

**FURTHER DETAILS REGARDING MAIN TOPICS OF  
PROGRAMME No. 01/2021 (Item No: 09)**

**LECTURER IN TOOL AND DIE ENGINEERING  
(POLYTECHNIC COLLEGES)**

**TECHNICAL EDUCATION**

**Category Number: 005/2019**

**Part I**

**Module I (a): Technical Mathematics**

- I. Matrices – Identification of Matrices, matrix operations, adjoint and inverse.
- II. Determinants – Evaluation of second and third order, minors and cofactors, solutions of simultaneous linear equation in three unknown using Cramer's rule.
- III. Binomial Series – Expansions using Binomial theorem.
- IV. Trigonometric functions – Signs of functions in each quadrant. Trigonometric values of angles, properties of trigonometric functions, applications of the identities  $\sin(A \pm B)$ ,  $\cos(A \pm B)$  and  $\tan(A \pm B)$ .
- V. Coordinate geometry – Equations to a straight line – slope-intercept form, intercept form, Angle between two lines, condition for two lines to be perpendicular, parallel.
- VI. Differentiation – Limits and continuity, derivatives of functions, equation to tangents and normals. Maxima and minima of functions of one variable.
- VII. Integration of functions – Integration of different types of functions.
- VIII. Applications of integration – Area bounded by a curve and X or Y axis, solutions of differential equations using the method of variable separable, solutions of linear differential equations of first order.

**Module I (b): Basic Civil Engineering**

**Materials:** Brick – varieties and strength, characteristics of good brick. Cement – varieties and grade of cement and its uses. Steel – types of steel for reinforcement bars, steel structural sections. Aggregates – types & requirements of good aggregates. Concrete – grades of concrete as per IS code, water cement ratio. Workability, mixing, batching, compaction and curing.

**Construction:** Parts of building – foundation – types of foundations – spread footing, isolated footing, combined footing, Raft, pile and well foundations. Masonry – types rubble masonry, brick masonry, English bond and Flemish bond. (One brick wall).

**Surveying:** Chain surveying – principles, instruments, ranging, and chaining survey lines, field work and field book, selection of survey stations, units of land area.

**Levelling:** Levelling instruments, different types, bench mark, reduced level of points, booking of field notes, reduction of levels by height of collimation method (simple problem). Modern survey – instruments – Total station, Electronics theodolite, Distomat.

### **Module I (c): Basic Mechanical Engineering**

**The importance of IC Engines:** Definition, classification – two stroke engines, four stroke engines, working of two stroke engines and four stroke engines with the help of line sketches, comparison between two stroke and four stroke engines, comparison between petrol and diesel engines, function of fly wheel, clutch, gearbox, propeller shaft and differential in power transmission, explain with sketch the working of differential, briefly explain power transmission of 4 wheel vehicle with line diagram.

**The importance of Power Plants:** Introduction, classification of power plants – working of hydroelectric power plant with schematic sketches – working of thermal (Steam and Diesel) power plant with schematic sketches – working of nuclear power plant with schematic sketches.

### **Module I (d): Basic Electrical Engineering**

Review with discussion of electric current, potential difference, power, EMF, resistance and its laws, Ohms law and series parallel circuit, electromagnetism, generation of AC and DC supply.

**Idea of Basic electrical circuit:** Electrical supply and load and its functioning, division of voltage and current in a parallel and series circuit – simple problems, units of power and energy, solution of DC circuit with calculation of energy consumption in an installation.

**Circuit parameters:** Resistance, Capacitance and inductance. AC circuit with R, L, C. Simple solution of typical AC circuit with resistance, impedance, power and power factor.

**Electrical circuit of an installation:** Earthing, lightning protection.

### **Module I (e): Essentials of Electronics Engineering**

Active and passive devices – review only. LED – working, applications, comparison of LED lighting and CFL lighting. Full wave rectifier – diagram and explanation, 5 V power supply – with bridge rectifier and 7805. SMPS – block diagram and advantages. Integrated circuits. SMDs – advantages. Static electricity – precautions in handling electronic circuits.

