

**SCHEME AND SYLLABUS OF EXAMINATION FOR THE PURPOSE OF FILLING UP
THE POST OF JUNIOR ENGINEER (MECHANICAL) UNDER VARIOUS
DEPARTMENT**

The Examination will consists of 2 papers:-

SUBJECT	PAPERS	FULL MARKS	TIME ALLOWED
MECHANICAL ENGINEERING	PAPER - I	300 (THREE HUNDRED)	3 HOURS
	PAPER - II	300 (THREE HUNDRED)	3 HOURS

VIVA-VOCE/PERSONALITY TEST - - **75 Marks**

SYLLABUS:

PAPER-I: - - **300 Marks**

1. MATHEMATICS

Surds, Logarithms and Quadratic Equations: Surds, Logarithms, Quadratic Equations.
Sequences and Series: Sequences, Arithmetic Progression, Geometric Progression.
Binomial Theorem and Computer Mathematics: Binomial Theorem, Computer
Mathematics. Trigonometric Functions: Angles, Circular Functions of Trigonometric
Ratios, Inverse Trigonometric Functions.

Applications of Trigonometry: Properties of Triangles, Solutions of Triangles, Heights and
Distance.

Coordinate Geometry and Straight Line: Cartesian coordinate system.

Circles and Conic Sections: Circle, Conic Section.

Vector Algebra: Basic Concepts, Components of a Vector, Operations on Vectors,
Product of Two Vectors.

Differential Calculus: Real Number System, Functions, Limits, Continuity, Derivative.

Applications of Derivatives: Application to Geometric, Derivative as a Rate Measure,
Increasing and Decreasing Functions, Maxima and Minima, Rolle's Theorems, Mean Value
Theorem, Curve Sketching.

Indefinite Integrals: Antiderivatives, Basic Definitions, Methods of Integration, Integration
of Rational Functions, Integration of Irrational Functions.

Definite Integrals: Definite Integrals, Fundamental Theorem of Calculus, Properties of
Definite Integrals: Applications.

Complex Numbers: Complex Numbers, Geometrical Representation of Complex
Numbers, Exponential and Circular Functions of Complex Numbers.

Matrices and Determinants: Matrices, Matrix Multiplication, Determinants, Adjoint and
Inverse of a Matrix, Solutions of Linear Equations with the help of Inverse of a Matrix

Statistics: Statistical Data and Variations and Units of Observations, Constructions of
Frequency Tables (or Frequency Distributions) from Raw Data, Graphical Presentation of
Frequency Distributions, Measures of Location and Dispersion.

2. PHYSICS

Properties of Matter: Surface Tension, Fluid Statics, Fluids in Motions, Elasticity.
Thermal Energy: What is Heat? Mechanical Equivalent of Heat, Modes of Heat Transfer, Kinetic Theory of Gases.
Sound: Waves, Sound and its Characteristics, Speed of Sound: Newton's Formula.
Light: Laws of Reflection and Laws of Refraction, Image Formation by Reflecting Surfaces, Image Formation of Refracting Surfaces, Optical Instruments, Photometry.
Electricity and its Effects: Electric Charge and Electric Force, Simple Electrical Circuits, Electrical Instruments, Heating Effects of Current, Chemical Effects of Currents, Sources of EMF: Battery.
Magnetism: Magnetic Field, Electric Origin of Magnetism, Biot-Savart's Law, Effects of Magnetic Field on Electric Current, Motion of a Charged Particles in magnetic Field, Magnetic Materials.

