DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY

5 year Integrated M. Tech. in Nanotechnology

COURSE STRUCTURE		
SEMESTER –I		
		SUBJECT
PHY-111021	**Theory**	Engineering Physics-I
NAN-111110		Engineering Mechanics
ENG- 110040		Communicative English
MAT-111010		Engineering Mathematics-I
CHM-110030		Engineering Chemistry-I
NAN-111120		Basic Electrical Engineering
PHY-112080	**Practical**	Engineering Physics Laboratory -I
CHM-112090		Engineering Chemistry Laboratory-I
NAN-112130		Basic Electrical Engineering Laboratory
		Total
SEMESTER –II		
PHY-120020	**Theory**	Engineering Physics-II
EVS-120050		Environmental Studies
COM-120040		Fundamental of Computer and C-Progra
MAT-120010		Engineering Mathematics-II
CHM-121031		Engineering Chemistry-II
NAN-121050		Basic Electronics Engineering
BIO-120060		Biology
CHM-122120	**Practical**	Engineering Chemistry Laboratory II
PHY-122110		Engineering Physics Laboratory II
NAN-122070		Basic Electronics Engineering Laborator
NAN-122130		Workshop Practices
		Total
SEMESTER –III		
NAN-211140	**Theory**	Engineering Mathematics-III
LRM-210100		Disaster Management
NAN-212190		Introduction to Materials Science
NAN-211180		Materials Thermodynamics
NAN-212130		Material characterization Laboratory
NAN-212120	**Practical**	Engineering Drawing
		Total

SEMESTER –IV		
NAN-221140	**Theory**	Engineering Mathematics-IV
NAN-221150		Synthesis and Properties of Nanomaterial
NAN-221160		Crystallography and Crystal structure

NAN-221190		Mechanical Properties of Materials
NAN-222200	**Practical**	Nanomaterial synthesis Laboratory
		Total
SEMESTER –V		
CODE		**SUBJECT**
NAN-315070	**Theory**	Advanced Functional Materials and Devic
NAN-321090		Nanotechnology for Energy Systems
NAN-315080		Self-Assembly and Molecular Engineering
		Elective I
		Elective II
		Total
SEMESTER –VI		
NAN-321120	**Theory**	Spectroscopic Techniques
NAN-321130		Modern Microscopic Techniques
NAN-321140		Introductory Quantum Mechanics
NAN-321150		Solid State Technology
NAN-321160	**Practical**	Computational Nanoscience
NAN-322050		Computational Nanoscience Laboratory
NAN-322160		Structural Characterization Laboratory
		Total
SEMESTER –VII		
NAN 411140	**Theory**	Nanomagnetism
NAN-411100		Nanoelectronics
NAN-411030		Surface Engineering and thin films
NAN-411050		Polymer Engineering
NAN-414070	**Practical**	Internship and Professional Training/Tern paper and Seminar
		Total
SEMESTER –VIII		
NAN-421050	**Theory**	Engineering Economics & IPR
NAN-421040		Nanophotonics
NAN-421060		Nanotribology and Nanomechanics
NAN-421030		Nanocomposite
NAN-424090		Project & Seminar
		Total
SEMESTER –IX		
NAN-514010		Project
NAN-514020		Dissertation & Interim Evaluation
		Total
SEMESTER –X		
NAN-522060		Project
NAN-524070		Dissertation -Evaluation
		Total
		Total Credits

INTEGRATED M.TECH DETAILED SYLLABUS

SEMESTER – I

BASIC ELECTRICAL ENGINEERING

Credit-03

UNIT-I

INTRODUCTION: Different types of Signal and System, Basic electrical elements, Ideal and Practical Sources, Source Conversion, Induced EMF, Energy Stored in Inductor & Capacitor, Electric Power, Duality, Star-Delta Conversion Technique.

UNIT-II

DC NETWORKS: Kirchhoff's Laws, Nodal and Mesh Analysis, Theorems applicable to DC networks: Thevenin, Norton, Superposition and Maximum Power Transfer Theorem, Transients in R-L and R-C circuits with DC excitation.

UNIT-III

AC CIRCUITS: Generation of alternating voltage and currents, Waveform and Phasor representation, RMS and Average value, form factor , crest factor, AC through resistance, inductance and capacitance, R-L , R-C and R-L-C series and parallel circuits, phasor diagrams , power and power factor, series and parallel resonance, Q-factor and bandwidth.

THREE-PHASE AC CIRCUITS: Comparison between single-phase and three-phase systems, Three-phase EMF Generation, Line and Phase quantities in star and delta networks, Power and its measurement in three-phase balanced circuits.

UNIT-IV

SINGLE-PHASE TRANSFORMERS: Construction and principle of operation, EMF Equation, Transformation ratio, Practical and Ideal transformers, Transformer losses, Brief idea on transformer phasor diagram and transformer rating

UNIT-V

BASIC INSTRUMENTS: Introduction, classification of instruments, operating principles, essential features of measuring instruments, Moving coil permanent magnet (PMMC) instruments, Moving Iron of Ammeters and Voltmeters (elementary Treatment only), Multimeter, Q-meter (Frequency measuring instrument).

Text /References Books:

1. Nagsarkar & Sukhija, "Basic Electrical Engineering", Oxford University Press (Printed in India), First Published-2005, Third Impression-2006.
2. B.L. Thareja & A. K. Thareja, "A Text Book of Electrical Technology" Volume-I, Basic Electrical Engineering, S. Chand.

3. A. K. Chakraborty, Circuit Theory (Analysis and Synthesis), 5th Edition, Dhanpat Rai & Co.
4. Van Valkenburg M E, Network Analysis 3rd Edition, Prentice Hall 1974.
5. A. K. Sawhney- *A course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Sons, 2010

ENVIRONMENTAL STUDIES

Credit-03

The multidisciplinary nature of environmental studies, definition, scope and importance, 1.2 needs for public awareness

Natural resources, renewable and non-renewable resources, natural resources and associated problems, forest resources, water resources, mineral resources, food resources, energy resources, land resources, equitable use of resources for sustainable lifestyles

Ecosystems, concept of an ecosystem, structure and functions of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems (ponds, lakes, streams, rivers, estuaries, oceans)

Biodiversity and its conservation, definition: genetic, species, ecosystem diversity, biogeographic classification of India, value of biodiversity: India as a mega diversity nation, hotspots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity: in-situ and ex-situ.

Environmental pollution, causes, effects and control measures of air pollution, water pollution, soil pollution , marine pollution, noise pollution, thermal pollution, nuclear hazards, solid waste management, role of individuals in pollution prevention, pollution case studies, disaster management

Social issues and the environment, sustainable development, Case studies, wasteland reclamation, environment protection act, air (prevention and control of pollution) act, water (prevention and control of pollution) act, wildlife protection act, forest conservation act, issues involved in enforcement of environmental legislation.

Human population and the environment.

Recommended Books

1. Principles of Environmental Science, Jan J. Boersema, Lucas Reijnders, Springer
2. A Text Book in Environmental Science, V. Subramanian, Alpha Science
3. Environmental Science, Daniel Chiras, Jones & Bartlett Learning

4. Environmental Science, Michael L. McKinney, Robert M. Schoch Jones & Bartlett Learning
5. Environmental science: Earth as a living planet Daniel B. Botkin, Edward A. Keller, Wiley

PHYSICS I

Credit-04

MATHEMATICS- I

Credit-04

PRINCIPLES OF CHEMISTRY

Credit-04

COMMUNICATION ENGLISH

Credits-03

Unit 01: Parts of speech; Articles; Auxiliary Verbs; Prepositions

Unit 02: Phrases; Clauses; Sentences; Tense; Voice; Narration; Functional Elements in Sentences

Unit 03: Paragraph writing; Summary writing; Paraphrasing; Précis writing; Letter writing; Resume; C.V.; Job Applications; Report writing; Note taking; Dictation

Unit 04: Reading Comprehension (from the subject area)

Unit 05: Functional use of language; Situational use of language; Academic use of language

Unit 06: Listening and Speaking; Conversation; Language Lab.

Recommended Books

1. Language in Use (Upper intermediate LeveAl,drian Doff Christopher Jones, Cambridge University Press

2. Common Errors in English, Abul Hashem, Ramesh Publishing House, New Delhi.
3. Objective English, Tata Mc. Graw Hill Publishing Company Ltd., New Delhi.
4. Spoken English for India, R.K. Bansal & J.B. Harrison, Orient Longman, Delhi.
5. The sounds of English, Veena Kumar, Makaav Educational Software, New Delhi.
6. English Phonetics & Phonology, P. Roach, Cambridge University Press, London.