**Switches:** ON / OFF, push to ON, push to OFF, push to ON / OFF, SPST, SPDT, DPDT. Working and application of limit switches, proximity switches, relays.

**Microcontrollers:** Simple block diagram of 8 bit microcontrollers – application.

**Mobile technology:** CDMA and GSM. Compare – 2G and 3G technologies.

**Inverter & UPS:** Block diagram. Compare – inverter and UPS. Online and off line UPS – differentiate. Battery selection for UPS and inverter.

**E-waste:** Health hazards of e-waste.

## **Part II**

### **Module I : Press Tool Technology and Tool Design**

**Press Tool Operations:** Piercing, Blanking, Lancing, extrusion, embossing, coining, bending, drawing, swaging, shaving, deep drawing etc.

Press Tools – Guide Plate Tool, Progressive Tool, Compound tool and Combination Tool  
Strip layout - % utilization.

Punches – Cutting and non cutting punches, hybrid punches – Load on punches – size determination – clearance, punch, die size, die block – solid, split.

Strippers – types, box, fixed, travellers, stripping force for blanking and piercing – fool proofing – pilots – purpose – direct and indirect pilots – size – methods of piloting.

Side Cutters – Functions, advantages.

Ejectors and Shedders – Functions and Types.

Knockouts – Functions.

Fasteners and dowel – Screws, function, types – socket head, counter sunk, cheese head, Rivets, Cotter pin. Positioning of screws.

Die sets – Types, precision and commercial / standard and non-standard, top plate, bottom plate, guide pillar material, Shut height.

Press – parts, capacity, power – mechanical, hydraulic, pneumatic, press selection.

Blank development for cylindrical shell – Algebraic method, graphical method, Layout method, CG method.

Fine Blanking – Calculation of Punch and die, materials suitable for fine blanking – work hardening – steel, copper and copper alloys.

### **Module II : Moulds and Dies Technology, Material Technology**

**Moulds and Dies Technology:** Plastics in the mould Industry, properties, applications processing Techniques – Injection moulding, principle, applications, Injection Moulding machines – Shot weight calculations, Plasticizing capacity, Clamping force – Number of cavity calculation – Testing of plastics – visual Test, Smoke Test, Carbon Black Test – Terminology, mould materials, feed system – Runner, types of runner, runner dia calculation, gate – Types of Gates, Ejection Techniques, Ejection force calculation. Venting, shrinkage, parting surface. Factors governing shrinkage, cooling – mould cooling calculation. Side core and side cavity – two, three plate moulds, runner less moulds, multi daylight moulds – mould maintenance – compression moulding – applications, basic types – Flash, positive, landed positive, semi positive.

Transfer moulds – application – advantages and limitations. Types – pot and plunger.

Extrusion moulds – application – blow moulding, rotational moulding, casting and moulding – advantages and applications.

Calendering – vacuum forming – preform moulding, mat and fabric moulding, premix moulding, filament winding, multicolour moulding.

Die casting – advantages of die casting – principle – limitations of pressure die casting process. Die casting Terminology – die casting alloys – Al, Zinc, Mg, Cu etc.

Composition – properties of different die cast alloys – Die casting machines Hot Chamber and cold chamber – die casting dies.

**Material Technology:** Mechanical properties of materials – Tensile strength, Compressive strength, Ductility, Malleability, Hardness, Brittleness, Impact strength, Fatigue and Creep resistance.

Structure of material – unit cell, space Lattice, BCC, FCC, HCP. Effect of grain size on mechanical properties.

Elastic deformation and plastic deformation, slip mechanism, work hardness, recrystallisation.

Ferrous metals and alloys – production and properties of pig iron, wrought iron and cast iron.