3. CHEMISTRY

Periodic Table and Periodic Properties; Development of Periodic Table, Periodic Table and Electronic Configuration of Elements, Periodic Properties.
Non-Metal; Atmosphere, Hydrogen, Nitrogen and Ammonia, Chlorine, Acids.
Metals; Occurrence and Properties of Metals, Iron and Steel, Copper, Aluminium, Alloys.
Water Technology; Sources of Water, Structure of Water, Solvent Action of Water, Hardness of Water, Sludge and Scale Formation of Boilers, Boiler Corrosion and its prevention, pH Value and Water Treatment.
Fuels: Classification of fuels, Calorific value of fuels, Characteristics of a Good Fuel, Comparison between Solid, Liquid, and Gaseous Fuels, Determination of Calorific Value, Solid fuels, Liquid Fuels, Gaseous Fuels.
Lubricants; Lubricants, Lubrication, Selection of Lubricants, Classification of Lubricants, Lubricating Emulsion, Gases as Lubricants, Properties of Lubricants.
Polymers: Importance of Polymers, Type of Polymers, Properties of Polymers, Moulding of Plastic, Rubber
Glass and Ceramics: Manufacture of Glass, Glass Transition, Varieties of Glasses, Ceramics. Refractories, Bleaching Powder, Commercial Bleaching Powder.

4. APPLIED MECHANICS

Coplanar and Non-Coplanar Forces: System of Forces, Coplanar Force, Resultant of Concurrent Forces. Moment of a Force, Resultant of Non-concurrent Forces.
Equilibrium; Free body diagram, Types of supports and Constraints, Free body Diagrams, Equilibrium of Coplanar Forces, Plane Trusses.
Friction; Laws of Friction, Problem Involving Dry Friction, Inclined Plane, Wedge Friction and Screw Friction, Simple Machines
Centre of Gravity and Moment of Inertia: Concept of Centre of Gravity, Moment of Inertia of Area.
Rectilinear Motion, Projectiles and Relative Motion: Rectilinear Motion, Projectiles, Relative Motion.
Laws of Motion: Newton's Laws of Motion, Motion on a Circular Path, Simple Harmonic Motion, Work, Power and Energy.

5. ENGINEERING MATERIALS

Classification of Iron and Steel, Types of Cast Iron, Steel and Alloy Steels, Important Ores and Properties of Non-Ferrous Materials, Properties and Uses of Alloys, Plastics, Reinforced Plastics, Classification, Ceramics, Refractory and Abrasives.

6. ENGINEERING DRAWING

INTRODUCTION TO DRAWING, GEOMETRICAL CONSTRUCTION, ORTHOGRAPHIC PROJECTIONS-I, ORTHOGRAPHIC PROJECTIONS-II, Sections of Solid, ISOMETRIC AND OBLIQUE PROJECTIONS, SURFACE DEVELOPMENT.

7. WORKSHOP TECHNOLOGY

Carpentry: Classification of Carpentry Tools, Types of Work & Working Procedure, Joints in Carpentry Work.

Pattern Making and Foundry: Pattern making Foundry

Fitting and Plumbing: Tools and Devices in Fitting – work, Operation in Fitting Work, Tools in Plumbing Work, Operations in Plumbing Work, Pipe Fitting and Joints.

Sheet Metal Work: Types of Tin-Smithy Joints, Soldering, Brazing, Fluxes, Metal Used in Tin Smithy Works, Hand Tools and Machines, Sheet Metal Operation, Layout of Patterns.

Welding: Gas Welding, Equipment for Oxy-Acetylene Gas Welding, Fluxes, Gas Flame, Arc Welding, Polarity in Arc Welding, and Electrodes for Arc Welding Equipment, Arc Welding Processes.

Smithy and Forging: Forging Materials, Tools and Equipments used in forging, Forging Operations, Power Hammers and Presses, Rivet, Heat treatment

Machine Tools: Function of Lathe, Types of Lathe Accessories and Attachments, Lathe Operations, Cutting Tools, Terms Used in Cutting Operation.

Painting: Paints, Varnishes.

8. BASIC THERMAL ENGINEERING

Basic Concepts and Gas Laws, Laws of thermodynamics, Formation of Steam and its Properties, Steam Generators, Steam Prime Movers, Steam Condensers, Steam Power Plants, Heat Transfer, Other sources of energy.

9. E/M ENGINEERING

Introduction to Electricity: Electricity, Current, Resistance of a Conductor, Kirchhoff's Laws, Batteries.

Electromagnetism, Electrostatics and Electrical Instruments:

Magnetism, Biot-Savart Law and its Applications, Electromagnetic Induction, Static Electricity, Electrical Instruments, Hysteresis

AC Circuits: Sinusoidal Signals, Impedance Concept, Concepts Relating to Power, Three-phase Circuits.