PHYSICS- I

LABORATORY

Credit-02

1. Measurement of Length and Error analysis (Screw Gauge and Slide caliper)
2. Radius of Curvature of Spherometer
3. Determination of 'g' by bar pendulum
4. Determination of 'g' by free fall
5. Moment of Inertia of irregular body
6. Moment of Inertial (Fly wheel)
7. Viscosity of liquid (Stoke's law)
8. Spring constant (Static method)
9. Spring constant (Dynamic method)

CHEMISTRY LABORATORY

Credit-02

Qualitative inorganic analysis of mixtures containing not more than 4 radicals from the following:
Basic radicals: Na^+, K^+, Ca^{2+}, Sr^{2+} Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Fe^{3+}, Co^{3+}, Ni^{3+}, Cu^{2+}, Zn^{2+}
Acid radicals: F^-, Cl^-, Br^-, I^-, S^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, NO_3^-, NO_2^-
Interfering radicals: PO_4^{3-}, AsO_4^{3-}, BO_3^{3-}

Determination of strength of acid and base by neutralization reaction (double titration involving strong acid-weak base, etc).

Recommended books:

1. G. Svehla: Vogel's text book of Qualitative Inorganic Analysis (revised), Longman, Pearson Education.
2. A.K. Nad, B. Mahapatra and A. Ghoshal: An Advanced Course in Practical Chemistry

BASIC ELECTRICALS ENGINEERING LABORATORY

Credit-02

1. To show the variation of resistance of a Lamp with temperature by plotting a V-I curve for 60W and 100W filament lamps.
2. Verification of Kirchhoff's Law.
3. To find the relationship between voltage & current for R-L series circuit for variable resistance & inductance.
4. Verification of Laws of capacitors in Series & parallel.
5. Verification of Superposition theorem.
6. Verification of thevenin's & norton's theorem.
7. To charged & discharged a capacitor and to show the graph on CRO.
8. Frequency response of series & parallel RLC circuit.
9. Verification of maximum power transfer theorem.
10. Measurement of Power & Power factor of single phase at varying load.
11. Verification of voltage & current relation in star & delta connected system.
12. To determine the variations in the values of inductance of a coil for different position of the movable iron core.

INTEGRATED M.TECH

SEMESTER – II

BIOLOGY

Credit-03

Small and large scale molecules in biology: water, acid, bases, buffers, functional groups, macromolecules and origin of life, Introduction to Biological Polymers (primary, secondary, tertiary and quaternary structure of proteins, carbohydrates, lipids, nucleic acids.

Cell-The basic unit of life: Prokaryotik cell, Eukaryotic cell, cellular Organelles, Endomembrane system, cytoskeleton, extracellular structures

Energy, enzymes and metabolism: Energy and energy conservation, ATP: Introduction to enzyme structure and function, metabolism and basic principles of functioning of metabolic pathways

Photosynthesis and cellular respiration: Place of photosynthesis, light and dark reaction, glycolysis, TCA cycle, electron transport chain

Introduction to Mendelian Genetics: Mendel's experiment and laws of inheritance, Dominant and recessive alleles- and their interaction, Gene interaction (codominance, Epistasis, hypostasis etc) Genes and chromosomes, non-nuclear inheritance, introduction to sex determination and sex linked inheritance.

Recommended Books

1. The Science of Biology, 7th edition, Purves, Sadava, Orians and Hellar
2. Lehninger Principles of Biochemistry: Fourth edition,
3. David L.Nelson and Michael M. Cox An introduction to genetic analysis: Eight edition A. J. F. Griffiths, S.R.Wessler, R.C.Lewontin, William M. Gelbert, D.T.Suzuki and J.H.Miller

FUNDAMENTALS OF COMPUTER & C PROGRAMMING

Credit-04

UNIT-I: Introduction to computers, generations of computer, processors, memory hierarchy and I/O devices, System and application software, generation of languages, compiler, interpreter, assembler, Number systems, computer arithmetic.

UNIT-II: Flow Charting, Sequential, Branching & Iterative. Introduction to 'C' as Programming Language An overview of a 'C' programme, 'C' character set, 'C' tokens 'C' keywords, Data Types (Primary, derived & user defined), Storage classes, symbolic constants, operators (Arithmetic, logical & Relational) Flow of control (If- else, switch-case; while, do-while & for-loops).

UNIT-III: Functions (UDF, String Functions, Mathematical function). Recursion, pointers, array (2-D & 3-D), Strings, pre-processor directives, structures, linked list file handling.

UNIT-IV: C-lab. Execution of a simple programme, Conditional & Un-conditional Branching, Loops, Functions (Interative & Recursive), Arrays (2-D & 3-D), Structures, Linked Lists, File I/O.

Recommended books

1. B.W. Kernighan, D.M. Ritchie: The C Programming Language, Prentice Hall India, 1990.
2. Yashwant Kanetkar, "Let us C", BPB Publications, 2nd Edition, 2001.
3. E. Balagurusamy: Programming in ANSI C, 4th edition, Tata McGraw Hill.

PHYSICS-II

Credit-04

Vector calculus: Cylindrical and Spherical coordinate systems: Line, surface and volume elements, Gradient, Divergence and curl of Fields, Divergence theorem, Stokes Theorem.

Electrostatics: Coulomb's Law, Gauss's law (integral and differential form) and its applications, Energy of a charge distribution, Laplace's and Poisson's equations, Conductors, Method of images, Field and Potential due to dipole. Polarization in a dielectric, vectors **D**, **P** and **E**, linear dielectrics, force on dielectrics.

Electric currents: Line, surface and volume currents and current densities, electrical conductivity and Ohm's law, equation of continuity, energy dissipation, Motion of charged particles in electric and magnetic fields

Magnetostatics: Magnetic flux, Biot-Savart and Ampere's law, divergence and curl of **B** and the differential form of Ampere's law, Vector potential.

Electrodynamics: Electromagnetic induction, motional emf and Faraday's law, inductance and energy in magnetic field, the displacement current, Maxwell's equations.

Electromagnetic Wave: EM wave in vacuum, dielectrics and conductors, Poynting's theorem, Fresnel's equation. .

Recommended books

1. D.J. Griffiths, *Introduction to electrodynamics 3rd Ed.*
2. E.M. Purcell, *Electricity and Magnetism (Berkeley Physics course) 2nd Ed.*
3. R.P. Feynman, R. B. Leighton and M. Sands, *The Feynman Lecture of Physics Vol. 2.*
4. E. Hecht, *Optics, 4th Ed.*
5. F.A. Jenkins and H.E. White, Fundamentals of Optics.
6. A.K. Ghatak, *Optics.*
7. K.K. Sharma, *Optics: Principles and applications.*
8. G.R. Fowles, *Introducton to Modern Optics.*

MATHEMATICS-II

Credit-04

Linear Algebra: Vectors in $\mathbb{R}^n$ and $\mathbb{C}^n$, notions of linear dependence and independence, linear span of a set of vectors, vector subspaces of $\mathbb{R}^n$ and $\mathbb{C}^n$, the basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product space, the Gram-Schmidt process, orthonormal bases, projections, and the least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, the eigenvalue of special matrices (orthogonal, unitary, symmetric, Hermitian, skew-symmetric, normal). Algebraic and geometric multiplicities, diagonalisation by similarity transformations, Spectral theorem for real symmetric matrices and applications to quadratic forms.

Differential Equations – I: Basic concepts, Geometric meaning, Direction fields. 1st order linear equations, homogeneous and non- homogeneous, Solution Method for Nonlinear equations, Separation of variables, Exact Differential equations, integrating factors Bernoulli Equation, Orthogonal trajectories, Existence Uniqueness: Picards iteration, 2nd order Linear Differential equations: homogeneous equation with constant coefficients, Mass spring system, Existence Uniqueness, Wronskian, non-homogeneous equation, Method of undetermined coefficients, variation of parameters method, Higher Order equations: Wronskian Existence of solution: Solution Methods for constant coefficients, Laplace transform generalities, Shifting theorems, Convolution theorem.

Recommended books

1. E. Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley, 2005.
2. G. Strang, Linear Algebra and its applications, 4th edition, Thomson, 2006.
3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equation, 8th edition, Wiley, 2005.
4. H. Anton, C. Rorres, Elementary linear algebra with applications, 9th edition, Wiley, 2005.
5. T.M Apostol, Calculus, Volume II, 2nd edition, Wiley, 1980.

CHEMISTRY -II

Credit-04

Unit-I: Surface Chemistry - Adsorption-types-adsorption of gases on solids-adsorption isotherms – Langmuir, Freundlich adsorption isotherms-adsorption of solutes from solution–role of adsorbents in catalysis, ion-exchange adsorption and pollution abatement.

