital Photography Book, Peachpit Press, 2009

AC5491 GREEN CHEMISTRY L T P C
3 0 0 3

OBJECTIVES

- To introduce the basic concept and principles of green chemistry for environmental management.
- To make the students know about green reagents and its importance to the environment
- To acquaint the student with green solvents and its impacts in green chemistry
- To familiarize the synthesis of materials using green methods
- To impart the knowledge on applications of green synthesis technology

UNIT I PRINCIPLES OF GREEN CHEMISTRY 9

History of green chemistry and sustainability- Prevention of waste/by-products – maximum incorporation of reactants in final product-Atom economy – Prevention/minimization of hazardous products – Designing safer chemicals – optimizing reaction conditions.

UNIT II GREEN REAGENTS AND CATALYSTS 9

Choice of starting materials – reagents (Dimethyl carbonate, polymer supported reagents) – catalysts (microencapsulated Lewis acids, zeolites, basic catalysts polymer supported catalysts, introduction to biocatalysts).

UNIT III GREEN SOLVENTS 9

Aqueous phase reactions (Claisen rearrangement, Aldol condensation, wurtz reaction, reduction of carbon carbon double bond, oxidation of amines into nitro compounds – Electrochemical synthesis (synthesis of adiponitrile) - Ionic liquids – reactions in acidic ionic liquids- reactions in neutral ionic liquids (hydrogenations, diels-Alder reactions, Heck reactions, O-alkylation and N-alkylation, methylene insertion reactions.

UNIT IV GREEN SYNTHESES 9

Microwave induced green synthesis (Hoffmann Elimination and Oxidation of alcohols) – Ultra sound assisted green synthesis (Esterification, Saponification and Cannizaro reaction) – Solid state green synthesis (Dehydration of alcohols to alkenes, Grignard reaction)- Solid supported organic synthesis (Synthesis of furans and pyrrole)

UNIT V APPLICATIONS OF GREEN SYNTHESIS 9

Introduction – synthesis of styrene, adipica acid, catechol, 3-Dehydroshikimic acid, methyl methacrylate, urethane. Environmentally benign synthesis of aromatic amines – free radical bromination – synthesis of ibuprofen and paracetamol.

TOTAL: 45 PERIODS

OUTCOMES

- To be familiar with basic concepts of green chemistry and apply to them in various field
- To recognize the catalytic reaction with green reagents and its importance. To identify available green solvents and apply them to various synthesis process
- To recognize the preparations of materials with green process and its application to the environment.
- To gain the knowledge of preparation of various drugs using green synthesis methods
- To be have the skills and technology towards green chemistry and apply in industry.

REFERENCES

1. V.K. Ahluwalia and M. Kidwai, New trends in Green Chemistry, Anamaya Publishers, 2004.
2. V. K. Ahluwalia, Green Chemistry, Narsoa publishers, 2012
3. Bela Torok and Timothy Dransfield ,Green Chemistry, An Inclusive Approach, 1st Edition, Elsevier, 2017.

AC5492 FOOD CHEMISTRY L T P C
3 0 0 3

OBJECTIVES

- To enable the students to acquire knowledge on the macro and micro constituents of the food
- To know the structure and chemical characteristics of constituents of food.
- To demonstrate the knowledge of food chemistry and applying, the principles and concepts of chemistry as they apply to food systems.
- To familiarize the student with the relationship between water and food.
- To explain the rationale for certain food processes and preservation

UNIT I INTRODUCTION TO FOOD AND ITS PROPERTIES 12

Proteins-Enzymes- Chemistry and structure, kinetics, Maillard reaction. Food carbohydrates: Structural, nutritional and functional aspects. Emulsifiers-role of emulsifiers selection of emulsifier based on hydrophilic and Lipophilic balance (HLB) and its application. Thickeners-definition, chemical structure, gel formation, list of permitted thickeners and food application. Chemical and biochemical changes: changes occur in foods during different processing.

UNIT II PROCESSING AND PRESERVATION 12

Scope and benefits of industrial food preservation. Preservation of foods by chemicals, antibodies, antioxidants, salt and sugar. Principles of food freezing: freezing point of foods Psychrometric chart, Freeze concentration, freeze drying, IQF. Nanotechnology: Principles and application in foods, Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.

