

PART - A

1. **Engineering Mathematics:** Linear Algebra Matrices. System of Linear Equations, Eigen values and Eigen vectors; Calculus: Taylor's Series. Partial Derivatives. Total Derivatives. Definite Integrals. Differential Equations: Linear Ordinary Differential Equations, First Order Non Linear Ordinary Differential Equations, Initial and Boundary Value Problems, Laplace Transformation. Partial Differential equations: Numerical Methods: System of Linear equations. Jacobi, Gauss Siedel and Crout's methods, Runge Kutta and Newton - Raphson methods: Probability and Statistics: Gaussian and Weibul distribution and properties, Method of Least Square, Regression Analysis, and Analysis of Variance, Fourier Transforms.
2. **Engineering Materials:** Structure and properties of engineering materials. Heat treatment, composite materials and their applications
3. **Engineering Mechanics:** Free body concepts, Equations of Equilibrium. Centroids and Moment of inertia.
4. **Strength of Materials:** Stress and Strains. Elastic Constants. Principal Stresses, Maximum Shear Stress, Theories of failure, Shear Force and Bending Moment diagrams. Shear and bending stresses in Beams, Deflection of Beams, Torsion, Columns.
5. **Fluid Mechanics:** Fluid properties, fluid statics, Manometry, Buoyancy, Conservation laws, Euler's equation, Bernoulli's equation, Viscous flow of incompressible fluids, Laminar and Turbulent flows, Flow through pipes, Dimensional analysis.
6. **Thermodynamics:** Laws of thermodynamics, internal energy, enthalpy and entropy, Thermodynamic processes, Heat and work, Irreversibility and availability, perfect gas, properties of pure substances, Air standard and fuel air cycles, IC engines and Gas turbines, centrifugal and axial flow compressors.
7. **Theory of Machines:** Analysis of planar mechanisms, Dynamic analysis of Slider-Crank mechanism, Cams and followers, Kinematics of Gears, Governors and flywheels, balancing of reciprocating and rotating masses, Free and Forced vibrations of single degree freedom systems, Effect of damping, Transmissibility, Vibration Isolation, Critical speed of shafts.
8. **Design of Machine Elements:** Material and manufacturing considerations, Design of Shafts, keys, couplings, bolted, riveted and welded joints, Dynamic loads, Design of power screws, helical springs, Spur gears, clutches and brakes, Hydro-dynamic lubrication, Journal bearings and anti-friction bearings

9. **Production Engineering:** Metal casting processes, Melting and Pouring of cast iron, Ferrous and non-ferrous metals and alloys, casting defects, Inspection of castings, Hot and Cold working of metals, Metal joining processes: Soldering, brazing and welding, modern welding processes; Metal cutting tools - machine tool operations, Non-traditional machining processes.

10. **Industrial Engineering and Management:** Introduction to work study and method study. Principles of organization, types of organizations, types of ownership, functions of personnel management, functions of sales management. Materials management, inventory control, value analysis, scheduling & production control, PERT and CPM.

MODEL QUESTIONS
MECHANICAL SCIENCES
(AUTO/IPE/IEM/MNF/ME)
(Common to AUTO/IPE/IEM/MNF/ME)

SECTION – I OF PART (A)

