ROE030/ROE040: MANUFACTURING PROCESS

UNIT I

Basic Metal and Alloys: Properties and Application

Properties of material: Strength, elasticity, stiffness, malleability, ductility, brittleness and hardness. Elementary ideas of fracture, fatigue, and creep. Testing of materials, destructive and nondestructive testing.

Ferrous materials: Carbon steels, its classification based on % carbon as low mild, medium and high carbon steel, its properties and applications. Wrought iron, Cast iron, Alloy steels: stainless steel, tools steel.

Heat Treatment of Materials: Elementary introduction to Heat-treatment of carbon steels: annealing, normalizing, quenching and tempering and casehardening.

Non-Ferrous metal and alloys: Common uses of various non-ferrous metals and alloys and its composition such as Cu-alloys: Al-alloys such as Duralumin.

UNIT II

Metal forming: Introduction, Cold working and hot working, basic metal forming operations and use of such as: Forging, Rolling, Wire & Tube drawing and Extrusion, product and applications. Press-work, die and punch assembly, cutting and forming, applications.

Casting: Introduction, Casting process, Pattern and allowances, Moulding sands and its desirable properties, Mould making techniques, Gating system, Casting defects and remedies, Cupola Furnace, Die-casting and its uses.

UNIT III

Machining: Introduction, Classification of machining processes, Lathe-machine: working principle, parts and operations. Shaper and planer machines: principles, parts and operations. Drilling machine: principle, parts and operations. Milling: Principle, parts and operations. Grinding: principle, parts and operations.

Welding: Introduction, classifications, basic principles of welding processes, Arc welding: principle, equipment and operations. Gas welding: working principle, types of flames, Soldering and brazing and its uses, heat affected zone in welds and weld defects.

UNIT IV

Manufacturing: Importance of Materials and Manufacturing towards Technological and Socioeconomic developments, Plant location, plant Layout- its types. Types of Production systems, Production versus Productivity.

Product quality: Introduction, definition of quality, improvement of product quality, basic quality tools, flow charts, check sheets, histogram, cause and effect diagram, pareto diagram, control charts, their applications and importance, consequences of bad quality.

UNIT V

Non-Metallic Materials: Common types and uses of Wood, characteristics of wood, applications, Cement, types, composition, Concrete, properties and applications, Ceramics, classifications and applications, Rubber, Plastics and Composite-materials, classifications and applications.

Miscellaneous Process: Powder-metallurgy process, working principle and applications, plastic-part manufacturing, processes and applications, Galvanizing and Electroplating, principles, processes and applications.

Text/Reference Books:

1. Kalpakjian and Schmid, Manufacturing Engineering and Technology, 6 ed., Pearson.
2. Lindberg, Processes & Materials of Manufacture, Prentice Hall India.
3. Kumar & Gupta, Manufacturing Processes, Prentice Hall India.
4. Jain, Production Technology, Khanna Publications.
5. Rao, Manufacturing Processes, McGraw Hill Education.
6. James G Brala. Handbook of Manufacturing Processes, How Products, Components and Materials are Made. Industrial Press, New York, 2006.
7. Bruce J Black. Workshop Processes, Practices and Materials, 4 ed., Elsevier, 2010.

ROE031/ROE041: INTRODUCTION TO SOFT COMPUTING

UNIT I

Neural Networks-1(Introduction & Architecture): Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

UNIT II

Neural Networks-II (Back Propogation networks): Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; Back Propagation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting Back Propagation training, applications.

UNIT III

Fuzzy Logic-I (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

UNIT IV

Fuzzy Logic –II (Fuzzy Membership, Rules): Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

UNIT V

Genetic Algorithm (GA): Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.

References:

1. S. Rajsekaran & GA Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall of India.
2. NP Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.
3. Siman Haykin, “Neural Netowrks”, Prentice Hall of India
4. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India.
5. Kumar Satish, “Neural Networks”, Tata Mc Graw Hill
6. Fakhreddin O. Karray, Clarence W. De Silva, “Soft Computing and Intelligent System Design: Theory Tools and applications”, Pearson
7. Tripathy, Anuradha, “SoftComputing: Advances And Applications”, Cengage

ROE032/ROE042: NANO SCIENCE

UNIT I

Introduction: Definition of Nano-Science and Nano Technology, Applications of Nano-Technology.