Electrical Machines: DC Machines, Transformers, Distribution of Electricity

Units of Measurement, Gas Laws and Fuels: Basic Units of Measurement, Thermodynamic Systems, Gas Laws, Laws of Thermodynamics, Energy Conversion Cycles, Fuels.

Internal Combustion Engines: Classification, Cycles, Four Stroke and Two Stroke Engines, Engine Performance, Octane and Cetane Numbers, Pollution.

Refrigeration and Air-conditioning: Refrigeration Cycle, Vapour Compression Refrigeration, Refrigeration Capacity, Refrigerants, Absorption System, Ammonia Hydrogen Refrigeration System, Steam Jet Refrigeration, Thermoelectric Cooling, Indirect Refrigeration, Air Conditioning, Psychrometry, Comfort Air Conditioning, Summer Air Conditioning (Humid Air), Winter Air Conditioning, Summer Air Conditioning (Dry Air), Package Air Conditioner, Evaporative Cooler, Ducting.

Lifts and Cranes: Basic Principles, Lifts (Elevators), Escalator, Lifting of Load, Some Basic Crane Mechanisms, Types of Crane, Rotary Cranes or Derricks.

10. COMPUTER BASICS

Introduction to Computers: Why Computer?, Evolution of Computers, Components of a Computer, Hardware Vs Software, System Vs Application Software, Bits and Bytes, Input and Output Devices, ROM/RAM, Secondary Storage Devices

Microsoft Windows: Microsoft Windows, Windows Desktop, Working with Windows, Exploring the Control Panel, Common Accessory Applications, Windows Explorer

Ms Word Part I: About Ms Word, Ms Word Screen Layout, Creating Documents, S Word Menus, Standard Toolbar, Formatting Toolbar

Ms Word II: Creating a Simple Document, Bullets, Numbering the Text, Aligning the Text, Spelling and Grammar Check, Print Preview, Print, Saving the document, Closing the document, Opening the document, Exiting MS Word, Selecting a Template,

Starting the Template and selecting the Template Style, Header and Header Items, Recipients name and the closing items, Header and Footer, Typing the Text, Creating and modifying tables, Creating rows and columns, Inserting rows and columns, Merging rows and columns,

Introduction to Spreadsheets Part-I: Starting Ms Excel, Excel Screen Layout, and Excel Menu Ms

Excel Toolbars: Standard Toolbar, Formatting Toolbar, Creating a Simple Worksheet, Functions Ms Power Point: About Power Point, Toolbars, Creating a simple presentation, Making yours presentation attractive, Viewing a presentation, Printing a presentation, Getting Help.

Internet and E-Mailing: Internet Basics, Starting the Internet, Searching, E-Mailing, Internet Chat.

11. STRENGTH OF MATERIALS

Stresses and Strains: Basic Concepts, Mechanical Behavior of Materials, Deformation of Bars, Composite Bars, Thermal Stresses and Strains, Relationship between Elastic Constants.

Principle Stresses: State of Stresses, Normal and Shear Stresses, Stress on Oblique Sections, Principle Stresses and Principal Planes.

Shear Forces and Bending Moments: Beams, Shear Forces and Bending Moment, Shear Force and Bending Moment Diagram.

Stresses in Beams: Simple Bending or Pure Bending, Moment of Resistance, Bending Stress Distribution, Practical Applications, Section Modulus, Shear Stress Distribution in Beams.

Deflection of Beams: Curvature of Bending Beam, Differential Equation of Deflection Curve, Double Integration Method for Slope and Deflection.

Torsion: Torsion of Circular Shafts, Power Transmission by Shafts.

Columns and Struts: Failure of a Column or Strut, Sign Conventions, Types of End Condition of Columns, Equivalent Length of a Column, Slenderness Ratio, Factor of Safety, Indian Standard Specifications for Columns.

12. MACHINE DRAFWING

Different Views in Orthographic Projections

Sectional Views, Other Sections, Auxiliary View, Missing Lines and Missing Views.