Instrumental Methods of analysis - Introduction; Principles of spectroscopy; Laws of absorbance. IR: Principle, Instrumentation, Application. UV: Principle, Instrumentation, Application

Unit-II: Radioactivity and Nuclear chemistry - Origin of radioactivity, decay law, half-life, liquid drop model, and shell model, uses of radioactivity such as radiocarbon dating, radiotracers, agricultural and medicinal uses including imaging. Nuclear reactions, fission, fusion, spallation; reactions involving α, β, γ rays; neutron diffraction. Counting techniques, Geiger-Muller counter, Scintillation counter, nuclear reactors, nuclear reactions as alternative source of energy, nuclear reactors, variable energy cyclotron.

IUPAC Nomenclature of Organic compounds: Alkane, alkene, alkyne, alcohol, thiol, ether, aldehyde, ketone, acid, acid derivatives, amines, nitriles, cyclic compounds and common names of few aromatic compounds.

Optical isomerism in compounds containing one and two asymmetric centres, designation of absolute configuration, Aromaticity and Huckel's rule, Establishment of structure of benzene (heat of hydrogenation, calculation of resonance energy).

Unit-III: Water Technology - Introduction and specifications of water Hardness and its determination, Alkalinity, Boiler feed water, boiler problems – scale, sludge, priming & foaming: causes & prevention, Boiler problems – caustic embrittlement & corrosion : causes & prevention, Carbonate & phosphate conditioning, colloidal conditioning & calgon treatment, Water softening processes : Lime – soda process, Ion exchange method, Reverse osmosis, Water for domestic use.

Recommended Books:

1. G. Svehla: Vogel's Qualitative Inorganic Analysis
2. A.K. Nad, B. Mahapatra and A. Ghoshal: An Advanced Course in Practical Chemistry
3. T. M. Penning: Chemical Carcinogenesis
4. Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, John Wiley, 8th Edn., 2007
5. Organic Chemistry, Stanley H Pine 5th Edn., 2007.
6. Engineering Chemistry- Sunita Rattan
7. Engineering Chemistry-Shashi Chawla
8. Physical Chemistry of surfaces A. W. Adamson and A.P. Gast
9. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill, 1995.
10. Modern Spectroscopy, J.M. Hollas, John Wiley, 4th Edn., 2004.

BASIC OF ELECTRONIC ENGINEERING

C

redit-03 UNIT –I

SMICONDUCTOR, DIODE AND ITS APPLICATION: Insulators, semiconductors and metals, Mobility and conductivity, Intrinsic and extrinsic semiconductors and charge densities in semiconductors, Energy Band, Fermi level, current components in semiconductors. Properties of P-N Junction, Current component of PN Diode, V-I Characteristics, Diode resistance, Diode as a rectifier-Half wave & Full wave rectifier, Clipper, Clamper, Types of diodes – Zener diodes, Photodiodes, Light emitting diodes (LED's).

UNIT –II

BIPOLAR JUNCTION TRANSISTOR AND FET: Introduction to Bipolar Junction Transistor, Transistor current components. Construction and Characteristics of Transistor, Transistor Circuit Configuration (Common Base , Common Emitter, Common Collector). Transistor Load Line, Transistor Biasing- Base Bias, Voltage Divider Bias, Emitter Bias.

Single-Stage & Multistage Transistor Amplifiers- Class A, AB, B, C- Amplifier; Class B Push-Pull Amplifier, Complementary Symmetry Push-Pull Class- B Amplifier, RC-Coupled Amplifier. Introduction to JFET, MOSFET, V-I and Transfer characteristics of JFET and MOFET

UNIT – III

FEEDBACK AMPLIFIER: Classification of feedback amplifier, Feedback concept, Properties of Feedback Amplifier, Effect of Feedback on Gain and Impedance. **SCILLATOR:** Barkhausen Criteria, Wien Bridge, Tuned, Hartley, Colpitt and RC Phase shift oscillators.

UNIT-IV

OPERATIONAL AMPLIFIERS: Basic of Op-Amp, Op-Amp Symbol and terminal characteristics, Block Schematic of OPAMP, Ideal OPAMP Characteristics, Practical OPAMP Characteristics, Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower, Adder, Substractor, Comparator, Integrator, Differentiator, Instrumentation Amplifier.

UNIT –V

DIGITAL ELECTRONICS: Introduction, Decimal and Binary Number System, Binary Arithmetic, Hexadecimal, Octal, Conversion. Binary Code: Gray Code, Excess-3 Code, BCD Code, ASCII Code. Boolean Algebra and Logic Gates: Introduction to basic logic operation, Theorems of Boolean Algebra, Logic circuit implementation of Boolean expressions, Minimization Technique: K-Map. Combinational Circuit: Adder, Subtractor, Comparator, Decoder, Mux-Demux, Encoder; Flipflops: Basic introduction of FF, SR-FF, JK-FF, D-FF, T-FF.

BOOKS & REFERENCE:-

1. Integrated Electronics: Analog & Digital Circuit Systems – Jacob Millman & Halkias, TMH.
2. Electronic Devices and Circuit Theory – Boylestad & Nashelsky, 8th Ed. PHI.
3. Electronic Devices & Circuits – Allen Mottershead, PHI
4. A Text Book of Electrical Technology, Volume-IV (Electronic Devices & Circuits), B. L. Thareja, S. Chand & Co.

BASIC ELECTRONIC ENGINEERING LABORATORY

Credit-02

1. Measurement of the following using Cathode Ray Oscilloscope (CRO):
    a. DC Voltage
    b. Peak & RMS Value of AC Voltage
    c. Time Period and Frequency of Periodic Signals

    (Sine wave, Square wave, Triangular wave).
2. Verification of Forward and Reverse bias characteristics of a PN junction diode.

3. Design of an RC Low Pass filter & RC High Pass Filter circuit & observing its response to sinusoidal and square wave inputs.
4. Verification of Zener diode characteristics and calculation of its dynamic resistance.
5. Measurement of ripple factor with and without filter for Half wave and Full wave rectifier circuits.
6. Observation of output waveforms of Diode Clipper and Clamper Circuits.
7. Obtaining the frequency response of CE transistor amplifier and measurement of its bandwidth (Using IC 741).
8. Obtaining the frequency response and measurement of Bandwidth of an inverting OPAMP. (Using IC 741).
9. Obtaining the frequency response and measurement of Bandwidth of a non- inverting
10. OP-AMP. (Using IC 741).
11. Design of a Wein Bridge Oscillator (Using IC 741 OP AMP) and calculation of its frequency of oscillation.
12. Implementation of different gates using universal gate (NAND gates).
13. Design of an Integrator circuit (using IC 741 OP-AMP) and observation of its output waveform

PHYSICS II LABORATORY

Credit-02

CHEMISTRY II LABORATORY

Credit-02

WORKSHOP PRACTICE

Credit- 02

Introduction to various shops

1. Carpentry: Timber kind, Seasoning, Defects, Tools, Joints, Preservation
2. Fitting: Tools and equipments and their uses
3. Welding allied process: Types of welding, Flame cutting, Brazing and soldering

4. Smithy and Forging: Tools and equipments, Furnaces used, Forging operations, Sheet metal working
5. Foundry: Pattern making, Tools and Equipment used in Foundry, Molding sands and types of molds
6. Machine Tools: Construction and operation of Centre lath, Shaper, Planner, Milling Machine, Drilling Machine

INTEGRATED

M.TECH

SEMESTER – III

ENGINEERING MECHANICS

Credit-04

UNIT-I

Introduction: Idealization of mechanics, Concept of rigid body, External forces (Body and surface forces), laws of mechanics, Equality and Equivalence of vectors, Free and bound vectors, Principal of transmissibility of forces, Moment of a force about a point and about a line, Couple and moment of couple, Couple moment as a free vector, Addition and Subtraction of couples, Statically equivalent force system, Simplest equivalent of a system of forces, Force analysis, Free body diagram, Equations of equilibrium and their application to various system of forces, Plane trusses.

UNIT-II

Friction: Friction on Dry surfaces, Static and kinematics friction, Application to inclined planes and wedges.

UNIT-III

Center of Gravity and Moment of Inertia: First and second moment of area and mass, radius of gyration, parallel axis theorem, product of inertia, rotation of axes and principal moment of Inertia, moment of Inertia for rectangle section prism, sphere etc from first principle.