Quantum Theory for Nano Science: Particle in a box, Potential step: Reflection and tunneling (Quantum leak). Penetration of Barrier, Potential box (Traped particle in 3D: Nanodot).

Physics of Solid State Structures: Size dependence of properties, crystal structures, face centered cubic nanoparticles; Tetrehedrally bounded semiconductor structures; lattice vibrations.

Energy Bands: Insulators, semiconductor and conductors; Reciprocal space; Energy bands and gaps of semiconductors; effective masses; Fermi Surfaces.

Localized Particles: Acceptors and deep taps; mobility; Excitons.

UNIT II

Quantum Nanostructure: Preparation of quantum wells, Wires and Dots, Size and Dimensionality effect, Fermi gas; Potential wells; Partial confinement; Single electron Tunneling, Infrared detectors; Quantum dot laser superconductivity.

Properties of Individual Nano Particles: Metal nano clusters; Magic numbers; Theoretical modeling of nanoparticles; geometric structure; electronic structure; Reactivity, Fluctuations, Magnetic clusters; Bulk to nanostructure, semiconducting nanoparticles, Optical Properties, Photofragmentation, Coulombic Explosion. Rare Gas & Molecular clusters; Inert gas clusters; Superfluid clusters; Molecular clusters.

UNIT III

Growth Techniques of Nanomaterials: Litho and Nonlithograpahic techniques, RF Plasma, Chemical methods, Thermolysis, Pulsed laser method, Self-assembly, E-beam evaporation, Chemical Vapour Deposition, Pulsed Laser Deposition.

UNIT IV

Methods of Measuring Properties: Structure: X-ray Diffraction Technique, Particle size determination, surface structure. Microscopy: Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy(TEM). Spectroscopy: Infra red and Raman Spectroscopy, X-ray Spectroscopy, Magnetic resonance, Optical and Vibrational Spectroscopy, Luminescence.

UNIT V

Carbon Nano Materials: Bucky Ball and Carbon Nano- Tubes: Nano structures of carbon (fullerene), Fabrication, Structure. Electrical, Mechanical and Vibrational properties and applications. Nano Diamond, Boron Nitride Nano-tubes, Single Electron Transistors, Molecular Machine, Nano-Biometrics, Nano Robots.

Text/Reference Books:

1. CP Poole Jr, FJ Owens, “Introduction to Nanotechnology”.
2. C Kittel, “Introduction to S.S. Physics”-(7^{th} Edn.) Wiley 1996.
3. HS Nalwa, “Handbook of Nanostructured Materials & Nanotechnology” vol. 5. Academic Press 2000.

ROE033/ROE043: LASER SYSTEMS AND APPLICATIONS

UNIT I

Basic Principle of Modern Physics: Black body radiation, Atomic structure, Spectral series of hydrogen atom, Polarization, Absorption and florescence of X-ray, Energy distribution in electrons, Probability of distribution of free electrons, Free electron in metals, Energy level in free electrons, Application of Schrodinger equation in potential well, potential step, tunneling effect.

UNIT II

Elements and Techniques of Laser: Concept of coherence, Temporal and Spatial coherence, Coherence length and time, Brightness and Intensity, Directionality and Monochromacity. Absorption, Spontaneous and Stimulated Emission process and Einstein's coefficients. Population inversion, Pumping and pumping schemes, laser gain, Optical cavities and its types.

UNIT III

Principle of Laser & General Lasers: Main components of Laser, Principle of Laser action, Introduction to general lasers and their types. Three & four level Lasers, Continuous Wave Lasers, Pulsed Lasers, Q-switch lasers.

UNIT IV

Types of Laser Systems:

Solid state Lasers: Neodymium laser, Nd-Yag laser, Nd-Glass laser and Alexandrite laser.

Liquid Lasers: Dye laser, Tuning in Dye laser, Model-Locked Ring Dye laser.