UNIT III FLAVOURS AND COLOURING AGENTS 9

Chemistry of food flavor, definitions, Flavourmatics /flavouring compounds, flavor retention-off flavours and food taints. Colour -Natural and synthetic food colours, their chemical structure, stability, permitted list of colours, usage levels and food application.

UNIT IV WATER RELATIONS IN FOOD 6

Moisture in food: Structure, properties, Types of water in food and their specific function water activity and stability.

UNIT V FOOD ADDITIVES 6

Definitions, uses and functions of: Acids, Bases, Buffer system, chelating/sequestering agents, Antioxidants, Anti-caking agents, Firming agents. Flour bleating agents and Bread improvers. Anti-microbial agents/ class I & II.

TOTAL: 45 PERIODS

OUTCOMES

- Will know about the factors governing the food quality and chemical constituents.
- Will be able to name and describe the general chemical structures of the major components of foods and selected minor components
- Will come to know about the techniques involved in food processing and preservation
- Will be acquitted with food additives and their function in preservation
- Will be familiarize with the nature of packed food from industrial processes

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4. Peter C. K. Cheng, Handbook of Food Chemistry, Vol 1, Springer Reference, 2015
5. Jaswinder Kaur and Barry H. Grump Fundamentals of Food Chemistry, Abhizeet Publications, 2010.
6. Harish Kumar Chopra and Parmjit Singh Panesar, Food Chemistry, Narosa Publication, 2010.

AG5491 NATURAL HAZARDS AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES
- To teach characteristics of natural hazards.
- To teach mitigation methods for natural hazards.
- To provide knowledge on assessment and management of natural hazards.

UNIT I DISASTER PHENOMENON 9
Disaster threat - characteristics-parameters – mapping aspects for earthquake, landslides, tsunami, cyclones, flood, drought and epidemics.

UNIT II MITIGATION 9
Geological and hydrological hazards - Reduction of hazard proneness – reducing structural vulnerability – changing the functional characteristics of settlement – building code provisions.

UNIT III ASSESSMENT 9
Elements of risk – vulnerability analysis on dam and other infrastructures – risk assessment – plan area – organizational aspects, planning and mapping levels – socio-economic aspects – cost of risk reducing measures.

UNIT IV MANAGEMENT 9
Prevention – preparedness – response – recovery – resource utilization – international assistance – policy and legislation – training – public awareness.

UNIT V CASE STUDIES AND ADVANCED TOOLS 9
Post disaster review – role of remote sensing and GIS –National and state level case studies on various disasters.

TOTAL: 45 PERIODS

OUTCOMES
On completion of this course, the students expected to be able to:
- Gain knowledge on natural hazards and their characteristics
- Have better understanding on geological and hydrological hazards
- Appreciate various mitigation techniques.
- Carryout risk assessment and vulnerability mapping
- Understand the role of remote sensing and GIS in natural hazard risk reduction.

REFERENCES
1. Nick Carter, W. Disaster management, A Disaster manager's Handbook, Publisher: Asian development bank, Manila, 1992.
2. Mitigating natural disasters: Phenomena, effects and options, a Manual for policy makers and planners. Publisher: United Nations, Hew York, 1991.

3. Edward A. Keller, DeVecchio. Natural Disasters: Earth's Processes as Hazards, Disasters and Catastophes, Routledge, 3rd Edition, 2011.
4. Harsh K. Gupta, Disaster Management, Indian National Science Academy, ISBN 8173714568,788173714566, 2006 second Edition, 152 Pages.
5. Ghanshyam Singh and Sandip Bhandari, Disaster Management, Gullybaba Publishing House (P) Ltd; 1st edition (2012), ISBN-13: 978-9381066492.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√	√	√
CO5	√		√	√	√	√	√			√		√

AG5492 OCEAN RESOURCES AND EXPLORATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

- To understand the Sources of Marine Minerals.
- To understand the various energy resources pertain to marine system
- To understand the importance and economic aspects of marine minerals

UNIT I INTRODUCTION 9

Marine Mineral Resources - sources of Marine Minerals -sources in ocean basins. Formation Processes of Polymetallic Sulfides (PMS) on the Ocean Floor- Plate boundaries and associated mineral and energy occurrences.