UNIT-IV

Work, Energy and Power: Work done by forces and couples, Potential, elastic and kinetic energy, Work

energy analysis, Conservation of energy, Concepts of power and efficiency **UNIT-V**

Kinematics and Kinetics of a Particle: Rectilinear and curvilinear translations, Normal and tangential components of acceleration, Radial and transverse components of acceleration

UNIT-V

Kinematics and kinetics of Rigid Bodies: Angular velocity and angular acceleration, Effective force on a rigid body, D' Alembert's principle, Instantaneous zero velocity, Rotation of rigid bodies, Rolling motion and plane motion of rigid bodies

Text /References Books:

1. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002.
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 3rd Ed, Tata McGraw Hill, 2000.
3. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 5th Ed, John Wiley, 2002.
4. R. C. Hibbler, Engineering Mechanics, Vol I and II, Pearson Press, 2002

MATHEMATICS-II

Credit-04

Tensor Analysis:

Unit-1

Physical laws, Spaces for N dimensions, Coordinate transformations, summation convention, Contravariant and covariant vectors and mixed tensors. Kronecker delta, Tensor of rank greater than two, Scalar or invariants, Tensor fields, symmetric and skew symmetric tensors,

Unit-2

Fundamental operations with Tensors, metric tensor, conjugate or reciprocal tensors, Associated tensors, Christoffel's symbols, Geodesics, covariant derivatives, permutation symbols and tensors, Tensor form of gradient, divergence and curl, intrinsic or absolute derivative, relative and absolute tensors.

Differential Equations:

Unit-3

Legendre polynomials and Bessel's functions of the first kind and their properties, Laguerre polynomials, Hermite Polynomials

Unit-4

Partial Differential Equations: Separation of variables method, Laplace equation, elimination of constants and variables, solutions of one dimensional heat and wave equations.

Recommended Books

1. Mathematical Methods for Physicists- G. Arfken, Academic Press.
2. Engineering Mathematics- Kreyszig
3. Engineering Mathematics- B. S. Grewal
4. Special Functions of Mathematical Physics and Chemistry- I.N. Sneddon, Longman.
5. Applied Mathematics for Physicists and Engineers- L.A. Pipes and L.R. Harwill, McGraw-Hill.

INTRODUCTION TO MATERIAL SCIENCE

Credit-04

Unit-I

Introduction: Materials Science & Engineering, Classification of Engineering Materials and their selections, Crystalline and Non-Crystalline solids, Bonds in Solids **Unit-II**

Crystal structure: Classification of crystals: Unit cell, Bravais lattices, Symmetry in crystals; Crystal directions and planes; Reciprocal lattice; Crystal Imperfections: Point, line and planar defects; Dislocation Energy; Burger vector.

Unit-III Diffusion in Solids: Introduction, Types and Mechanism of Diffusion, law of diffusion (Fick's laws); factors-affecting diffusion, Determination of diffusion constant, The Kirkedal effect, Homogeneous and heterogeneous nucleation kinetics; growth and overall transformation kinetics; Kinetics of polymerization.

Unit-IV Phase Diagrams: Phase stability; Phase rule; Single & Binary phase diagrams (Pb-Sr, AlSi, Ge-Si, Au-Ag etc), microstructure and its effect on properties; Fe-C phase transformations in

ferrous alloys.

Unit-V Deformation Mechanism and Mechanical Properties of Materials: Elastic and Plastic deformation; strengthening mechanisms; Mechanical properties: tensile, impact, fatigue and creep; factors affecting the mechanical properties: temperature and grain size; deformation behavior of ceramics and polymers.

Recommended Books:

1. Elements of Materials Science and Engineering, Lawrence H. Van Vlack, Pearson Education (6^{th}Edition).
2. Materials Science and Engineering: an introduction, William D. Callister, John Wiley and Sons, Inc.
3. The Science and Engineering of Materials, Donald R Askeland, Pradeep P Phule,Thomson Learning
4. Materials Science and Engineering : A first Course, V.Raghavan, Prentice Hall of India
5. Introduction to Physical Metallurgy, Avner, Tata McGraw Hill. 6. Introduction to Solid State Physics, Charles Kittel, Wiley

MATERIAL THERMODYNAMICS

C

redit-04 Unit-I

Basic thermal Properties: Basic concept of Kinetic theory of gases, Real gases, Van der Waals' equation,

Unit-II

Transport Phenomena, Brownian motion, heat capacity and specific heat, thermal expansion, thermal conductivity, thermal stress, Radiation: Emission and Absorption, Black body radiation, Wien's displacement law, Planck's radiation formula

Unit-III

Elements of thermodynamics: Concept of Heat and Work as a path function, Zeroth Law of Thermodynamics, First Law of Thermodynamics, Isothermal Process, Adiabatic Process, Isobaric process, Isochoric Process, First law applied to flow process.

Unit-IV

Second Law of Thermodynamics, Heat engines and Refrigerators Entropy, Thermodynamic relations, Free energies, Phase and equilibria, Properties of pure substance: p-v, T-s, h-s and p-T diagram for pure substance, Entropy equation for flow process, Third law of thermodynamics **Unit-IV**

Small system thermodynamics, Nonextensivity and nonintensivity, nanothermodynamics of a single molecule

Text/Reference Book

1. *Heat and Thermodynamics*-M.W.Zemansky, McGraw Hill .
2. *Thermodynamics*-Enrico Fermi, Dover Publication, New York

3. *Elements of statistical thermodynamics* - L. K. Nash, Addison Wesley

4. *Introduction to Engineering Thermodynamics*-R. E.Sonntag and C. Borgnakke, Wiley

5. *Statistical thermodynamics*- B. J. McCell and, Chapman and Hall.

6. *Fundamentals of Statistical and Thermal Physics*- F. Reif, McGraw-Hill

7. *Thermodynamics, Kinetic Theory of Gases, and Statistical Mechanics*- F.W. Sears and G.L. Salinger, Addison-Wesley.

MATERIALS CHARACTERIZATION LABORATORY

Credit-02

1. Determination of tensile strength, yield strength, percentage of elongation, and percentage of area reduction of steel
2. Impact test of notch bar specimen
3. Find the hardness of the given materials with the help of Brinell hardness testing machine
4. Find the hardness of the given materials with the help of Rockwell hardness testing machine
5. Find the modulus of rigidity of mild steel and Aluminum specimen using torsion test
6. Determination of fatigue strength of the given specimen
7. Find modulus of rigidity of a closed coil helical compression spring and to determine its proof load
8. To determine Young's Modulus of elasticity of the materials of a cantilever beam 9. Compression test of a timber specimen using UTM

ENGINEERING DRAWING

Credit- 02

Unit-1

Introduction: Drawing board, T – square, drawing instrument box, scales, sheet layout, type of machine drawings, free – hand sketching, lines – types of lines, lettering, dimensioning – dimensioning terms and notations, scaleson drawing, types of scales

Unit-2

Geometrical construction: Bisecting a line, to draw perpendicular and parallel, to divide a line and circle, to bisect an angle and trisect an angle, to find the centre of an arc, to construct square, regular polygons, regular polygons inscribed in circles, curves used in engineering practice, conic section, ellipse, parabola, hyperbola, tangent and normal, cycloidal curves, helix, a method of drawing a helical curve

Unit-3

Orthographic Projection: Principle of projection, method of projection, orthographic projection, plane of projection, four quadrants, first and third angle projection, projection of points and lines, a point is situated in the first, second, third and fourth quadrant, line parallel to one or both the plane, line contained by one or both the planes, line inclined to both the planes

Recommended Books:

1. *Engineering drawing*- N. D. Bhatt, Charotar Publishing House
2. *Manual of Engineering Drawing*- Colin. H. Simmons and Dennis. E. Maguire, Elsevier
3. *Engineering Drawing and Graphics Technology Problems Book III* - Hugh. F. Rogers, Elsevier

INTEGRATED M.TECH

SEMESTER – IV

MATHEMATICS-IV

C

redit-04

Unit-1

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, Bayes Theorem, random variables, discrete and continuous distributions, Binomial, Poisson, and normal distributions, correlation and linear regression.

Unit-2

Beta and gamma functions, Error function, Fourier

Transformations, Laplace Transformation **Unit-3**

Complex variables: Analytic functions, Cauchy-Riemann equations, Application in solving potential problems, Line integral, Cauchy's integral theorem and integral formula (without proof), Taylor's and Laurent' series, Residue theorem (without proof) and its applications. **Unit-4**

Numerical Methods: Solution of a system of linear equations by L-U decomposition, GaussJordan and Gauss-Seidel Methods, Newton's interpolation formulae, Solution of a polynomial and a transcendental equation by Newton-Raphson method, numerical integration by trapezoidal rule, Simpson's rule and Gaussian quadrature, numerical solutions of first order differential equation by Euler's method and 4^{th} order Runge-Kutta method.