Classification of Cast Iron – white, mottled, Grey cast iron alloy cast iron

Production and properties of Steel – Bessemer, LD, open hearth, Electric Furnace.

Effect of alloying elements on properties of steel – Nickel, Chromium, Manganese, Molybdenum, Silicon, Vanadium, Tungsten.

Properties and uses of alloy steel – nickel steel, Tool and Die steel, HSS Tool steel, Stainless steel, spring steel.

Nonferrous metals and alloys in Engineering application – Properties and uses of Al, Cu, lead, Tin, Zinc, Magnesium, Nickel.

Nonferrous alloys – Cu base, Brass, Bronze, Aluminium Alloys.

Bearing or Antifriction alloys – Properties and uses of Phosphor Bronze, White metal, Babbit metal.

Destructive and Non-destructive Tests – Tensile Test, hardness Test, Impact test, Fatigue Test, Creep test.

X ray, magnetic particle, Fluorescent penetrant Test, ultrasonic test, Crystallographic test, X-ray diffraction test, electron microscopic Test.

Heat Treatment – objectives – Annealing, Normalizing, hardening and Tempering.

Surface hardening – Case hardening, nitriding, cyaniding, flame hardening, induction hardening.

Heat Treatment of Tool Steel – TTT diagram, Bainite Transformation, Martensite Transformation, Austempering, Martempering – heat Treatment Furnaces – Defects in heat treatment.

Polymers – polymerisation – Types of Thermosetting and Thermoplastics – examples – properties and uses of polythene, PVC, PTFE, Acrylics, Bakelite, Phenolics, Epoxies, Silicone, Polysters

### **Module III : Production Technology & Engineering Metrology**

Metal Joining - Permanent and semi-permanent and Temporary

Welding – Fusion and non-fusion – Arc welding – principle, tools and equipments – Electrode – Types and specifications.

Resistance Welding – spot, seam, projection, butt and percussion

Other welding methods – Thermit, TIG, MIG, Ultrasonic, Plasma Arc, Electron Beam and Laser Beam.

Gas Welding – Gases, Different Flames, Welding Techniques, Gas cutting – Welding symbols as per BIS.

Lathe – Types – specifications, accessories, functions, work holding and tool holding devices, single point cutting Tool, nomenclature, mechanism of tool cutting, chip formation, Types of chips, Tool life, equation.

Cutting speed, feed and Depth of cut.

Lathe operations – Plain turning, Taper turning, Thread cutting and other operations.

Shaper, Slotter and Planer – Parts, Functions, mechanisms, work holding devices, specifications, cutting speed, feed and depth of cut.

Drilling machines – types – specifications – speed, feed and depth of cut – parts and its functions – Drill bit, types, nomenclature.

Grinding and Grinding machine – Abrasives, Types, Types of bonds, selection of Grinding wheel, Specification of Grinding wheel, cylindrical grinder and surface grinder, special purpose grinders – specifications – working – parts – functions. Work holding devices – mounting of wheel, truing and dressing of wheel, various speed, feed and depth of cut for different materials – Balancing of wheel.

Milling Machines – Types – specifications – parts – functions – milling cutters – Types – nomenclature – Tool material – specification – cutter holding devices – work holding devices – speed, feed, Depth of cut – milling operations – conventional milling and climb milling

Plain milling – Key way milling, T-slot milling. Indexing Head, Calculation – direct indexing, simple and differential indexing.

Cutting fluid – functions – properties – classification – effect on tool life - selection – method of application.

JIG Boring Machine – Types – open front, cross rail, Jig grinding, internal - proper selection of Jig grinding wheel – Method of holding work.

Surface finishing and Coating – Lapping, Honing and super finishing, electroplating, Hot dipping, tin coating, metal spraying.

Broaching – Purpose – tools – parts of the tools – Broaching machine

Die sinking and engraving – Necessity and use – cutter for die sinking – Pantograph machine – applications.

