

**MT(Technical) Preliminary Written Test - 20<sup>th</sup> June, 2010 Forenoon**

**(A Broad Outline)**

<b>Post</b>	<b>Section</b>	<b>Structure of Test</b>	<b>Total Questions and time allotted</b>
<b>Management Trainee (Technical)</b>	<b>I (General Aptitude Test)</b>	1. General Awareness	<b>Total Questions : 140 Nos.</b> <b>Total Time: 90 Minutes.</b>
		2. General English	
		3. Quantitative Aptitude	
		4. Verbal & Non-Verbal Reasoning	
	<b>II (Basic Engineering Test)</b>	1. Engineering Mathematics	
		2. Engineering Physics	
		3. Engineering Chemistry	
		4. Fundamentals of Computing & Computer Programming	
		5. Engineering Mechanics	
		6. Basics of Electrical & Electronics Engineering	

# **BASIC ENGINEERING TEST**

## **Indicative Syllabus not exhaustive**

### **1. ENGINEERING MATHEMATICS**

#### UNIT I - MATRICES

Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

#### UNIT II - INFINITE SERIES

Sequences – Convergence of series – General properties – Series of positive terms – Tests of convergence (Comparison test, Integral test, Comparison of ratios and D'Alembert's ratio test) – Alternating series – Series of positive and negative terms – Absolute and conditional convergence – Power Series – Convergence of exponential, logarithmic and Binomial Series.

#### UNIT III FUNCTIONS OF SEVERAL VARIABLES

Limit and Continuity – Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Errors and approximations – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

#### UNIT IV IMPROPER INTEGRALS

Improper integrals of the first and second kind and their convergence – Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions – Properties – Evaluation of integrals using Beta and Gamma functions – Error functions.

#### UNIT V MULTIPLE INTEGRALS

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals – Area of a curved surface.

#### UNIT VII DIFFERENTIAL EQUATIONS

Method of variation of parameters – Method of undetermined coefficients – Homogenous equation of Euler's and Legendre's type – System of Simultaneous linear differential equations with constant coefficients.

#### UNIT VIII VECTOR CALCULUS

Gradient and directional derivative – Divergence and Curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface Integral and Volume Integral - Green's, Gauss divergence and Stoke's theorems – Verification and Application in evaluating line, surface and volume integrals.

#### UNIT IX ANALYTIC FUNCTION

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal Mapping –

$$w = z + c, az, \frac{1}{z}, z^2$$

Mapping by functions - Bilinear transformation.

#### UNIT X COMPLEX INTEGRATION

Line Integral - Cauchy's theorem and integral formula – Taylor's and Laurent's Series – Singularities – Residues – Residue theorem – Application of Residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

## UNIT XI LAPLACE TRANSFORMS

Existence conditions – Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and Final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

## 2. ENGINEERING PHYSICS

### UNIT I PROPERTIES OF MATTER

Elasticity – Poisson's ratio and relationship between moduli (qualitative) – Stress-strain diagram – factors affecting elasticity – bending of beams – cantilever – bending moment – theory and experiment of Young's modulus determination – Uniform and non-uniform bending – I shaped girders – twisting couple – hollow cylinder – shaft – torsion pendulum – determination of rigidity modulus – moment of inertia of a body (regular and irregular).

### UNIT II ACOUSTICS AND ULTRASONICS

Classification of sound – loudness and intensity – Weber-Fechner Law – standard Intensity and Intensity level – decibel – reverberation – reverberation time – rate of growth and decay of sound intensity - derivation of Sabine's formula – absorption coefficient and its determination – factors affecting acoustics of buildings : focussing, interference, echo, Echelon effect, resonance – noise and their remedies. Ultrasonics – production – magnetostriction and piezoelectric methods – detection of ultrasound – acoustic grating – Industrial applications – NDT - Ultrasonic method: scan modes and practice.