Recommended Books

1. *Mathematical Methods for Physicists*- G. Arfken, Academic Press.
2. *Advance Engineering Mathematics*- E. Kreyszig
3. *Higher Engineering Mathematics*- B. S. Grewal

4. *Special Functions of Mathematical Physics and Chemistry*- I.N. Sneddon, Longman.
5. *Applied Mathematics for Physicists and Engineers*- L.A. Pipes and L.R. Harwill, McGraw-Hill.
6. *Advanced Engineering Mathematics*- C.R. Wylie and L.C. Barrett, McGraw-Hill.
7. *M.R. Spiegel in Schaum's outline series, (i) Complex Variables (ii) Laplace Transforms (iii) Differential Equations* McGraw-Hill

SYNTHESIS AND PROPERTIES OF NANOMATERIALS

Credit-04

Unit 1: Introduction: Synthesis and processing, synthesis approach-Top down and bottomup, preparation of materials using Solid state route, physical chemistry of Solid surfaces: surface Energy, Chemical potential as function of surface curvature, electrostatic stabilization, DLVO theory, steric stabilization, Oswald Ripening and sintering, nucleation and growth phenomenon: Homogenous and heterogenous nucleation, growth of nuclei.

Unit 2: Bulk Synthesis: Synthesis of bulk nanostructured materials, Sol gel processing, Mechanical alloying and mechanical milling, Inert gas condensation technique.

Unit-3Fabrication of Nano film structures: Fundamentals of film growth, physical vapour deposition (PVD), Chemical Vapour Deposition (CVD), Atomic Layer deposition (ALD), selfassembly, Langmuir Blodgett (LB) technique.

Unit 4 Lithography: photolithogragphy, Nanomanipulation and Nanolithography, soft lithography- Assembly of Nanoparticles and Nanowires, sol gel lithography

Unit 5 Vapour (or Solution) liquid solid: Fundamental aspects of VLS and SLS growth- VLS growth of Nanowires, control of the size of the

nanowires precursors and catalysts, SLS growth, stress induced recrystallization.

Unit 6 Temperature Based synthesis: Electrochemical deposition, electrophoretic deposition- Template filling Electrospinning , micro emulsion, riverse micelles method

Recommended Books

1. Nanostructures and Nanomaterials: Synthesis, properties and Application – G.Cao, Imperial College press, 2004.
2. Introduction to Nanotechnology – Charles P. Poole Jr., John Willey and sons, 2003
3. Nano the essential , Understanding Nanoscience and Nanotechnology- T. Pradeep, Tata Mc Graw Hill Publishig Co. Ltd , 2007
4. Chemistry of Nanomaterials: Synthesis, Properties and Applications- C.N.R.Rao, A.Muller. A.K.Cheetam, Willey-VCH Verlag, Germany , 2005
5. Nano chemistry: A chemical approach to nanomaterials- G.A.Ozin, A.C.Arsenault, Cambridge, UK.

CRYSTALLOGRAPHY AND CRYSTAL STRUCTURES

C

redit-04

Unit-1

Crystalline and non-crystalline solids, Geometry of crystals, Choice of unit cell, Crystallographic directions and planes, Miller indices, Miller-Bravais indices, Interplaner spacing, Crystal system, Atomic radius, Co-ordination number, Anisotropy, Isomorphism, Transformation in crystals: Allotrophic-polymorphic transformation, Martensitic transformation, Quasicrystals, Liquid

crystals, Intermetallic compound, Defects in crystals.

Unit-2

Symmetry elements, Point group and physical properties: Dielectric properties, Refractive index, Space group. Experiment and theory of crystal growth: Formation of crystal, crystal growth, Twinning, Atomic packing, closed packed structures, axial ratio and lattice constant, Voids in closest packing, Classification of voids,.

Unit-3

Structure of metals, Ionic Compound Structure: Rock salt structure, CsCl structure, Rutile structure, Flourite structure, structure of urea, Covalent Structure: Diamond structure, Graphite structure, carbon nanotube, Other hexagonal ring structures, Zinc Blende structure, Wurtzite, Fullerenes, Fullerites and Fullerides, Quartz, Other silicate structures, Zeolites, Structure of polymers. Composite crystal structure: Perovskite structure, Spinel structure, Surface to volume ratio: ideal model nanostructures geometries.

Unit-4

Types of Bonding, Mechanism of bond formation, Cohesive energy of ionic crystal, Evaluation of Madelung constant for NaCl structure,

Variation in bonding character and

properties. **Unit-5**

Categories of physical technique to characterize solids, Properties of X-rays-continous spectrum, X-rays and their interaction with matter: Scattering, Absorption, Refraction, Reflection, Coherence, Sources of X-rays: Synchrotron radiation, Diffraction Geometrical representation of Bragg's diffraction condition, Diffraction Techniques to determine crystal Structure

Recommended Books

1. Crystallography Applied to Solid State Physics- Verma and Srivastava, New Age Int
2. Introduction to Solids- L. V. Azaroff, Tata McGraw Hill.
3. Introduction to Crystal and Crystal structure- R. Tulley, Wiley Interscience
4. Introduction to Crystal Structure- M. A. Wahab

MECHANICAL PROPERTIES OF MATERIALS

C

redit-04

Unit 1:

Concept of stress/strain: Types of stress/strain, Elastic behaviour of Materials: Atomic basis, Anelasticity, Thermoelastic effect, Damping capacity, Viscoelasticity, state of stress in two & three dimensions, stress tensor, Hydrostatic & deviator components of stress, Elastic stress- strain relations, strain energy.

Unit 2:

Theory of plasticity: Flow curve, True stress & true strain, Yielding criteria, Yield locus, Octahedral shear stress & shear strain, Invariants of stress & strain, plastic stress – strain relations, Two dimensional plastic flow, Slip line, field theory.

Unit 3:

Structural Imperfections: Theoritical yield strength, Dislocations & their types, Energy of dislocations, Dislocation interactions & movement in crystals, Dislocation multiplication, Dislocation in crystals, Partial dislocations & stacking faults, Role of Dislocations in plastic deformations.

Unit 4:

Plastic deformation of materials: slip & twinning, Concepts of critical resolved shear stress,

Deformations bands & kinks, strain hardening of single & polycrystals,

Unit 5:

Mechanical Testing: Mechanism of Creep, fatigue & fracture, Superplasticity, Mechanical properties of Nanomaterials: Hall-Petch & inverse Hall-Petch effect, Deformation mechanism in nanostructured materials, Creep & fatigue in nanostructured materials.

Recommended Books:

1. Mechanical Metallurgy: George E.Dieter, McGraw Hill
2. Materials Science & Engineering: William D.Callister, Wiley.
3. Plastic Deformation of Metalas ; Honeycombe
4. Physical Metallurgy and Advanced Materials, R.E.Smallman, A.H.W. Ngan

DISASTER MANAGEMENT

Credit- 4

NANOMATERIAL SYNTHESIS LABORATORY

Credit-02

1. Synthesis of metal nanoparticles
2. Synthesis of oxide nanoparticles
3. Synthesis of composite nanoparticles
4. Synthesis of spherical nanoparticles
5. Synthesis of nanowires
6. Synthesis of platelet nanoparticles

Synthesis will be done by using different solid states and chemical routes

INTEGRATED M.TECH

SEMESTER – V

ELECTIVE I- ADVANCED FUNCTIONAL MATERIALS AND DEVICES

Credit-04

Dielectrics, ferroelectrics, pyroelectrics, piezoelectrics, electrooptics, magnetoelectric, thermoelectric, semiconducting materials, defect chemistry, Brouwer diagrams, Ellingham diagrams, Heckman diagrams will be introduced. Important technological applications including varistors, sensors, MEMs, capacitors, memories, transistors, night vision systems, positive temperature coefficient resistors, electro-optic devices

Reference books

1. Ferroelectric Devices, Kenji Uchino, , Publisher: CRC, 2nd edition
2. Electro-ceramics, Materials Properties, Applications, J. Moulson and J. M. Herbert, Publisher: Wiley, Edition: 2nd edition

ELECTIVE II SELF-ASSEMBLY AND MOLECULAR ENGINEERING

Credits-04

Unit-I: Unified approach for self-assembly

General Scheme for the formation and process of Self-Assembly, Self-Assembly through Force

Balance, Van der Waals Force, Electrostatic Force: Electric Double-Layer, Steric and Depletion

Forces, Solvation and Hydration Forces, Solvation Force, Hydration Force, Hydrophobic Effect, Hydrogen Bond.

Unit - II: Molecular self-assembly in solution

Surfactants and Micelles, Physical Properties of Micelles, Thermodynamics of Micellization:

Mass-Action Model, Pseudo-phase Separation Model, Hydrophobic Effect and Enthalpy– Entropy Compensation, Micellization versus General Scheme of Self-Assembly: Change of Micelle Structures, Concept of Force Balance and Surfactant Packing Parameter, Applications of Surfactants and Micelles, Micellar Catalysis, Bilayers: Bilayer-Forming Surfactants,

Bilayerization, Physical Properties of Bilayers.