NC machines – use, principles of EDM, Electro discharge grinding, ECM, AJM, LBM, wire cut EDM, Ultrasonic machining.

NC / CNC / DNC – Classification based on Control system – Point to point, straight, contour system, classification based on feedback, open loop, closed loop, elements of CNC – work holding devices.

CAD – CAM – Advantages, applications, CNC programmes G code & M code.

Robots – Classifications, features, necessity – components – various generation – power drives used – Types of grippers – manipulators – degree of freedom – end effecters – types – applications – advantages.

FMS – Basic components of FMS.

**Engineering Metrology:** Definitions – Range, sensitivity, True value, Indicated value, error, corrections, Accuracy, Precision.

Linear measurements & Angular measurements – surface plate, angle plate, ‘V’ Block, Straight edge, Combination set, universal surface Gauge, Feeler Gauge – Bevel protractor, sine bar, Clinometer.

Precision Instruments – Vernier Caliper, height gauge, depth gauge, micrometer, micrometer depth gauge, slip gauge. Measurement of tapered recess whose angle is very small

Gauges – limit gauges, Go and No go gauges, Plug gauge, Snap gauge, Ring gauge – advantages and limitations.

Dial Gauge – profile projector.

Comparator – Mechanical, electrical and electronic, optical comparator, pneumatic comparator.

Surface finish – Evaluation of surface roughness – CLA and RMS value – method of measuring surface finish – Interferometer – Michelson’s Interferometer – Tomlinson’s surface meter – working of optical flat – classification, Type A, Type B, flatness test, parallelism test.

Calibration – need – requirements – annual calibration programme – calibration of Vernier calliper, Vernier height gauge, depth gauge, dial gauge, limit gauges, slip gauges, Surface plate.

Measuring machines – Toolmaker’s microscope, Vernier optimeter, CMM, Computer aided metrology.

### **Module IV : Applied Mechanics, Strength of materials & Fluid Mechanics**

**Direct Stresses and Strains:** Types – tensile and compressive – longitudinal and lateral strain – Poisson’s ratio – behaviour of mild steel under tension – stress strain diagram – limit of proportionality – elastic limit – yield point – ultimate stress – working stress – factor of safety – comparison of stress strain diagram of a mild steel and a brittle material – Hooks law and Young’s modulus – principle of superposition – stresses in varying, composite sections, Shear stress and shear strain – modulus of rigidity – volumetric strain, bulk modulus, Thermal stress and strain, Nature and magnitude of stresses due to change in temperature – total or partial prevention of expansion and contraction – temperature stress on composite bar.

**Friction:** Type – static, dynamic, sliding, rolling, pivot, limiting friction, angle of friction, coefficient of friction, cone of friction – Laws of friction – static friction and kinetic friction – sliding body resting on a horizontal plane – force acting along the plane and at an angle.

**Centre of Gravity of Sections:** Centroids – centre of gravity – axis of symmetry and axis of reference – methods to find centre of gravity – simple geometric sections – Triangle, Circle, semi circle – Combination of symmetrical Sections T- sections, I-sections, Channel sections, Combination of unsymmetrical sections, L section, plane sections with cut out holes.

**Moment of Inertia:** Radius of gyration, methods to find moment of inertia, Moment of inertia of rectangular and circular sections – parallel axis theorem, perpendicular axis theorem, Moment of inertia of T-section, I, L and channel Sections.

**Riveted Joints:** Types – lap joint – single riveted, double riveted (Chain and zigzag) – butt joint - single cover, double cover single riveted – failure of riveted joints – design of riveted joints, failure of rivets – shearing and crushing – failure of plates – tearing across a row of rivets - tearing off plate at an edge – strength of rivet, plate and riveted joints – efficiency of a riveted joint – single cover and double cover single riveted butt joint, caulking and fullering of riveted joints.