### UNIT III THERMAL PHYSICS

Thermal expansion - thermal stress – expansion joints – bimetallic strips - thermal conductivity – conduction in solids – Forbe's and Lees' disc methods – thermal insulation of buildings – Laws of thermodynamics – Otto and diesel engines and their efficiency – entropy – entropy of Carnot's cycle – reverse Carnot's cycle – refrigerator.

### UNIT IV APPLIED OPTICS

Interference - Michelson interferometer: construction, working, determination of wave length and thickness – anti-reflection coating – air wedge and its application – Lasers – Einstein's coefficients – CO<sub>2</sub>, Nd:YAG and semiconductor lasers - construction and working – applications – Optical fibres – classification (index & mode based) – principle and propagation of light in optical fibres – acceptance angle and numerical aperture – fibre optic communication system - active and passive sensors.

### UNIT V SOLID STATE PHYSICS

Nature of bonding – growth of single crystals (qualitative) - crystal systems - crystal planes and directions – expressions for interplanar distance – coordination number and packing factor for simple structures: SC, BCC, FCC and HCP – structure and significance of NaCl, ZnS, diamond and graphite – crystal imperfections: point defects, dislocations and stacking faults.

### 3. ENGINEERING CHEMISTRY

#### UNIT I THERMODYNAMICS

Statement of second law of thermodynamics – Clausius and Kelvin – definition of entropy – entropy change for a reversible process – entropy change for flow of heat in an irreversible process – entropy change for an isothermal expansion of an ideal gas – problems – entropy of phase transitions- problems – definition of free energy and work function – Gibbs Helmholtz equation – applications – problems – derivation of Maxwell relations – van't Hoff isotherm and isochore – applications – problems – chemical potential – variation of chemical potential with temperature and pressure - significance.

#### UNIT II PHASE RULE

Phase rule – statements and explanation of the terms involved – condensed phase rule – construction of phase diagram – water system – sulphur system – phase rule for two component alloy systems- thermal analysis – eutectic system - Lead-Silver system – simple eutectic formation – Zinc-Magnesium alloy system – Iron-Carbon alloy system- solved examples.

#### UNIT III SURFACE CHEMISTRY AND CATALYSIS

Adsorption – types of adsorption – adsorption of gases on solids – adsorption isotherm – Freundlich and Langmuir isotherms – adsorption of solutes from solutions – applications – role of adsorption in catalytic reactions – ion exchange adsorption – basic principles in adsorption chromatography – Catalysis – classification – characteristics of catalysis - auto catalysis – enzyme catalysis – Michaelis – Menten equation – solid acid catalysis.

#### UNIT IV ORGANIC REACTIONS AND SPECTROSCOPY

Electrophilic and nucleophilic, substitution and elimination reactions mechanisms –  $SN^1$ ,  $SN^2$ ,  $E^1$ ,  $E^2$  reactions – Electromagnetic spectrum – absorption of radiation – electronic transition – vibrational transition – rotational transition – intensities of spectral lines – Beer-Lambert's law – type of instrument used for absorption measurements –UV & visible spectroscopy, IR spectroscopy – principles of instrumentation and applications.

#### UNIT V ENERGY SOURCES:

Thermal Energy: Coal- Ranking of coal - analysis (proximate and ultimate ) Calorific value and determination (Bomb calorimeter method ) – COKE – Manufacture – Otto Hoffmann's process – Applications.

Chemical Energy: Electrode potential – Calomel electrode – Galvanic cells – primary secondary – Acid and alkaline cells – fuel cells.

Nuclear Energy : Fission and fusion – power reactors – Atomic pile applications .

Solar Energy : Methods of utilization – thermal conversion – Liquid Flat – Plate collector – Photovoltaic conversion - solar cell - Applications.

#### UNIT VI CORROSION:

Origin and theories of corrosion – Types of corrosion - Factors affecting corrosion – corrosion control methods . Protective coatings –Metallic coatings – Chemical conversion coatings - phosphate , chromate , Anodized . Organic Coating – paints – special paints – Varnishes and lacquers.

## UNIT VII FUELS AND LUBRICANTS

Petroleum – refining - Motor fuels – Petrol and Diesel Oil - Knocking – Octane number - Cetane number. Synthetic petrol – Fisher - Tropsch and Bergius methods. LPG and CNG - Applications. Rocket fuels -Propellants - Classification.

Lubricants: Classification - mechanism - properties of lubricating oils - Selection of lubricants for Engineering applications.

## 4. FUNDAMENTALS OF COMPUTING & COMPUTER PROGRAMMING

### UNIT I

Computer systems – Exploring computers – Inside the system – Processing data – CPUs – Types of storage devices - Operating systems basics – Networking basics.

### UNIT II

The internet and the WWW – Internet services – connecting to the internet - Working with applications software – productivity software – graphics and multimedia – Data base Management systems – Creating computer program.

### UNIT III

Computer Programming in C:

Basics: Variables – Constants – Expressions – Operators and their precedence and associativity. Basic input and output statements. Control structures. Simple programs in C using all the operators and control structure.

Functions: Concept of a function – Parameters and how they are passed – Automatic Variables – Recursion – Scope and extent of variables. Writing programs using recursive and non-recursive functions.

Arrays and Strings: Single and multidimensional arrays-Character array as a string- Functions on strings. Writing C Programmes using arrays and for string manipulation.

Structures: Declaring and using structures-Operations on structures – Arrays of structures- User defined data types-Pointers to using files.

Files: Introduction –file structure- File handing functions- file types- Files- Error handing- C Programming examples for using files.

## 5. ENGINEERING MECHANICS

### Unit I BASICS & STATICS

Introduction - Units and Dimensions - Laws of Mechanics – Lame’s theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations on forces, dot product and cross product - Coplanar Forces – Resolution and Composition of forces – Equilibrium of a forces – Forces in space - Equilibrium in space - Equivalent systems of forces – Principle of transmissibility – Single equivalent force

### Unit II EQUILIBRIUM OF RIGID BODIES

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon’s theorem - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

### Unit III PROPERTIES OF SURFACES AND SOLIDS

Determination of Areas and Volumes – First moment of area and the Centroid of standard sections – T section, I section, Angle section, Hollow section – second and product moments of plane area – Rectangle, triangle, circle - T section, I section, Angle section, Hollow section – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia - Mass moment of inertia – Derivation of mass moment of inertia for rectangular solids, prism, rods, sphere from first principle – Relation to area moments of inertia.

### Unit IV DYNAMICS OF PARTICLES

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum

### Unit V CONTACT FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS

Frictional force – Laws of Coloumb friction – simple contact friction – Rolling friction – Belt friction Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion – Impact of elastic body

## 6. BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

### Unit I ELECTRICAL CIRCUITS

Basic principles involved in power generation, transmission and use – Ohms Law – Kirchoff's Law – steady state solution of DC circuits – Theorem: Thevinin's, Norton's and Superposition Theorems.

### Unit II AC CIRCUITS

Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits, housing wiring, industrial wiring materials of wiring.

### Unit III ELECTRICAL MACHINES

Principles of operation and characteristics of DC machines. Transformers (single and three-phase) – synchronous machines – three-phase and single-phase induction motors – (op. Principles).

### Unit IV ELECTRONIC DEVICES & CIRCUITS

Types of Materials –Silicon & Germanium- N type and P type materials – PN Junction – Forward and Reverse Bias –Semiconductor Diodes –Rectification – Bipolar Junction Transistor – Characteristics – transistor as an Amplifier –Introduction to operational Amplifier –Inverting Amplifier –Non Inverting Amplifier –DAC – ADC .

### Unit V MEASUREMENTS & INSTRUMENTATION

Introduction to transducers: pressure, temperature, position, electrical measurements - Classification of instruments – moving coil and moving iron ,Ammeter and Voltmeter – multimeters – dynamometer type Wattmeter – three-phase power measurements – energy meter – megger – instrument transformer (CT and PT ).

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