UNIT II OCEAN RESOURCES 9

Mineral deposits derived from land sources - Placer Deposits - Lime, Phosphorite and Salt Deposits - Beach Deposits of Continental Margins - rock salt (sodium chloride) - magnesium metal - magnesium compounds and bromine. metalliferous sediments-Seafloor Polymetallic Massive Sulphides - polymetallic manganese nodules. Methane hydrate.

UNIT III ENERGY RESOURCES 9

Wind Energy - Wave Energy - Tidal Energy - Ocean Current Energy - Ocean thermal energy conversion (OTEC) - osmotic power plant-Petroleum resources and radioactive nuclear mineral deposits

UNIT IV OCEAN RESOUCE EXPLORATION AND EXPLOITATION 9

Marine sampling - Water Samplers - Bottom Samplers - Instrumentation

UNIT V OCEAN MINERAL MINING 9

Mining aspects of deep-sea polymetallic sulphides - Manganese Nodules - Methane Hydrates. Sand, Sand Mining & Beach replenishment-Marine maps of Exclusive Economic Zone (EEZ)

TOTAL: 45 PERIODS

OUTCOMES

- Students will understand the various sources of marine minerals.
- Students will able to understand the Mineral deposits derived from land sources.
- Students will learn about the energy resources of marine system.
- Students will learn about various sampling methods and instrumentation.
- Students will able to understand the economic aspects of marine minerals.

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REFERENCES

1. H. Kunzendorf, Marine Mineral Exploration, Volume 41, 1st Edition, Elsevier Science, 1986
2. David Spencer Cronan, Handbook of Marine Mineral Deposits, CRC Press, 24-Nov-1999
3. Yves Fouquet , Denis Lacroix , Deep Marine Mineral Resources, 2014th Edition, Springer Dordrecht Heidelberg London New York
4. H. Kunzendorf , Marine Mineral Exploration, ISBN-10: 0444426272, Elsevier Oceanography Series

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		√
CO5	√		√	√	√	√	√		√	√	√	

MC5491 BASIC CRYSTALLOGRAPHY AND CRYSTAL GROWTH L T P C
3 0 0 3

OBJECTIVES

- To introduce the basics of crystal symmetry and crystal structures.
- To provide students with a background to X-ray generation and detection
- To provide instruction on the steps involved in single crystal structure determination
- To teach the concept of powder X-ray diffraction and its applications
- To teach various crystal growth techniques

UNIT I CRYSTAL SYMMETRY AND STRUCTURES 9

Crystalline and non-crystalline materials — symmetry: symmetry operations, symmetry elements - translational symmetries - point groups - space groups – equivalent positions - space lattice - crystal systems – Bravais lattices – crystal directions - crystal planes – Miller indices- interplanar spacing – coordination number– atomic radius – atomic packing factor of SC, BCC, FCC and HCP structures – linear density – planar density – close packed structures.

UNIT II X-RAYS 9

X-rays - generation of X-rays - sealed tube and rotating anode generators – synchrotron radiation – continuous and characteristic X-rays - X-ray absorption – X-ray monochromators – collimation – Soller slits - X-ray detectors (principles only)

UNIT III SINGLE CRYSTAL STRUCTURE DETERMINATION 9

Diffraction by X-rays - Bragg's law – reciprocal lattice and Ewald sphere – atomic scattering factor - intensities of diffracted X-rays -– Single crystal X-ray diffractometers – measurement of intensities – systematic absences – space group determination - factors affecting X-ray intensities – data reduction – solving the structure - phase problem in crystallography – direct methods – refining the structure – results - geometrical parameters.

UNIT IV POWDER X-RAY DIFFRACTION 9

X-ray diffraction by polycrystalline materials - formation of powder diffraction patterns - Debye-Scherrer camera – powder X-ray diffractometer – diffractograms – sample holders – sample preparation – orientation of crystallites – sample rotation – diffraction geometries – indexing of powder pattern – applications of powder diffraction.