Screw Threads, Nuts And Bolts

Screw Threads Terms, Standard Thread Forms, Right and Left Hand Threads, Single and Multiple Start Threads, Thread Profile Types, Square, Acme and Buttress Threads, Representation of Threads, Nut and Bolt, Shape of Bolt Head and Nut, Procedure of Drawing, Drawing Complete Bolt, Square Headed Bolt and Square Nut, Washer, Stud, Eye, Bolt, Other Bolt Heads, Other Nut Shapes.

Riveted Joints.

Riveting, Types of Riveted Joints, Nomenclature.

Key, Cotter and Knuckle Joints

Key, Types of Key, Gib Head Key, Cotter and Cotter Joint, Sleeve Cotter Joint, Socket and Spigot Cotter Joint, Joining of Roads, Knuckle Joint.

Assembly Drawing

Valve drawing spring loaded valves, coupling, universal coupling, flang coupling, bearings and plumber blocks ball and roller bearings.

13. THEORY OF MACHINES

Simple Mechanisms, Friction, Power Transmissions, Flywheel, Governor, Balancing, Vibrations.

14. REFRIGERATION AND AIR-CONDITIONING

Refrigeration and Air Conditioning, Refrigeration Cycle, Refrigeration Equipment, Refrigerants, Refrigeration Systems, Properties of Moist Air, Air Conditioning Equipment and their Applications.

Refrigeration Systems: Basic definitions, scope and relevance of ME081, applications, Components of Refrigeration System, Refrigerants, Methods of Refrigeration, Air Refrigeration Systems simple Vapour Compression System, Multi Pressure Systems, Vapour Absorption System Production of low temperatures, All Methods and need of defrosting.

Ice Manufacturing- principle, methods, systems used to form ice, quality of ice, ice factory, special ice machines. Case study on ice production and ice cream production.

PAPER- II:**1. HEAT POWER TECHNOLOGY**

Engine Fundamentals, Intake and Exhaust Systems, Ignition and Starting Systems, Friction and Lubrication, Cooling Systems, Mechanisms, Power Transmission, Governors, Flywheel, LIMITS FITS and Gauges.

2. MECHANICS OF MATERIALS

Basic Concept, Principal Stresses and Strains, Bending Stresses, Torsion in Circular Shafts Strain Energy and Impact.

3. POWER TRANSMITTING ELEMENTS

Power Transmission Concepts, Drives, Chain Drives, Bevel Gears, Worm Gears, Gear Manufacturing.

4. ENGINEERING THERMODYNAMICS

Basics of Thermodynamics, First Law of Thermodynamics, Second Law of Thermodynamics, Ideal Gas Properties and Processes, Properties of Steam and Vapour Processes, Fuels and Combustion, Availability (Energy).

5. FLUID MECHANICS

Basic Concepts, Flow of Fluids, Flow through Orifices, Flow through Mouthpieces and Minor Losses, Flow through Simple Pipes.

6. ENGINEERING METALLURGY

Introduction and scope of the subject, Introduction to Engineering Materials. Lattice Structures and effect on their property relationship, indexing to Lattice planes and directions.

Plastic deformation- Mechanisms. Deformation of single crystals and polycrystalline metals, Imperfections in crystals, dislocations, work hardening, cold and hot working of metals.

Engineering Steels and Alloys-

Detail study of equipments and methods for micro structural analysis

Microstructure and Microstructure property relationship of following steels-

Plain carbon steels, Effects of alloying elements, alloys steels such as stainless steels, tools steels,

Special purpose steels with applications.

Cast Iron – Microstructure and Microstructure property relationship –Classification of cast iron- Gray C.I., White C.I., Nodular C.I., Chilled C.I., Alloy C.I., Malleable C.I., and applications of all types.

Engineering Nonferrous Alloys- Microstructure and microstructure property relationship- Copper alloys, Aluminium alloys, Nickel alloys, Bearing materials and applications of all types.

Heat Treatment of steels- Transformation products of austenite. Time –temperature-transformation diagrams, critical cooling rate. CCT diagrams.

Heat treatment of steels – Annealing, Normalizing, Hardening and tempering. Hardenability of steels,

Surface hardening treatments – carburizing, Nitriding, Carbonizing, Induction hardening, and flame hardening.