Unit- III: Colloidal self-assembly

Forces Induced by Colloidal Phenomena: Surface Tension and Capillarity, Contact Angle and Wetting, Adhesion, Gravity and Diffusion, Pressures by Osmotic and Donnan Effects, Electrokinetic Force, Magnetophoretic Force, Force by Flow; Force Balance for Colloidal Self-

Assembly, General Scheme for Colloidal Self-Assembly,

Unit- IV: Self-assembly at interfaces

General Scheme for Interfacial Self-Assembly: Surfaces and Interfaces, Force Balance with Interfaces; Control of Intermolecular Forces at Interfaces: Packing Geometry: Balance with Attractive and Repulsive Forces, Packing with Functional Groups: Balance with Directional Force, Assembly at the Gas–Liquid Interface: Langmuir Monolayer, Surface Micelles; SelfAssembly at the Liquid–Solid Interface, Self-Assembly at the Liquid–Liquid Interface, Self-

Assembly at the Gas–Solid Interface, Interface-Induced Chiral Self-Assembly

Unit-V: Self-assembled nanostructured thin film

General Scheme for Nanostructured Films, Preparation and Structural Control of selfassembled Nanostructured Films: Self-Assembled Monolayer (SAM), Layer-by-Layer Assembly, Vapor-Deposited Films, Sol–Gel Processed Films, Langmuir-Blodgett (LB) Films,

Unit-VI: Self-Assembly and Nanofabrication

Self-Assembly and Nanofabrication, Unit Fabrications: Jointing, Crossing and Curving, Alignment and Stacking, Reconstruction, Deposition, and Coating, Symmetry Breaking, Templating and Masking, Hybridization; Nanointegrated Systems

Text/References Books:

1. Self-assembly and Nanotechnology, Yoon S. Lee, John Wiley & Sons
2. Alexandridis , P. , Lindman , B. , eds. *Amphiphilic Block Copolymers: Self - assembly and Applications* (Elsevier : 2000).
3. Nagarajan, R., Ruckenstein, E. "Self-Assembled Systems,"*Experimental Thermodynamics*, Vol. 5, Issue Pt. 2, pp. 589 – 749 (Elsevier : 2000).

ELECTIVE III- NANOROBOTICS

Credit-04

Construction and manipulation of robots at nanoscale, rapid prototyping, Nanoassembly by Sintering, Drift Compensation in AFMs, Active Self-Assembly, Bio nanorobotics, Nanomechatronics, Robotic Arms and End-Effectors , Quick-Motion Robots Locomotion Control

Physical System Modelling, Rail bound Mechatronic Systems An Evidence Accrual Data Fusion Technique for Situational Assessment

Intelligent Mechatronic System for Automatically Evaluating the Training of the Laparoscopic Surgery

Reference Books

1. Hewit, J.R., "Mechatronics: An Introduction," (Source unknown)
2. Kyura, N., and Oho, H., 1996, "Mechatronics—An industrial perspective," IEEE/ASME Transactions on Mechatronics, Vol. 1, No. 1, Mar., pp. 10-15.
3. Brochure, 2004, Mechatronics Lab. Brochure, Dept. of Mech. Eng., IIT Dlehi.

ELECTIVE IV- NANOTECHNOLOGY FOR ENERGY SYSTEM

Credits-04

Unit 1

Energy conversion process, indirect and direct energy conversion, Introduction to physics of semiconductor devices and basis of solar cells, Material aspect of solar cells, High efficiency solar cells, Shockley-Queisser equation, Photovoltaic conversion: Optical effects of p-n junction, design and analysis of PV cells, PV cell fabrication, system design,

Unit 2

Compound Semiconductor PV cell- III-IV and II-VI: Tandem / multi junction and stacked solar cells, thin film cells, Solar PV concentrator cells and systems, Advanced solar cell concepts, Solar cell characteristics and characterization, Applications of nano semiconductors for PV devices.Conjugated polymers, organic/plastic/flexible solar cells, Polymer composites for solar cells, Dye sensitized solar cells, device fabrication and characterization, future of PV cell. **Unit 3**

Basic Principles of Photo-catalytic Hydrogen Generation: Fundamental Mechanism of Photocatalytic Hydrogen Generation, Main Processes of Photo-catalytic Hydrogen Generation;
Evaluation of Photo-catalytic Water Splitting: Photo-catalytic Activity, Phot-ocatalytic Stability ; Theoretical Efficiencies for Water Splitting Cells, Calculation of Solar-to-Chemical Conversion Efficiencies, Photo-electrolysis Cell Configurations, Micro- and Nanostructural Effects on the Efficiency of Photo-electrodes

Unit 4:

Fuel Cells, Polymer membranes for fuel cells, PEM fuel cell. Acid/ alkaline fuel cells, design of fuel cells, Carbon Nanotubes for energy storage, Hydrogen Storage in Carbon Nanotubes, Use of nanoscale catalysts to save energy and increase the productivity in industry, Rechargeable batteries based on nanomaterials, Nanocomposites for electrodes and electrolyte applications.

Text/Reference

1. Solar cells: Operating principles, technology and system applications by Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Semiconductor for solar cells, H J Moller, Artech House Inc, MA, USA, 1993.
3. Solids state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.

4. Direct energy conversion, M.A. Kettani, Addision Wesley Reading, 1970.
5. Thin film Solar Cell Fabrication, characterization & Application, Jef Poortmans, Wiley Publication , 2006.
6. Hand Book of Batteries & fuel cells, Linden, Mc Graw Hill, 1984.

ELECTIVE V- FIBER AND INTEGRATED OPTICS

Credit-04

INTEGRATED M.TECH

SEMESTER – VI

SPECTROSCOPIC TECHNIQUES

Credit-04

Unit I

Atomic, molecular and nuclear structure: Vector atom model, angular momenta and magnetic moments, quantum numbers, spin orbit coupling, Zeeman effect, stark effect, Stern- Gerlach experiment, Spontaneous and stimulated emission, Einstein's' theory types and applications of laser, molecular spectra, vibrational and rotational spectra, rotation-vibration-electronic spectra,Raman effect,Compton effect, X-rays: production, properties and applications, characteristic and continuous X-rays, fine structures, Moseley's work, absorption and scattering of X-rays,Nuclear structure, nuclear magnetic moment, nuclear magnetic resonance, quadrupole moment, nuclear energy levels, nuclear spin, parity, radioactivity, EM wave and its interaction with mater,

Unit-II

Spectroscopic techniques: Rotational spectra, Microwave spectroscopy, vibrational-rotational spectra, IR spectroscopy**,** Polarization of light, Raman

spectroscopy,angular momentum of electrons, photoelectron spectroscopy, Auger electron spectroscopy, nuclear magnetic resonance spectroscopy, electron spin resonance spectroscopy, Solidstate and surface spectroscopy: vibrational and electronic studies of surfaces, nuclear magnetic resonance, Mossbauer spectroscopy , Atomic absorption spectroscopy, Mass spectrometry.State of the art recent advancement in spectroscopy and their application in the field of nanotechnology

Recommended books

1. Fundamentals of Molecular Spectroscopy, Colin N. Banwell, Elaine M. McCash, Tata McGraw-Hill
2. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan; Brooks Cole
3. Modern Spectroscopy, J. Michael Hollas, Wiley
4. Bransden, B. H. & Jaochain, C. J., Physics of Atoms & Molecules, Addison-Wesley, 1983
5. Pauling, L. and Wilson, E.B.: Introduction to Quantum Mechanics, McGraw-Hill, 1935.
6. Pauling, L., Nature of the Chemical Bond, Cornell University Press, 1960.
7. Rybicki & Lightman, Radiative Processess in Astrophysics, John Wiley, 1985
8. Tennyson, J., Astronomical Spectroscopy, Imperial College Press, 2005.

COMPUTATIONAL NANOSCIENCE

Credit-04

MODERN MICROSCOPIC TECHNIQUE

Credit-04

DIFFRACTION TECHNIQUES

Credit-04

Unit-1

Categories of physical technique to characterize solids, Properties of X-rays-continous spectrum, characteristic spectrum, X-rays and their interaction with matter: Scattering, Absorption, Refraction, Reflection, Coherence. Magnetic interactions, Sources of X-rays: Synchrotron radiation, Diffraction: an optical grating and the diffraction of light, Ewald construction, Geometrical representation of Bragg's diffraction condition.

Unit-2

Refraction and reflection from interfaces, Scattering from an electron, atom, unit cell, molecule, liquids, glasses, crystal, Geometrical structure factor, Factors affecting diffracted beam intensities. Application of kinematical diffraction

Unit-3

Diffraction by perfect crystals, photoelectric absorption: X-ray absorption by an isolated atom, EXAFS and near-edge structure, X-ray dichroism, Resonant scattering, Imaging: Absorption contrast imaging, phase contrast imaging, coherent diffraction imaging,

Unit-4

Overview of X-ray diffractometer, Diffractometer geometry, Bragg-Brentano geometry for powder diffractometer, Thin film structure analysis, Grazing incidence X-ray diffraction, Parallel geometry for thin film diffraction, SAXS (small angle X-ray scattering), Reflectivity, High temperature X-ray powder diffraction, Indexing of powder diffraction pattern, Application of

Xray powder diffraction, Sources of background radiation-fluorescence.