UNIT V CRYSTAL GROWTH TECHNIQUES 9

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: 45 PERIODS

OUTCOMES

Upon completion of the course the students will

- understand crystal symmetry, crystal planes and simple crystal structures
- gain a knowledge of X-ray generation, absorption, monochromatization and detection
- get a working knowledge of single crystal structure determination
- get some insight into the powder diffraction and its applications
- be able to understand the basics of various crystal growth techniques

REFERENCES

1. Tareen, J.A.K. and Kutty, T.R.N. A Basic course in Crystallography. University Press, 2001.
2. Cullity, B.D. and Stock,S.R. Elements of X-ray Diffraction. Pearson, 2014
3. Stout, G.H. and Jensen, L. X-ray Structure Determination, A Practical Guide. Macmillan : New York, 1989.
4. Woolfson, M.M. An Introduction to X-ray Crystallography. Cambridge University Press, New York, 1997.
5. Bhat, H.L Introduction to Crystal Growth: Principles and Practice. CRC Press, 2014.

MC5492 NONLINEAR SCIENCE L T P C
3 0 0 3

OBJECTIVES

- The students will be introduced to the basics of nonlinear dynamics and its applications.
- The students will learn about the mathematical models needed to study the concepts of fixed points, oscillations, bifurcations and integrability.
- The students will know about the nonlinear dynamical phenomena in chemical systems.
- The students will understand the importance of nonlinear dynamics in biological systems.
- The students will be introduced to the concepts of nonlinear dynamical analysis in geological systems.

UNIT I NONLINEAR DYNAMICS 9

Dynamical systems - linear systems - importance of nonlinearity - nonlinear dynamical systems - Autonomous and non-autonomous systems - phase-space, flows and limit sets . Classification of equilibrium points in planar systems – periodic and chaotic motions - fractals - pattern formation - cellular automata - self-self-organised criticality - networks - stochastic resonance.

UNIT II MATHEMATICAL MODELS 9

First-order differential equations - separation of variables - slope fields - Euler's method - equilibria and phase plane - bifurcations - higher-order equations - trace-determinant plane - harmonic oscillators - equilibrium point analysis - non-autonomous systems and chaos - finite dimensional integrable systems - dispersive systems - solitary waves - solitons - analysis of soliton solutions.

UNIT III CHEMICAL SYSTEMS 9

Chemical oscillations - waves and patterns - transport and external field effects - polymer systems - coupled oscillators - Turing patterns - stirring and mixing effects - Briggs-Rauscher reaction - Belousov-Zhabotinsky reaction - BZ waves - propagating pH front - chemical clocks.

UNIT IV BIOLOGICAL SYSTEMS 9

Biological oscillators - excitable systems - neuronal systems: HH equations - FN equations - physiological control systems - dynamics of bone remodelling - dynamics of nucleic acids:Protein complexes - patterns in biological membranes - cell replication and control - pupil light reflex - dynamical analysis of human tremor - fractals in living organisms.

UNIT V GEOLOGICAL SYSTEMS 9

Computational models of earthquakes - earthquake processes - multi fractals in geosciences - entropy analysis of seismicity - tectonics - spatial distribution of earthquakes - volcanic eruptions - short and long range interactions - RJB model - precursory dynamics - landscape dynamics - dynamics of earth's magnetosphere. Snow avalanches and system model - geomorphology: drainage networks, fractal trees, growth models, diffusion-limited aggregation.

TOTAL: 45 PERIODS

OUTCOMES

After completing this course, the students should able to

- Understand the basics of nonlinear dynamics and its applications.
- Gain knowledge on the concepts of fixed points, oscillations, bifurcations and integrability.
- Appreciate the importance of nonlinear dynamical phenomena in chemical systems.
- Understand the role of nonlinear dynamics in biological systems.
- Apply nonlinear dynamical analysis for geological systems.