Gas Laser: Ionic lasers, Argon ion laser, Krypton ion laser, He-Cadmium laser, Copper vapour laser, Carbon dioxide laser and Excimers laser.

Semiconductor Laser: Characteristics of semiconductor lasers, Semiconductor diode lasers, Hetrojunction lasers, Homojunction lasers, Quantum well lasers.

UNIT V

Laser Applications:

Material Processing: Material processing with lasers, Interaction mechanism, Material processing mechanism, Drilling, Cutting and Welding process with laser. Laser hardening.

Medical Science: Medical lasers, Laser diagnostic, Laser in ophthalmology, laser in glaucoma, Laser for general surgery, Laser in dermatology, laser in dentistry, Laser in medicine.

Optical Communication: Optical source for fiber optical communication, powering and coupling, Transmission, Hologram their characteristics. LIDAR.

Reference Books:

1. KR Nambiar, "Laser Principles, Types and Application" New Age International.
2. SA Ahmad, "Laser concepts and Applications" New Age International.
3. AK Katiyar, CK Pandey and Manisha Bajpai, Fundamentals of Laser Systems and Applications.

ROE034/ROE044: SPACE SCIENCE

UNIT I

Introduction: Important Individual Contributions [Pre Telescopic: Ptolemy, Copernicus, Brahe and Keplar. Post Telescopic Era: Galileo, Newton, Hubble, Gauss, Riemann, Einstein and Hawkins]. Various International Organizations involved in the development of space Science (NASA, ESA, ISRO)

UNIT II

Space Observations: Problems related to Eye and Atmosphere and their Remedies, Distance in Space and Magnitude, Measurement Techniques, Non-Optical Telescopic Techniques used in space observation (Covering entire Electromagnetic Region).

UNIT III

Solar System: Nebular theory of formation of our Solar System. Sun-its origin and fate, Source of Energy and Solar wind. Brief description of Planets about shape, size, period of rotation about axis and period of revolution, distance of planets from sun. Bode's law, Keplar's Laws of planetary motion, Newton's deductions from Kepler's Laws, Newton's Law of gravitation, correction of Kepler's third law. Determination of mass of Earth, Determination of mass of planets with respect to earth. Brief description of Asteroids, Satellites and Comets.

UNIT IV

Stars and Galaxy: Stellar Evaluation and Stellar Remnants, Nucleo-Synthesis and Formation of Elements. Classification of Stars: Harvard classification system, Hertzsprung-Russel Diagram, Luminosity of star, variable stars; composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars); Chandrasekhar limit. Galaxies: Galaxies and their evolution and origin, active galaxies and quasars.

UNIT V

Cosmology: Hubble Law, Redshift and Expansion of the Universe, Cosmic Microwave, Background Radiations, Matter density in Universe, Cosmological principle, Important Models of Universe (Steady State and Big Bang), Dark Matter and Dark Energy.

Text Books / Reference Books:

1. Baidyanath Basu, T. Chattopadhyay, SN Biswas, "An Introduction to Astrophysics" PHI 2nd Edition.
2. KS Krishnaswami, "Astrophysics: A modern Perspective" New Age International.

ROE035/ROE045: POLYMER SCIENCE AND TECHNOLOGY

UNIT I

Basic Concepts of Polymers: A brief history. what are polymers? how are polymers made? Classification of polymers.

UNIT II

Chemistry of Polymerization: Introduction, Chain polymerization, step growth polymerization, Miscellaneous polymerization reactions. Polymerization Techniques.

UNIT III

Molecular weight and Size: Average molecular weight, Number average and weight average molecular weight. Sedimentation and viscosity-average molecular weight. Molecular weight and degree of polymerization. Polydispersity and molecular weight distribution in polymers. Practical significance of polymer molecular weight. Size of polymer molecules.

UNIT IV

Polymer Degradation: What is polymer degradation? Types or degradation, thermal and mechanical degradation, degradation by ultrasonic waves. photo degradation, degradation by high energy radiation, oxidative degradation, hydrolytic degradation.