Unit-5

Introduction to Rietveld refinement technique for structural analysis, Electron diffraction, Neutron diffraction.

Recommended Books

1. *Elements of Modern X-ray physics*- J. A. Nielsen, D. McMorrow, Wiley
2. *Elements of X-ray diffraction*- B. D. Culity, S. R. Stock, Prentice Hall
3. *The Rietveld Method*- Young, Oxford press
4. *X-ray Diffraction Crystallography*- Y. Wasea, E. Matsubara, K. Shinoda, Springer

STRUCTURAL CHARACTERIZATION LABORATORY

Credit-02

1. To study the surface topology and determination of size of particles using AFM
2. Determination of thickness of thin films using elipsometry Preparation of metallographic sample
3. Measurement of grain size of ferrous materials
4. Measurement of grain size of Non-ferrous materials
5. Indexing of XRD pattern of given materials
6. Determination of strain and crystallite size using XRD
7. Indexing of selected area electron diffraction pattern of the given material 8. Fractography study of given sample using SEM

COMPUTATIONAL NANOSCIENCE LABORATORY

Credit-02

1. MATLAB program to plot the first four Eigen functions of a one - dimensional rectangular potential well with infinite potential barrier.
2. Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using MATLAB program.
3. Understanding the IE3D and HFSS Simulation Tools.
4. RF MEMS Switch using IE3D.
5. Rat-race using IE3D.
6. CPW using IE3D.
7. Bend CPW using IE3D.
8. Design of Antenna using HFSS.

REQUIREMENTS OF SIMULATION SOFTWARES:
MatLab, HFSS, IE3D

INTEGRATED M.TECH

SEMESTER – VII

Credit-04

NANOMAGNETISM

Unit-1

Atomic origin of magnetism, Magnetic moments of electron and atom, Precession, Bohr magneton, Experimental evidence of spin, Stern Gerlach experiment, Pauli spin matrices, Magnetic field production.

Unit-2

Kinds of Magnetism, Diamagnetism, Magnetism in super conductors, Paramagnetism, Adaiabatic demagnetization, Magnetic Dipolar interaction, Exchange interaction- origin of exchange interaction, Direct exchange interaction, Indirect exchange: double exchange, Superexchange and RKKY interactions, Crystal fields, Jahn-Teller effect, Orbital quenching **Unit-3**

Order and magnetic structures: Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Helical order, Spin glasses, Magnetic domains and magnetization process,

Domian wall observation, Elements of micromagnetism-equation of motion, Magnetostatic energy, Magnetic anisotropy, Law of approach to saturation, Magnetostriction, Magnetoresistance- Giant magnetoresistance and Colossal magnetoresistance

Unit-4

Origin of nanomagnetic behavior, Broken translation symmetry, Single domain and multi domain behavior, coercivity of fine particle, Magnetization reversal by spin rotation-fanning and curling, Superparamagnetism-Langevin function, one -dimensional magnets, Surface Effects, Stoner-Wohlfarth model, Magnetism of thin film and multilayers-Exchange bias, Magneto transport, Magnetism of nanodisks, nanorings, nanowires,

Unit-5

Application of magnetic nanomaterials, Soft and hard magnetic materials, Instrument for measuring magnetization-VSM, SQUID, AC susceptibility, Magnetic resonance technique- Mossbauer spectroscopy

Recommended Books:

1. *Principles of Nanomagnetism*- Guimaraes, Albert P., Springer, 2009.
2. *Introduction to Magnetic Materials*- Culity & Graham, IEEE Press, Willey.
3. *Introduction to Magnetism and Magnetic Materials*- D. Jiles, Chapman and Hall
4. *Modern Magnetic Materials*- R. C. Handley, John Wiley & Sons
5. *Magnetism in Condensed Matter*- S. Blundell, Oxford Master Series

NANOELECTRONICS

Credit-04

UNIT-1: Introduction of Nanoelectronics:
Evolution of Electronic Computing, Introduction of VLSI-micro to nano, Moore's Law, Semiconductor Technology road map;

Physics of MOSFET: Basic MOS structure, Energy Band diagram of MOS structure, MOS system under external bias, Basic operation of MOS Transistor, MOS Threshold voltage, I-V Characteristics of MOSFET, Body bias, channel length modulation, MOSFET Capacitances,

Geometric scaling theory: Full-voltage scaling, constant-voltage scaling; Small device effects:

Threshold voltage modifications, short channel effect, narrow width effect, Mobility variations, Hot electrons; Small device model. **UNIT-2: Fabrication Process:**

Crystal growth and purification, Epitaxy, Oxidation, Lithography, Etching, Doping and Ion implantation, Diffusion, Deposition, Device Isolation, Metallization, surface micromachining of silicon, wafer bonding, LIGA process, evaporation, sputtering, e-beam lithography, focused ion beam application, self-organized structures, laser nanopaterning, nano-imprint, electrochemical synthesis.

UNIT-3: Funtamentals of Nanoelectronic and Nanodevice :

Device scaling, Quantum dot devices, Quantum wire devices, Quantum of Conductance, Landauer theory, Ballistic transport model, Quantum wire FETs, Quantum Hall effect,

Introduction to single electron transistors (SETs): quantum dots, single electron effects, Coulomb blockade, kronig-Penney Model of band structure, tunnelling device and its application, carbon nanotube transistor(FETs & SETs), spintronics

REFERENCE:

1. Fundamental of Nanoelectronics, George W. Hanson.
2. Physics of Semiconductor Devices, S M Sze, Wiley.
3. Introduction to Nanoelectronics, Vladimir V. Mitin Viatcheslav A. Kochelap Michael A. Stroscio
4. Solid State Electronic Devices, B G Streetman, Prentice Hall.
5. CMOS Logic Circuit Design, John P Uyemura, Kluwer Academic Publishers.
6. CMOS Digiral Integrated Circuits, Kang and Leblebici, Tata McGraw-Hill.
7. The Science and Engineering of Microelectronics Fabrication, S A Campbell, Oxford Unversity Press.
8. Fundamental of semiconductor Fabrication, S M Sze, Willey Sons.
9. VLSI Fabrication Principles, S K Gandhi, Willey Sons.
10. Nanotechnology & Nanoelectronics – material, devices, measurement techniques – Springer –by Dr. W. R. Fahrner.

11. Nanotechnology - A Gentle Introduction to the Next Big Idea, Ratner and Ratner, Prentice Hall PTR,1st edition (2002).

SURFACE AND THIN FILMS

Credit-04

Unit-1

Surface Phenomena: Relaxation and reconstruction at the surface, surface structure and crystallography, surface lattice dynamics, surface diffusion, surface melting, contact potentials, work functions, ion surface interactions, surface segregation, plasmons, surface optics, surface chemistry

Unit-2

Deposition Techniques: Evaporation, RF-DC Sputtering, magnetron sputtering, ion beam assisted depositions, Molecular Beam epitaxy, Atomic Layer deposition, pulsed laser depositions, physical and chemical vapour depositions, plasma enhanced depositions, deposition from aqueous solutions, sol gel.

Unit-3

Thin film properties: Epitaxial growth modes, lattice misfit and imperfections, interdiffusion and reactions, adsorption process, microstructures, Mechanical properties of thin film, stress in thin films, optical properties, superconductor films, tribology of films and coatings, organic polymer coatings, microelectronic applications.

Unit-4

Surface Engineering: sand blasting, grit blasting, Heat treatment: Carburizing, Nitriding, Boriding, Aluminzing, Diffusion coating, welding, Thermal spray, cold spray, thermal barrier coatings, lase surface modifications, metallurgical hard protective coatings

Unit-5

Surface characterizations: thickness measurements, surface profilometry Grazing incidence , X-ray diffraction, X-ray reflectivity and standing waves, , Scanning Auger microscopy, Transmission Electron microscopy, Scanning Electron Microscopy, Scanning

Tunneling microscopy, Field ion microscopy, assessment of hardness, adhesion and tribological properties of films

Recommended Books

1. Modern Techniques of Surface Science-D.P.Woodruff , T.A.Delchar, Camb Univ. Press
2. Deposition Technologies for Films and coatings-R.F.Bunshah, Noyes Publications
3. Introduction to Surface Physics-M.Prutton, Clarendon Press, Oxford
4. Advanced Surface Coatings: a Handbook of Surface Engineering,-R. S. Rickerby, A. Mathews, Chapman and Hall
5. The Materials Science of Thin Films-M.Ohring, Academic Press incorporation 6. Thin Film Phenomenon-K.L.Chopra, MacGraw-Hill

POLYMER ENGINEERING

Credit-04

Unit-I: Introduction to polymer

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

Unit-II: Polymer Structure and Property Relationship

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Unit-III: Polymerization techniques and characterization

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific

polymerizations, Catalysts-their utility in polymer manufacture, Zieglar-Natta, Metallocene and others. Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of

FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

Unit-IV: Polymer science and technology:

Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers. Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, poly(vinyl alcohol), polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells. Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

References Books

1. D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer , 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970)
5. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).