REFERENCES

1. M. Lakshmanan and S. Rajasekar. Nonlinear Dynamics: Integrability Chaos and Patterns. Springer-Verlag, 2003
2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific,Singapore, 1996.
3. S.H.Strogatz. Nonlinear Dynamics and Chaos. CRC Press, 2014.
4. Paul Blanchard, R.L.Devaney and G.R.Hall. Differential Equations. Brooks/Cole, 2012.
5. Irving R.Epstein and J.A. Pojman. An Introduction to Nonlinear Chemical Dynamics. Oxford University Press, 1998.
6. Anne Beuter, Leon Glass, M.C.Mackey and M.S.Titcombe. Nonlinear Dynamics in Physiology and Medicine. Springer, 2003.
7. Donald L. Turcotte. Fractals and Chaos in Geology and Geophysics. Cambridge University Press, 1997.

MT5491 STATISTICAL METHODS L T P C
3 0 0 3

OBJECTIVES

- To organize and describe the data and hence compute the various descriptive measures
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using standard sampling distributions
- To expose to the basic principles of experimental design and hence carry out the analysis of variance
- To use non parametric methods on data sets which are not from normally distributed population
- To prepare the students to implement the various concepts in statistics using R statistical tool

UNIT I DESCRIPTIVE STATISTICS 9

Frequency distribution - Graphs of frequency distribution - Descriptive Measures - Quartiles and Percentiles - Calculation of sample mean and population mean

UNIT II HYPOTHESIS TESTING 9

Sampling Distributions- Central Limit Theorem - Testing a Statistical Hypothesis - Tests Concerning Means and variances - Independence of Attributes - Goodness of Fit

UNIT IV ANALYSIS OF VARIANCES 9

One way and two way classification - Completely Randomized Design - Randomized Block Design - Latin Square Design

UNIT V NONPARAMETRIC METHODS 9

Sign Test - Wilcoxon's Signed Rank Test - Rank Sum Tests - Tests of Randomness - Kolmogrov Smirnov and Anderson Darling Tests

UNIT V CALCULATIONS USING R 9

Classification and tabulation of data - Graphical representation - Calculation of central tendency and dispersion of data - Implementation of skewness, moments and kurtosis - Hypothesis Testing - Implementation of ANOVA, sign test and rank sum test.

TOTAL: 45 PERIODS

OUTCOMES

- It equips the student to compute mean, variances, quartiles and percentiles for a large set of data points obtained from a series of measurements
- It imparts the knowledge of various test statistics used in hypothesis testing for mean and variances of large and small samples
- It enables the students to compare several means
- It makes the students use sign test and rank test which can be applied to any raw data without the underlying assumptions that the observations are from normal population.
- It equips the students to implement the various concepts learnt using R tool for statistics

REFERENCES

1. Gupta S. C. and Kapoor V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 11th Edition, New Delhi, 2002.
2. John E. Freund ," Mathematical Statistics with Applications", 8th Edition, Pearson Education, New Delhi, 2017.
3. Richard A. Johnson, Irwin Miller and John Freund, "Miller and Freund's Probability and Statistics for Engineers", 8th edition, Pearson Education, New Delhi, 2015.

HS5491 PROFESSIONAL EMAIL COMMUNICATION L T P C
3 0 0 3

UNIT I Email as a medium of professional communication (1 hour)

a. Clear, grammatically correct sentences
b. Clear and coherent paragraphs
c. Polite and professional expression
d. Accurate punctuation

The nature of the e-mail in its present technological state

a. The pros and cons of using email for professional communication

UNIT II Standard email conventions and etiquette

a. Conventions for effective emailing intra and inter workplaces(inclusive of formatting)
b. Interpersonal etiquette to be used in professional emailing
c. Cross- cultural dos and don'ts when using email across borders

UNIT III Understanding email messages accurately (2 hours)

a. Understanding the core message
b. Understanding the writer's intention and expectation accurately

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c. Interpreting the style ad tone of the message
d. Reading and understanding messages quickly

UNIT IV Writing clear and contextually appropriate responses (12 hours)

a. Writing appropriate opening and closing sentences
b. Structuring the email logically and coherently
c. Positioning the core message for reader attention and action
d. Writing messages for a range of professional functions such as giving an update, reporting, requesting , clarifying and confirming, giving instructions etc.