**Welded Joints:** Types of fillet and butt weld – welding terms – Leg of the weld, size of the fillet weld, throat thickness – effective length of the weld, side fillet weld and end fillet weld, strengths of welded joints, fillet and butt, transverse, single and double rows – parallel welds, combination of transverse and parallel – butt weld.

**Thin Cylinders:** Failures of thin cylinder – stresses in thin cylindrical shell – hoop stress – longitudinal stress, pressure of thin cylinders.

**Torsion of Circular Shafts:** Assumptions for shear stresses in a circular shaft subjected to torsion, torsion equation, strength equation for a solid and hollow shaft – power equations, polar moment of inertia – strength and power of shafts.

**Springs:** Types of springs, leaf and Helical – closely coiled, open coiled, deflection, stiffness, torque and energy stored.

**Shear Force and Bending Moment:** Types of beams – cantilever, simply supported, overhanging, built in and continuous beam.

Types of loading – point load, uniformly distributed load, uniformly varying load, Shear force diagram, Bending moment diagram – combination of point load, UDL load – maximum bending moment.

Deflection of beams – simply supported beam with Point Load (central), SS with UDL on entire span, cantilever with point load at free end. Cantilever with UDL over entire span.

**Columns and Struts:** Column, strut, buckling load, equivalent length, slenderness ratio – types of columns – short, medium, long – Euler equation and its assumptions for crippling load – for different end conditions. Both end hinged, one end fixed and other end free – one end fixed and other end hinged. Both ends fixed – Rankine's formula for columns – equivalent length – Slenderness ratio equivalent length on different end conditions.

## **FLUID MECHANICS, PNEUMATICS**

**Properties of Fluid:** Specific weight – specific volume – specific gravity – viscosity – kinematics viscosity – Newton's law of viscosity – types of fluids – compressibility – surface tension – capillarity.

**Fluid Pressure and Measurements:** Pressure at a point – pressure head – Pascal's law – absolute, gauge, atmospheric and vacuum pressures – measurement of fluid pressure – Piezometer tube – simple manometer – differential manometer – inverted differential manometer – Bourdon's tube pressure gauge – total pressure – total pressure on immersed surface – horizontal – vertical – inclined.

**Kinematics and Dynamics of Fluid Flow:** Types of fluid flow – steady and unsteady – uniform and non-uniform flow – laminar and turbulent – compressible and incompressible flow – rotational and irrotational flow – one, two and three dimensional flow – rate of flow or discharge – equation of continuity of liquid flow – energy of a liquid in motion – potential energy – kinetic energy – pressure energy – total energy – total head of liquid in motion – Bernoulli's equation – assumptions – applications – venturimeter – Orifice meter – Pitot tube.

**Flow through Orifices, Notches, Pipes and Nozzles:** Orifices – types – Vena Contracta – coefficient of contraction – coefficient of velocity – coefficient of discharge – Notches – types of notches – rectangular – triangular – trapezoidal – discharge over notches – simple pipes – loss of head in pipes – major energy losses – minor energy losses – losses due to friction – Darcy's formula, loss of head in pipes – Chezy's formula, loss of head due to sudden enlargement – sudden contraction – water hammer.

**Fluid Power:** Basic law – Applications of fluid power – properties of fluid such as viscosity index, oxidation stability, demulsibility, lubricity, rust prevention, pour point, flash and fire point – neutralisation number.

**Hydraulic System:** Basis of system – oil reservoir pump unit, principle of working of positive displacement pump – classifications – gear pump, screw pump, Vane pumps, lobe pump, simple piston pumps, hydraulic actuators – classifications – rotary, semi-rotary – Linear motion type – hydraulic motors – hydraulic cylinder types – single acting, double acting.

**Hydraulic Control Elements and Components:** Control valves – functions – classifications – relief valves – poppet valves – direction control valves – types – sliding spool type – check valves – 1, 2, 3, way directional control valves, solenoid control valves –

flow control valves – types – gate, globe, butterfly valves – non return valves, application circuits and control valves – intensifier – accumulators – purpose – types – weight loaded, spring loaded, gas loaded.