INDUSTRIAL PROJECT/INTERNSHIP

Credit-04

INTEGRATED M.TECH

SEMESTER – VIII

NANOPHOTONICS

Unit 1

Introduction to nanophotonics, trend and scope of nanophotonics, overview of optical properties of materials, Photons and Electrons: Similarities and Differences- free-space propagation, confinement of photons and electrons, propagation through classically forbidden zone: tunneling, localization under a periodic potential: bandgap, cooperative effects for photons and electrons, Nanoscale optical interactions: axial and lateral nanoscopic localization, Nanoscale confinement of electronic interactions-quantum confinement effects, nanoscopic interaction dynamics, new cooperative transitions, nanoscale electronic energy transfer, cooperative emission.

Unit-2

Near field interaction and microscopy: near field optics, near field microscopy, example of near field studies-study of quantum dots, nanoscale enhancement of optical interaction, Quantum confined materials: Inorganic semiconductors-quantum wells, quantum wires, quantum dots, quantum rings, manifestations of quantum confinement-nonlinear optical properties, dielectric confinement effect, superlattices, quantum confined structure as lasing media

Unit-3

Photonic crystals: Basic concepts, TE/TM modes, dispersion relation, features of photonic crystals, wave propagation, method of fabrication, photonic crystal optical circuitry, nonlinear photonic crystals, photonic crystal fibers (PCF), photonic crystals and optical communications, photonic crystal sensors, physical origin of photonic band gaps, evanescent modes in photonic band gaps.

Unit-4

Nanocomposites as photonic media, nanocomposite waveguides, Introduction to plasmonics, metallic nanoparticles, nanorods and nanoshells, local field enhancement, plasmonic wave guides, coupling between localized plasmons, surface plasmons, surface plasmon polaritons at metal-insulator interface, surface plasmon polaritons at single interface, localized surface plasmons

References:

1. Principles of Nanophotonics- M.Ohtsu, K. Kobayashi, T. Kawaze, T. Yatsui, M. Naruse, CRC Press, Taylor and Francis
2. Nanophotonics- Paras N Prasad, John Wiley & Sons (2004)
3. Introduction to Nanophotonics- S. V. Gaponenko, Cambridge University Press
4. Surface Plasmon Nanophotonics- M. L. Brongersma, P.G. Kik, Springer, 2007.
5. Photonic Crystals-John D Joannopoulos,Princeton University Press

NANOTRIBOLOGY AND NANOMECHANICS

Credit-04

Unit – 1. *Introduction of Nanotechnology: -*

Introduction of Nanotribology, significance and need of nanotribology, Nanomechanics.

Unit – 2. *Physical Principles of Micro- and Nanotribology: –*

Mechanical Properties, Adhesion, Lubrication, Friction, Wear, Surface force apparatus, Actuators, Cantilevers, MEMs Inductor and capacitors magnetic storages devices, Micro and Nano electro mechanical systems, Fabrication process MEMS/NEMS based Sensors and devices, micropumps and microfluidics, RF/Microwave MEMS phase shifter, RFMEMS Switches, microarrays, magnetic-MEMs.

Unit – 3. *Test equipment: -*

Microscale Test Equipment - Micro tribometer, Mechanical Microanalysis, Accompanying Surface Science Techniques, *Micro/Nanotribology Test Equipment:* - Scanning Tunnelling Microscope, AFM, Nanoindentation (Nanoindentation: Continuous Stiffness measurement method and Oliver and Pharr model, nano-scratch), Microscopy Techniques.

Unit – 4. *Biomimetic: -*

Multifunctional Plant Surfaces and Smart Materials, Lotus Effect: Surfaces with Roughness-Induced Super hydrophobicity, Self-Cleaning, and Low Adhesion, Biological and Biologically Inspired Attachment Systems, Gecko Feet: Natural Hairy Attachment Systems for Smart Adhesion.

Referred Books: -

1. Nanotribology and Nanomechanics: Measurement Techniques and Nanomechanics, Bharat Bhushan, Springer
2. Nanoindentation, Fischer Cripps, Springer
3. Handbook of Micro/Nanotribology, Bharat Bhushan, CRC, Boca Rotan

NANOCOMPOSITES

Credit-04

Introduction to Composites and nanocomposites: Introduction, functional nanostructures by quantum confinement and size control, nanofibre composites, nanostructure architecture, synthesis of composites and nanocomposites nanocomposite thin films and coatings, Types of Composites and nanocomposites**:** Particle reinforced composites: Large particle composites, dispersion strengthened composites: Fiber reinforced composites: Fibre and matrix phase; influence of fibre length, orientation and concentration, Polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon-carbon composites, Structural Composites: Laminar composites, sandwich panels Properties of Composites and nanocomposites**:** Structural evaluation of composites, Physical and mechanical behavior of composites; macro and micromechanics

of nanocomposites; degradation of composites due to various environmental conditions and corrosion resistance of Composites Applications of Composites and nanocomposites**:** Nanocomposites for food packaging applications, Polymer nanocomposites for biomedical and aerospace applications. Important industrial applications. Carbon Nanomaterials: Structure and Properties of Graphene, Carbon nano tubes (single wall & multi wall) Diamond-like Carbon films

References:

1. Composite Materials: Science & Engineering- K.K.Chawla, 2nd edition, Springer International Edition, 2006.
2. Properties and Processing of Nanocomposites- S.G.Advani, World Scientific Publishing Co. Singapore.
3. Polymer-Clay Nanocomposites-T.J. Pinnavaia and G.W.Beall (eds.) John Wiley and Sons, 2000
4. Advances in Nanocomposites-Synthesis, Characterization and industrial Applications Boreddy Reddy, In Tech Publications
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
6. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing

ENGINEERING ECONOMICS AND IPR

Credit-04

Objective: The objective of this course is to impart the knowledge of economic tools and techniques essential for the appraisal of engineering alternatives with respect to their cost performances and profitability.

Module-1

The basic economic problems, Engineering and Economics, Meaning, Nature and Scope of Engineering Economics, engineering economic methodology and applications; Steps in Engineering Economic Analyses; Time value of money, concept of interest and calculations, nominal and effective rate of interest, derivation of interest factors – single payment, equal payment, linear and geometric gradient series; concept of inflation and its importance in engineering decision making.

Module-2

Principle of economic equivalence, evaluation of engineering alternatives – present worth, future worth, annual worth, internal rate of return, benefit-cost ratio, payback period methods; comparison of equal, unequal and infinite live engineering alternatives; Evaluation of engineering alternatives under risk and uncertainty.

Module-3

Depreciation analysis-meaning, causes, and need for depreciation calculations, methods of deprecation calculations–straight line method, written down value method, sum-of-year's-digits method; Replacement analysis–meaning, causes, concepts of defenders and challengers, determination of economic life of an asset.

Module-4

IPR significance and international conventions/treatie:
Impact of international conventions on

IPR, Role of world Intellectual property Organisation (WIPO) GATT, WTO, TRIPs

IPR Tool Kit: Copyright, trademark, integrated circuits, Patents

IPR Commercialization: IP contracts, IP licensing, Confidentiality agreements, Anti-competitive practices in contractual licenses, IPR as a strategic

Suggested Readings

1) John A. White, David B. Pratt and Kenneth E. Case, "*Principles of Engineering Economic Analysis*", 5th Edition, 2011, John Wiley & Sons

2) Joseph C. Hartman, "*Engineering Economy and the Decision Making Process*", Prentice Hall India, 2010.

3) Donald Newnan, Ted Eschenbach and Jerome Lavelle, "*Engineering Economic Analysis*", 11th Edition, 2011, Oxford University Press.

4) Mishra, P. K. and S. K. Mishra, *Engineering Economics and Costing*, 4th edition, 2012, Mok Publications, Odisha, India

5) William G. Sullivan, E.M. Wicks, Luxhoj J.T., "*Engineering Economics*", Prentice Hall India, 2011.

6) J. L. Riggs, D. D. Bedworth, and S. U. Randhawa, "*Engineering Economics*", TMH India, 2020

PROJECT AND SEMINAR

INTEGRATED M.TECH

SEMESTER – IX

PROJECT **Credit-15**

DISSERTATION-INTERIM
EVALUATION **Credit-05**

INTEGRATED M.TECH

SEMESTER – X

PROJECT **Credit-15**

DISSERTATION-INTERIM
EVALUATION **Credit-10**