UNIT V

Preparations and Applications: Preparation, properties and technical applications of thermoplastics, thermosetting, elastomer and synthetic fibres. Silicones. Applications of polymers in aerospace, ocean, electronics, medical, agriculture, automobile, sports and building constructions.

ROE036/ROE046: NUCLEAR SCIENCE

UNIT I

Nucleus and Its Basic Features: Nuclear structure, Nuclear forces and their properties, Nuclear binding energy, Nuclear stability, Nuclear radius and its measurement, Nuclear spin, Nuclear magnetic and Electrical moments.

UNIT II

Nuclear Models: Single particle model, Liquid drop model and Semi-Emperical mass formula, Nuclear potential and Shell model, Collective model.

UNIT III

Nuclear Reaction: Nuclear reaction and Laws of conservation, Types of nuclear reaction, Mechanism of nuclear reaction-Q value, Nuclear fission and their explanation by liquid drop model, Nuclear fusion and its applications.

UNIT IV

Radioactivity: Radioactive disintegration, Decay constant, Half life period and Mean life, Alpha decay, Beta decay, Gamma decay, Interaction of nuclear radiation with matter.

UNIT V

Accelerators: Mass spectrograph: General principle, Aston's Mass Spectrograph Van de Graph Generator, Cyclotron, Synchrotron.

Detectors: G M Counter, Scintillation counter, cloud chamber, Bubble Chamber, production and detection of neutrons and Gamma-photon.

Application of Nuclear Techniques: Nuclear magnetic resonance, positron emission topography, radiotracer techniques and applications in material science and agriculture.

Reference Books:

1. Tayal, "Nuclear Physics" Himalaya Publishing House.
2. SN Ghosal, "Nuclear Physics" S. Chand & Co.
3. SB Patel, "Nuclear Physics: An Introduction New Age International.
4. HB Lal, "Introductory Nuclear Physics" United Book Depot.
5. Wang, "Introductory Nuclear Physics", PHI Learning
6. Roy & Nigam, "Nuclear Physics" John Wiley & sons.

ROE037/ROE047: MATERIAL SCIENCE

UNIT I

Introduction: Historical perspective, importance of materials, Brief review of modern & atomic concepts in Physics and Chemistry. Atomic models, Periodic table, Chemical bonding.

Crystallography and imperfections: Concept of unit cell, space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. X-ray crystallography techniques, imperfections, Defects &Dislocations in solids.

UNIT II

Mechanical Properties and Testing: Stress strain diagram, Ductile and brittle materials, stress Vs strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength testing, Hardness testing, Impact testing, Fatigue testing Creep testing, Non-destructive testing (NDT)

Micro Structural Exam: Microscope principle and methods, Preparation of samples and micro structure exam and grain size determination, comparative study of microstructure of various metals and alloys, such as Mild steel, CI, Brass.

Phase Diagram and Equilibrium Diagram: Unitary and Binary diagrams, Phase rules, Types of equilibrium diagrams: solid solution type, eutectic type and combination type, Iron-carbon equilibrium diagram.

UNIT III

Ferrous materials: Iron and steel manufacture, furnaces, various types of carbon steels, alloy steels and cast irons, its properties and uses.

Heat Treatment: various types of heat treatment, such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams.

Non-Ferrous metals and alloys: Non-ferrous metals, such as Cu, Al, Zn, Cr, Ni etc. and its applications. Various types of Brass, Bronze bearing materials their properties and uses. Aluminum alloys, such as Duralumin, Other advanced materials/alloys.

UNIT IV

Magnetic properties: Concept of magnetism-Dia, para, ferro magnetic materials, Hysteresis, Soft and hard magnetic materials, Magnetic Storages.

Electric Properties: Energy band, concept of conductor, insulator and semi conductor. Intrinsic and extrinsic semi-conductors, P-n junction and transistors, Basic devices and their applications. diffusion of Solid. Super conductivity and its applications, Messier effect. Type I & II superconductors. High Temp. superconductors.

UNIT V

Ceramics: Structure, types, properties and applications of ceramics. Mechanical/Electrical behavior and processing of ceramics.

Plastics: Various types of polymers/plastics and their applications. Mechanical behavior and processing of plastics, Future of plastics.

Other Materials: Brief description of other materials, such as optical and thermal materials, concrete, composite materials and their uses.

Performance of materials in service: Brief theoretical consideration of fracture, fatigue, and corrosion and its control.

Text/ Reference Books:

1. WD Callisster Jr. “Material Science & Engineering Addition”, Wesly Publishing Co.
2. Van Vlash, “Elements of Material Science & Engineering”, John Wiley & Sons.
3. V. Raghvan, “Material Science”, Prentice Hall of India.
4. Narula, “Material Science”, Tata Mc Graw Hill.
5. Srivastava, Srinivasan, “Science of Materials Engineering”, New Age International.

ROE038/ROE048: DISCRETE MATHEMATICS

UNIT I

Relation: Definition, types of relation, composition of relations, pictorial representation of relation, properties of relation, partial order relation.

Function: Definition and types of functions, composition of functions, recursively defined functions.

Group: Monoid, Semi-group, Abelian Group, Properties of groups, Cyclic Group, Permutation groups, Caley's Theorem, Rings and Fields (definition, examples and standard results).

UNIT II

Propositional logic: Introduction to logic, logical connectives, truth tables, Tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification.

Notion of proofs: proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof, proof by using truth table, proof by counter example.

UNIT III

Combinatorics: Mathematical induction, recursive mathematical definitions, basics of counting, Cardinality and Countability, Pigeonhole principle, permutations, combinations, inclusion-exclusion.

UNIT IV

Recurrence relations (*n* th order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relation), generating function, properties of generating functions (G.F.), Solution of recurrence relation using G.F, solution of combinatorial problem using G.F.

UNIT V

Graphs: Graph terminology, types of graph, connected graphs, components of graph, Euler graph, Hamiltonian path and circuits, Graph coloring, Chromatic number.

Tree: Definition, types of tree (rooted, binary), properties of trees, binary search tree, tree traversing (preorder, inorder, postorder).

Text/Reference Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Mc.Graw Hill, 2002.
2. J.P. Tremblay & R. Manohar, "Discrete Mathematical Structure with Applications to Computer Science", Mc.Graw Hill, 1975.
3. V. Krishnamurthy, "Combinatories: Theory and Applications", East-West Press.
4. Seymour Lipschutz, M. Lipson, "Discrete Mathemataics", Tata McGraw Hill, 2005.
5. Kolman, Busby Ross, "Discrete Matheamatical Structures", Prentice Hall International.

ROE039/ROE049: APPLIED LINEAR ALGEBRA

UNIT I

Fields, Vector-spaces, sub-spaces, linear-combination, linear-dependence and independence. Basis and dimensions (each and every fact to be illustrated by suitable examples).

UNIT II

Linear-transformation, definition and examples, matrix representation, similarity, range and kernel, rank-nullity theorem and its consequences.

UNIT III

Singular and non-singular linear transformations, sum and product of linear transformations, vector space of linear transformations, nilpotent linear transformations.

UNIT IV

Inner product spaces, definition and examples, orthogonality, Cauchy-Schwartz Inquality, Minkowski Inequality, polarization Identity, complete orthonormal set, Bessel's Inequality, Gram-Schmidt's orthogonalization process.

UNIT V

Linear functional, definition and examples, vector space of linear functional, dual vector spaces, adjoint, self adjoint, unitary and normal operators, examples and properties, eigen values and eigen vectors, diagonalisation of linear operators, quadratic forms, principle axis theorem (without proof), some applications to engineering problems.

Text/Reference Books:

1. Dym, H., Linear Algebra in action, University Press, 2012
2. Halmos, PR, Finite Dimensional Vector Spaces (1990), Narosa.
3. Hoffman, K. and Kunze, R., Linear Algebra, PHI (2012)
4. Kolman, B. and Hill, DR, Introductory linear algebra with applications (2008), Pearson
5. Lipschutz, S. and Lipson M., Linear Algebra (2005), Schaum's Series.
6. Noble, B. And Daniel, JW, Applied linear algebra (1988), PHI