**Hydraulic Circuits:** Automatic cylinder, reciprocating circuit, circuit for robotic arm.

**Hydraulic Machines:** Centrifugal and reciprocating pumps – parts working, priming, air vessel efficiency.

Turbine – Pelton, Francis turbine, parts, working efficiency

**Pneumatic System:** Comparison of pneumatic & hydraulic system – basic pneumatic system – pneumatic symbols - air filter – pressure regulator – lubricator – mufflers.

**Control Elements and Components:** Control valves 2, 3, 4 way directional control valves, solenoid valves – Cam operated flow control valves – Air cylinders – types – light, medium, heavy, tandem, duplex, double end types.

**Pneumatic Circuits:** Basic pneumatic circuits, power operated holding devices – power operated chucks, mandrel, collet and clamping circuits.

**Hydro Pneumatic System:** Comparison of hydraulic, pneumatic & hydro-pneumatic system – advantages and application of combinational system of air and oil working of air controlled hydraulic valves

## **Module V : Industrial Management and Engineering**

### **INDUSTRIAL MANAGEMENT**

**Principles of Management:** Meaning of management – Taylor's scientific management, Functions of management – Different types of ownership – organizational structure.

**Wage Payment System:** Types of Wages – Nominal, real, living, fair and minimum wages – Incentives.

**Quality Planning and its developments:** Definitions of quality – TQM concept

**Project Management Techniques:** Network analysis – terms used in CPM, PERT – CPM operations, earliest finish time (EFT), latest finish time (LFT), critical path, event, slack or float, dummy activity, construction of network diagrams – Fulkerson's rule – PERT - Comparison – Calculation of expected time – Event, activity, successor event, predecessor event, earliest expected time, latest allowable time, slack.

**Quantitative techniques in Management:** Methods – Linear programming – formulation of LPP – transportation problem – North West corner rule, Vogel's approximation method – Game theory – two-persons zero sum game – Maxi-min and mini-max principle – saddle point.

**Materials and Sales Management:** Inventory management – definition and classifications – purchase procedure – buying techniques – EOQ and ABC analysis. Stores management – store keeping functions – duties of store keeper – store layout – Centralized and decentralized store – store records – indent forms – bin card – store ledger - Sales – importance – functions of sales department – sales forecasting.



## **INDUSTRIAL ENGINEERING**

**Production Planning and Control:** Concepts of industry – Production and productivity – types of production – Job production, batch production, mass production, continuous production – Planning and control – Definitions, benefits and functions.

Pre-planning activities – Forecasting, plant location, product planning, design and development, material selection.

Process planning, determination of men, machines, material and tool requirements – Process planning – Choice of machine in process planning – Break even analysis – Process sheet – Process planning procedure – Routing – Scheduling – Dispatching – value engineering – Plant location and layout – plant layout – Plant maintenance – Types of maintenance.

**Method Study:** Work study – Advantages, applications – Method study – Therbligs and their symbols – Process chart – preparation of operation process chart, flow process chart, man-machine chart, right hand and left hand process chart, SIMO chart – Flow diagram – Principles of motion economy – Rules concerning human body, work place layout and material handling, tools and equipments – work measurement – stop watch time study – standard time calculation – Production study – work sampling.

**Inspection and Quality Control:** Quality and quality control – product control – Inspection- Types – Advantages and limitations.

**Fundamental of Statistical Concepts:** Variability in measurements – Terms - variable, attribute, frequency, frequency distribution and frequency plot – Normal distribution curve, Tally sheet, Mean, mode, median and standard deviation  
Control charts – X, R, P, 100P and C.

**Project Analysis:** Need and scope – Elements of project analysis – Production cost – Market survey – Selling price – Capital investment – Return on investment – Elements of costing – Classification of cost – Depreciation – Types.

---

**NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper**