

AMIE Section A Syllabus

(with effect from 2005)

Subjects List

1. **Fundamentals of Design and Manufacturing**
2. **Material Science and Engineering**
3. **Computing and Informatics**
4. **Society and Environment**
5. **Mechanical science**
6. **Engineering Physics and Chemistry**
7. **Engineering Drawing and Graphics**
8. **Electronics and Instrumentation**
9. **Engineering Mathematics**
10. **Electrical Science.**

**Plus 2 / Intermediate holders should study all the 10 subjects in Section A.
Diploma holders need to study only the first 4 subjects in Section A**

1. FUNDAMENTALS OF DESIGN AND MANUFACTURING

Group A

Engineering design process and its structure. Identification and analysis of need, product designs specifications, standards of performance and constraints.

Searching for design concepts; morphological analysis, brainstorming. Evaluation of design concepts for physical reliability, economic feasibility and utility.

Detailed design; design for manufacture, assembly, shipping, maintenance, use, and recyclability.

Design checks for clarity, simplicity, modularity and safety. Standardization and size ranges. Reliability and robust design. Design organization and communication, technical reports, drawings, presentations and models.

Concept of manufacturing: classification of manufacturing process. Fundamentals of casting. Basic understanding of commonly used casting process (sand casting, investment and permanent mould casting process).

Fundamentals of metal forming. Hot and cold working; basic understanding of primary metal forming process(rolling, forging, extrusion and drawing process, punching and blanking)

Group – B

Fundamentals of metal cutting: tool-work interaction for production of machined surfaces. Classification of machining process. Basic machining operations. (Turning, shaping, planing, drilling and milling processes.)

Fundamentals of grinding and finishing; overview of unconventional machining process; fundamentals of welding process; introduction to primary welding and allied process, selection of manufacturing processes. Design for manufacturability.

Need for integration- commercial, economic and technological perspective; basic tools of integration; concept of a system. Introduction to information technology and its elements.

Introduction to group technology; introduction to simulation and data base management systems.

Elements of integration – controllers, sensors, robots, automated machines; AGVs, AS, RS, etc.

Product and process design for integration; design for economic manufacturing; design for manufacturing integration.

Introduction to computer aided process planning; selection of machine tools.

2. MATERIAL SCIENCE AND ENGINEERING

Group A

Introduction to materials. Metals and alloys, ceramics, polymers and semi conducting materials-introduction and application as engineering materials.

Defects in solids. Point, line and surface defects. Diffusion in solids.

Phase diagrams. Monocomponent and binary systems, non-equilibrium system, phase diagram and application in crystalline and non-crystalline solids.

Mechanical properties. Tensile strength, yield strength, elastic and visco-elastic properties, creep, stress relaxation and impact .Fracture behaviour. Ductile fracture, Griffith theory, effect of heat treatment and temperature on properties of metal.

Deformation of metals. Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, deformation in polycrystalline materials, strain cracking, Baushinger's effect, strengthening mechanisms, work hardening recovery, recrystallization and grain growth, cold and hot working.

Group B

Heat treatment. Iron-carbon system. Annealing, normalising, hardening, critical cooling rate, hardenability, age hardening, surface hardening, tempering.

Thermal properties. High temperature materials, materials for cryogenic application, thermally insulating materials.(Specific heat, thermal conductivity, thermal expansion).

Ceramic materials and polymers. Silicon structures, polymerism fraction in glass, electrical properties of ceramic phased, rocks, building stones, refractories.

Polymerisation mechanism, structural properties of polymer, thermoplastics, thermosets, elastomers, resins, composites, particle and fiber reinforced composites. Composite material including nano-material.

Electronic properties. Magnetism, diamagnetism, paramagnetism, ferromagnetism, magnetic energy, zone theory of solids, zones in conductors and insulators.

3. COMPUTING AND INFORMATICS

Group A

Programming languages. C including C++; Languages-declaration, expressions, control statements, arrays, function, pointers and structures; Algorithms and flow-charts. Introduction to Pascal.

Informatics: Information systems for decision making; Data management and database management technology; Office automation system - LAN, WAN, electronic mail, electronic data interchange; client server technology; overview of TCP/IP; Information systems for business; Strategic information systems; Information resources management.

Group B

Computer basics. History, generations and classification of computers. Number systems. Boolean algebra.

Hardware. Introduction to logic gates and flip flops. Components of a computer. input/output devices. CPU unit and memory unit. Secondary storage.

Softwares. System software; application software; compilers and translators.

Operating systems. Introduction to operating systems; types of operating systems and their function; popular operating systems- MS-DOS, UNIX and Windows; file management.

4. SOCIETY AND ENVIRONMENT

Group A

Society

Societal Structures and Dynamics

An analysis of basic sociological concepts and their applications to contemporary society; social stratification. Caste, class, cultural heritage, occupation, mobility and income distribution. Social tensions and their causes, societal responsibilities and social institutions.

Development Process

Parameters for development. Interrelationship between social, economic and scientific factors. Role of science and technology in development. Planning-its objectives and assessment.

Technology Assessment

Historical development of science and technology. Criteria for assessment of appropriate technology and technology adaptation.

Group B.

Environment

Ecosystems

Natural ecosystems. Principles of ecobalance. Biosphere cycle, carbon dioxide cycle. Causes for eco-imbalance,-its effects and remedies.

Environmental Degradation

Causes for degradation-its effects. Control of air, water, soil and noise pollutions. Protection of ozone layer.

Waste Management

Agricultural, Urban and industrial wastes.

Sustainable Development.

Definition and concept. Technology for sustainable energy and materials.

Compiled By

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Question Bank etc**

5. MECHANICAL SCIENCE

Group A

Mechanics of solids

Coplanar force systems, moment of a force, couple, equilibrium conditions, free-body diagram, laws of friction.

Centroid and area moment of inertia, mass moment of inertia, principle of virtual work, screw jack.

Kinematics of particles, velocity, acceleration, Newton's laws, equation of motion (rectilinear), momentum, impulse, work/energy, projectiles, moment of momentum, rotation and simple harmonic motion, free vibration.

Mechanics of Deformation

Stress, strain, Hooke's law, elastic constants, ultimate strength. Mohr's circle of stress, thin walled pressure vessels.

Deflection of beam-bending moment and shear force in beam/cantilevers, torsion of circular sections.

Group B

Fluid Mechanics

Fluid and their properties, viscosity, compressibility, surface tension, non-Newtonian fluids, pressure at a point, hydrostatic on immersed and floating bodies, type of flow, velocity and acceleration of a flow particle, hydrodynamics.

Thermodynamics

Basic concepts-properties of gases and equation of state, work, heat, heat capacity, internal energy, enthalpy.

First law of thermodynamics and law of conservation of energy, basic thermodynamic processes for ideal gases.

Second law of thermodynamics, cannot cycle, entropy, various process on T-s and H-s planes.

Ideal heat engine cycles-SI and CI engine cycles, principle of operation of SI and CI engines.

Recommended Book

- G.K Lal, Vijay Gupta, N G R Iyengar, B.N Banerjee and K Ramesh, Mechanical Science, Narosa Publishing House, New Delhi

Reference Books

- P.K Nag. Engineering Thermodynamics. Tata McGraw-Hill Publishing Co.Ltd., New Delhi.
- S.H Crandell, N C Dahl and TJ Larder. An Introduction to the Mechanics of solids. McGraw-Hill International.
- S.P Timoshenko. Strength of Materials-Vol. I. CBS Publishers and Distributors, New Delhi.

6. ENGINEERING PHYSICS AND CHEMISTRY

Group A

Engineering Physics

Atomic structure, Rutherford and Bohr's models, atomic process. Proton and neutron, radioactivity and decays. Nuclear energy and reactions, nuclear reactor. Introduction to quantum physics.

Inter-atomic forces in solids, anisotropic properties. Distinction between metal and semi-metals. Semi conductor, insulator and superconductor. Dielectric materials. Types of dielectric polarization. Piezo, pyro and ferroelectric materials and their electrical and optical properties.

Kinetic theory of gases. Temperature and kinetic energy, ideal gas laws. Principle of statistical mechanics. Boltzmann's law, Brownian movement, equipartition of energy and thermal equilibrium of radiation.

Optics. Interference, diffraction and polarization, laser, holography, fibre optics.

Crystalline and amorphous material, crystal geometry, crystal directions and planes. Space lattices. Crystal symmetry and structure. Crystal bonding. Interatomic forces in solids. Anisotropic properties.

Group B

Engineering Chemistry

Chemical bond. Ionic and covalent bonding; Lattice energy; Hybridisation; Resonance; Bond order; Fajan's rule; Metallic bond and intermolecular forces; Chemical kinetics.

Structure of organic molecules, nomenclature. Introduction to stereochemistry; Optical activity. Titration involving potassium permanaganate, potassium dichromate. Titration involving EDTA.

Oxidation-reduction reactions. Colloid and surface chemistry; Corrosion; chromatography and ion-exchange catalysis; Crystal structure and electro-chemistry; UV-visible spectrophotometry. Chemical kinetics-simple reactions.

Environmental chemistry. Pollutant analysis, e.g., CO, H₂, S, NO_x, Sox, oxidant.

Recommended Books

Engineering Physics

- David Halliday, R Resnick and K S Krane, Physics (vols I & II). John Wiley and Sons, International edition, Singapore.
- V Raghavan. Material Science and Engineering. Prentice Hall of India (P) Ltd., New Delhi.

Engineering Chemistry

- J E Huhey. Inorganic Chemistry. Harper and Row Publishing, Singapore.
- P W Atkins. The Elements of Physical Chemistry. Oxford, New York.
- R T Morrison and R M Boyed. Organic Chemistry. Allyn Bacon Publishing, Boslon.
- G H Jeffery, et al. Vogel's Textbook of Quantitative chemical Analysis ELBS, Longman.
- A K De. Environmental Chemistry. New Age International (P) Ltd., New Delhi.

7. ENGINEERING DRAWING AND GRAPHICS

Group A

Projection graphics. Objects, condition and methods of projection; Gnomonic, stereographic and orthographic projections; Coordinate systems and grid scales, scale distortion, and conditions of conformality and equivalence. Azonometric projections; Isometric; Dimetric and oblique projections; conical equivalent and equivalent cylindrical projections.

Spatial graphics. Basic principles of multiview drawings and Monge's projections; Points in quadrants and octants; Projections of lines and traces of line; True relative positions of two planes and of a straight line and a plane; Method of revolution. Projections of polyhedrons, curved lines and surfaces; contour mapping of curved surfaces; Plane sections of polyhedrons and curved surfaces; Development of curved surfaces. Affine correspondence and its applications.

Product graphics. Introduction to various product features; identification of functional and non-functional surfaces; selection of datum; Tolerancing of dimensions; Compatibility of product elements for manufacturing and assembly requirements; Sectional and auxiliary views.

Computer graphics. Basic principles for interactive computer graphics; Systems and peripherals required; Point plotting technique; Line drawing displays; Modelling of two- and three-dimensions; Display of solid objects.

Group B

Drafting principles. Manipulation and use of drafting equipment and instruments; Exercises in instrumental drawing; Introduction to drafting codes as per ISO and BIS; Technical lettering.

Drawing exercise. Drafting problems involving consideration of stereometric features; Toleranced dimensioning; partial views and sectioning. Auxiliary sections, schematic product symbols. Drafting exercises involving (a) preparation of details, (b) aggregation for assembly, (c) exploded machine kinematics, etc.

Recommended Books

- K Venugopal, Engineering Drawing and Graphics. New Age International (P) Ltd, New Delhi.
- P S Gill. Engineering Drawing. S K Kataria & Sons, Delhi
- W J Luzaddor. Fundamental of Engineering and Drawing. prentice Hall Inc., New York.
- T E French, C J Vierek and R J Foster. Graphics Science and Design. McGraw-Hill, New York.
- N D Bhatt. Engineering Drawing and Graphics. Charotar publishin House, Anand (Gujarat).

8. ELECTRONICS AND INSTRUMENTATION GROUP A

Electronics

Semiconductor materials, intrinsic and extrinsic semiconductors.

p-n junction diodes, rectifiers-half wave, full wave, capacitive filters, Zener diodes, their operation, characteristics and applications.

Transistors-p-n-p and n-p-n transistors, transistor as amplifier- CE, transistor characteristics, biasing and stability, small signal equivalent circuits. Field effect devices- MOSFET – characteristics and applications. BJT – characteristics.

Amplifier-Hybrid parameter equivalent circuits for common emitter configuration, current and voltage gain, input-output impedance, frequency response, concepts of feedback amplifiers, regenerative feedback and conditions for oscillation.

Thyristors-characteristics and applications. Triacs and GTOs.

Integrated circuits- IC devices. OPAMP applications. Analogue to Digital Conversion (ADC), Digital to analogue Conversion (DAC).

Group B

Instrumentation

Indicating instruments. Moving coil, moving iron, rectifier and dynamometer type meters for measurement of voltage, current, resistance and power. Integrating meters.

Electronic voltmeters-peak, r.m.s. and average reading type voltmeter. CRO-functional block diagram, operation and application.

Electronic instruments. Q-meters, distortion meters, spectrum analyzers, audio oscillators and RF signal generators, introduction to digital voltmeters, digital display devices.

Sensors and transducers. Resistive, inductive and capacitive pick ups for non-electrical quantities. Analogue and digital data acquisition and transmission systems.

Recommended Books

- A M Shed. Electronic Devices and Circuits. Prentice-Hall of India (P) Ltd, New Delhi.
- Boylestad and Nashelsky. Electronic Devices and Circuit Theory. Prentice-Hall of India (P) Ltd., New Delhi.
- E W Golding and F C Widdies. Electrical Measurements and Measuring Instruments. Pitman & Sons, UK.
- A D Helfrick and W D Cooper. Modern Electronic Instrumentation and Measuring Techniques. Prentice- Hall of India (P) Ltd., New Delhi

9. ENGINEERING MATHEMATICS

Group A

Calculus of Functions of Variables

Calculus of Functions of one variable: Successive differentiation, Leibnitz's theorem, Rolle's and Mean value theorems. Taylor's and Maclaurin's expansion theorems. Fundamental theorem of integral calculus. Elementary reduction formulae for integrals. Applications to length, area, volume, surface area of revolution, moments of centre of gravity. Infinite series- convergence, divergence ratio tests, etc.

Calculus of functions of several variables: Partial derivatives, gradient and directional derivatives. Differentiation of implicit functions, exact differentials, tangents, normals, maxima, minima, saddle points. Method of Lagrange's multiplier. Multiple integrals.

Vector Calculus

Scalar and vector fields. Line and surface integrals. Gradient and divergence. Green's and Stoke's theorems and their applications.

Linear Algebra

Vector spaces-linear independence and dependence of vectors, inner products, linear transformations. Matrices and determinants. Systems of linear equations consistency and inconsistency. Gauss elimination, rank of a matrix, inverse of a matrix. Eigen values and eigenvectors of a matrix, diagonalization of a matrix.

Group B

Ordinary Differential Equations (ODEs)

Formation of ODEs, definition of order, degree and solutions. ODEs of first order; separable variables, homogeneous and non-homogeneous equations, exactness and integrating factors, linear equations and Bernoulli's equations (general linear ODEs of nth order, solutions of homogeneous and non-homogeneous equations, operator method, methods of undetermined coefficients and variation of parameters). Solutions of simple simultaneous ODEs. Partial differential equations and its applications. Transforms theory-Laplace, Fourier, etc.

Numerical Methods

Difference operators-forward, backward, central, shift and average operators, and relations between them. Newton's forward and backward interpolations. Lagrange's interpolation and the error formula for interpolation. Numerical differentiation and integration-Trapezoidal rule and Simpson's one-third rule, including error formulae.

Introduction to Probability and Statistics

Basic concepts, including introduction to probability theory, Venn diagrams, central limit theorem, mean, mode and median. Properties of Beta, Poisson, Exponential and Normal distributions. Correlation and regression, Student's t-distribution test, Chi-square and F tests of significance.

Recommended Books

- E Kreyszig. Advanced Engineering Mathematics. New Age International Ltd., New Delhi.
- V Krishnamurthy, V P Maina and J L Arora. An Introduction to Linear Algebra. Affiliated East-West Press (P) Ltd., New Delhi.
- G B Thomas and R L Finney. Calculus and Analytic Geometry. Narosa Publishing House, New Delhi.
- F E Croxton, D J Cowden and Sidney Klein. Applied General Statistics. Prentice-Hall of India (P) Ltd, New Delhi.

10. ELECTRICAL SCIENCE

Group A

Review of basic concepts in electrostatics and magnetostatics. Basic laws due to Ohm, Coulomb, Faraday, Ampere and Kirchhoff. Network parameters and theorems. Network analysis. Steady state response of circuits of sinusoidal functions. Power and power factor. Phasor representation of sinusoidal complex impedances. Resonance. Magnetic field calculations. Magnetization curves. Magnetic circuit concepts and calculations. Hysteresis and eddy current losses. Relays.

Polyphase circuits-Three-phase supply systems phase sequence. Balanced three-phase circuits. Star and delta connected loads. Unbalanced three-phase circuits. Symmetrical components. Power measurement in the phase circuits. Active and reactive power. Power factor improvement.

Group B

Elements of power distribution-d.c. 2-wire, 3-wire distribution. a.c. 3-wire and 4-wire distributions. Radial and ring main distributions. Current loadings and voltage profile in distributions. Comparison of copper efficiencies in different systems of distribution.

Power transformers, theory of operation, phase diagram, equivalent circuit. Efficiency and regulation.

Principles of energy conversion; Basic concepts rotating machines, torque and emf; d.c. machines characteristics of series, shunt and compound motors and generators.

Basic principles of operation of synchronous and induction machines. Starting of induction machines. Starting of induction motors. Regulation of synchronous generator by synchronous impedance method.

Single-phase induction and commutator machines.

Recommended Books

- S Choudhuri, R Chakrabarti and P K Chattopadhyay. Electrical Science. The Institution of Engineers (India) Textbook Series, Narosa Publishing House, New Delhi.
- A H Cotton. Transmission and Distribution. ELBS edition (for Group B, first para of the syllabus only.)
- N Parkar Smith. Problems in Electrical Engineering. CBS Publishers and Distributors, New Delhi.