Powder Metallurgy- Advantages and limitations. Characterization and testing of metal powders, powder manufacture, powder conditioning. Production of sintered structural components, self lubricating bearings, cemented carbides, cermets, sintered carbide cutting tools. Refractory metals. Electrical contact materials, friction materials. Diamond impregnated tools.

Non Destructive Testing: Visual Inspection, Magna flux, dye penetration test, sonic and ultra sonic test, radiography and eddy current test. Examples of selection of NDT and mechanical testing methods for selected components like crankshafts, gears, razor blades, welded joints, steel and C.I. casting, rolled products.

7. MACHINE TOOLS

Introduction to Machine Tools & Lathe Machine, Drilling Machines, Milling Machines Grinding Machines, Shapers, Planers and Slotters

Broaching Types of broaching machines. Parts of the machine and their functions.

Components machined on broaching machine. Broach geometry.

Introduction to NC, CNC Machines- Introduction to NC, CNC, DNC machines.

Machining centres- principles, working, advantages, and applications. Introduction to FMS.

8. DESIGN OF MACHINE ELEMENTS

Design Process, Statistical consideration in design, Manufacturing considerations in design, Aesthetic and ergonomic considerations in design of products, Design for variable stresses, Design of Machine Parts, Design of Cotter joint and knuckle joint, Mechanical Springs, Bending Of Curved Bar, Stresses in ring, chain link and crane hook, C-Clamp design. Design of piston rod, push rod, connecting rod.

9. HEAT TRANSFER

Introduction, Fundamental equations of conduction, One dimensional steady state heat conduction, One dimensional steady state heat conduction with heat generation, Extended Surfaces, Unsteady state Heat Conduction, Convection, Dimensional analysis, Forced Condensation and boiling.

10. METROLOGY AND QUALITY CONTROL

Introduction, Comparators, Interferometry, surface finish measurement Comparators, Metrology of Screw Thread, Gear Metrology, Interferometer, Surface Finish Measurement, Machine Tools Metrology, Advances of Metrology

Concept of Quality- Definitions of Quality, Dr. Deming and Juran's Contributions, Elements/ Characteristics of Quality, Value of Quality, Cost of Quality, Quality Policy, Vision, Mission. Quality Control- Definitions, Scope and Applications, Quality Assurance, Causes of Variation.

Six Sigma- Types of Defects, DMAIC, Six Sigma Program, Zero Defect

Quality Standards – ISO 9000:2001, TS 16949 Standard, FMECA (Failure Mode Effect Criticality Analysis), FTA (Fault Tree Analysis)

Quality Circle- Kaizen Practice, Cause and Effect Diagram, Pareto Analysis, Total Quality Management (TQM), Statistical Quality Control, Acceptance Sampling, Types of Sampling Plan.

11. MAINTENANCE ENGINEERING

Maintenance Basics, Types of Maintenance and maintenance organization, Maintenance Activities and Planning, Maintenance Quality Indices and Measurements, Maintenance Management, Spare Parts Management and Inventory Control

12. INTERNAL COMBUSTION ENGINES

Introduction to Engine, Petrol Engine System, Diesel Engine System, Engine Cooling Engine Performance and Testing, Air pollution and control, Introduction to New technologies.

13. POWER PLANT ENGINEERING

Introduction and scope of the MEA051, Present status of Power generation in India, power plants in INDIA.

Fuels for Power Plants

Solid Fuels- Coal and its various types, calorific values, properties, analysis of coal.

Liquid Fuels- Petroleum and its various types, calorific values, properties.

Gaseous Fuels- Natural gas and all other types, calorific values, properties.

Nuclear Fuels- Sources of nuclear fuels, energy levels, calorific values, properties.

Thermodynamics of combustion, combustion process, proximate and ultimate analysis of fuel, mass fraction, mole fraction, theoretical, excess and deficient air.

Thermal Power Plants, Steam Generators, Steam Nozzles, Condensers, Steam Turbines, Hydro Power Plants, Nuclear Power Plants, Diesel Power Plants.

14. INDUSTRIAL ORGANIZATION AND MANAFGEMENT

Overview of Business, Management Process, Organizational Management, Human Resource Management, Financial Management, Materials Management, Project Management.