UNIT V Using a range of professional styles (10 hours)

a. Maintaining courtesy and professional poise in all messages
b. Being direct or indirect as necessary
c. Being elaborate or brief as necessary
d. Being assertive and decisive when needed

TOTAL: 45 PERIODS

Learning outcome: At the end of the course, the students should

- Understand email as a professional communication medium and as it is used in workplaces today.
- Use standard e-mailing conventions and etiquette used in workplaces internationally.
- Use appropriate style and tone for communicating a variety of professional messages that are generally communicated via e-mail in work and business communication.
- Read and interpret e-mail messages accurately and write contextually appropriate responses.
- Use English accurately while writing emails in generic professional contexts.
- Use punctuation accurately while writing e-mail messages.

Assessment (with individualised feedback for mid-course tests) :

Mid-course Assessment - 1 hour + 1 hour for feedback after evaluation)

Mid-course Assessment - 2 (1 hour + 1 hour for feedback after evaluation)

Final Assessment – 2 hours (inclusive of Email English test)

Classroom teaching methodology: Concept familiarisation will be accompanied with practice in generic professional emailing contexts. Practice tests and individualised feedback will be used feedback.

Material for the course will be teacher generated

HS5492 PROJECT REPORT WRITING L T P C
3 0 0 3

OBJECTIVES

The Course aims to,

- Develop the project writing skills of engineering graduates
- Give engineering and technology students practice in writing a project report
- Enhance their awareness on the importance of report writing in the professional context

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UNIT I

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing

UNIT II

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis

UNIT III

Structure of the Project Report: (Part 1)Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework

UNIT IV

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography

UNIT V

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report orally – Techniques

TOTAL: 45 PERIODS

OUTCOMES

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

- Write reports successfully
- Analyze issues threadbare and arrive at findings based on the analysis
- Write reports for different purposes

REFERENCE BOOKS:

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

HS5493 **BASIC PRESENTATION SKILLS** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to,

- Develop public speaking skills among students of engineering and technology
- Enhance the presentation skills of students
- Heighten the awareness related to the fundamentals of presentations

UNIT I

Presentation skills – Characteristics of an effective Oral Presentation – Audience - Context, Content, Speaker Status - Purpose – Modus Operandi – Extempore

UNIT II

Emphasis on syllable stress, pronunciation, intonation, pauses, pace - Preparation for a presentation – Avoiding plagiarism –Ample use of Referencing skills – Efficient ways of Collecting and Collating data (due emphasis on important information)

UNIT III

Impressive introduction – Body language – Use of icebreakers – "Start Proper" for the presentation – Relevant Anecdotes & Jokes - Responding constructively to questions – Time Management – Information sharing

UNIT IV

Impressive introduction – Body language – Use of icebreakers – "Start Proper" for the presentation – Relevant Anecdotes & Jokes - Responding constructively to questions – Time Management – Information sharing

UNIT V

Presentation skills – Guidelines – Group Presentation - Creative approaches to presenting – Technical presentation - Speaking under time constraint – variations in pitch, tone & intonation - Credibility in presentation (Use of authentic data/information) Podium panache – Effective Delivery

Learning Outcomes: At the end of the course, students will be able to,

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. Michael Osborn, Susan Osborn, Randall Osborn & Kathleen J Turner, "Public Speaking: Finding Your Voice", 10th Edition, Pearson, 2012.
2. John Hughes & Andrew Mallett, "Successful Presentations DVD & Student's Pack", OUP, Oxford, 2012.
3. Nancy Duarte, "Resonate: Present Visual Stories That Transform Audiences", John Wiley & Sons, New Jersey, 2010.
4. Scott Berkun, "Confessions of a Public Speaker", O'Reilly Media, Inc, Canada, 2010.
5. Barbara Pease & Allan Pease, "The Definitive Book of Body Language", Bantum Books, New York, 2006.
6. Naomi Karten, "Presentation Skills for Technical Professionals: Achieving Excellence (Soft Skills for IT Professionals), IT Governance Publishing, UK, 2010.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

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UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

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UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explaina critical understanding of key concepts in disaster riskreduction and humanitarian response.
CO3: Ability to illustratedisaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describean understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

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UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 VALUE EDUCATION **L T P C**

2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095	CONSTITUTION OF INDIA	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

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UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do's and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

Attested

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SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.