Each question carries One marks

1. The number of atoms per unit cell and the number of slip systems, respectively, for a face-centered cubic (FCC) crystal are
(A) 3, 3 (B) 3, 12 (C) 4, 12 (D) 4, 48
2. The time series forecasting method that gives equal weightage to each of the most recent observations is
(A) Moving average method (B) Exponential smoothing with linear trend
(C) Triple Exponential smoothing (D) Kalman Filter
3. Pre-tensioning of a bolted joint is used to
(A) Strain harden the bolt head (B) decrease stiffness of the bolted joint
(C) Increase stiffness of the bolted joint (D) prevent yielding of the thread root
4. Select the correct statement for 50% reaction stage in a steam turbine.
(A) The rotor blade is symmetric.
(B) The stator blade is symmetric.
(C) The absolute inlet flow angle is equal to absolute exit flow angle.
(D) The absolute exit flow angle is equal to inlet angle of rotor blade.
5. During solidification of a pure molten metal, the grains in the casting near the mould wall are
(A) Coarse and randomly oriented (B) fine and randomly oriented
(C) Fine and ordered (D) coarse and ordered
6. Feed rate in slab milling operation is equal to
(A) Rotation per minute (rpm)
(B) Product of rpm and number of teeth in the cutter
(C) Product of rpm, feed per tooth and number of teeth in the cutter
(D) Product of rpm, feed per tooth and number of teeth in contact
7. A local tyre distributor expects to sell approximately 9600 steel belted radial tyres next year. Annual carrying cost is Rs. 16 per tyre and ordering cost is Rs. 75. The economic order quantity of the tyres is
(A) 64 (B) 212 (C) 300 (D) 1200

8. For a floating body, buoyant force acts at the
 (A) Centroid of the floating body
 (B) Center of gravity of the body
 (C) Centroid of the fluid vertically below the body
 (D) Centroid of the displaced fluid.
9. Assuming constant temperature condition and air to be an ideal gas, the variation in atmospheric pressure with height calculated from fluid statics is
 (A) Linear (B) exponential (C) quadratic (D) cubic
10. In the absorption refrigeration cycle, the compressor of vapour compression refrigeration cycle is replaced by
 (A) Liquid pump (B) Generator
 (C) Absorber and generator (D) Absorber, liquid pump and generator
11. In an isothermal process, internal energy
 (A) Increases (B) Remains constant (C) Decreases (D) None of the above
12. For incompressible fluids the density of fluid
 a) Increase b) decreases c) remains constant d) varies with temperature
13. Specific heat of fluids is
 a) Extensive property b) chemical property c) Intensive property d) none of these
14. In diesel cycle the heat supplies at
 a) Constant temperature b) Constant volume
 c) Constant Pressure d) constant entropy
15. The temperature at which, the volume of a gas becomes zero is called
 a) Absolute temperature b) absolute zero temperature
 c) absolute scale of temperature d) none of these
16. The lip angle of a single point tool is usually
 (a) 20° to 40° (b) 40° to 60° (c) 60° to 80° (d) 80° to 90°
17. In lapping operation, the amount of metal removed is
 (A) 0.005 to 0.01 mm (b) 0.01 to 0.1 mm (c) 0.05 to 0.1 mm (d) 0.5 to 1 mm
18. Six Sigma methodology defines three core steps.
 (a) Analyze, improve, control (b) analyze, design, verify
 (c) Define, measure, analyze (d) define, measure, control

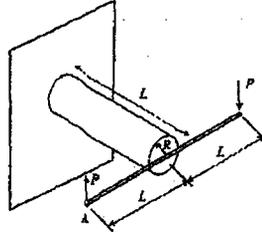
19. The pattern used for mass production is
 (a) Match plate pattern (b) split pattern
 (c) Skeleton pattern (d) single plate pattern
20. A cantilever beam having square cross-section of side a is subjected to an end load. If a is increased by 19%, the tip deflection decreases approximately by
 (A) 19% (B) 29% (C) 41% (D) 50%

SECTION – II OF PART (A)

Each question carries Two marks

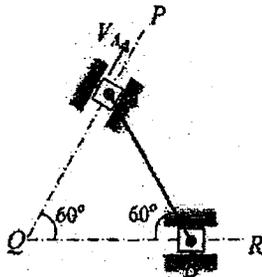
1. Calculate the weld per minute, work speed of circular electrode of 220 mm diameter for carrying out seam welding at 4 welds per cm on 1.6 mm thick mild steel tube. Welding cycle consists of 3 cycles 'on' and 2 cycles 'off' Power supply is at 50 Hz.
 (A) 3000 welds/min, 75 mm/min (B) 600 welds/min, 1500 mm/min
 (C) 500 welds/min, 1250 mm/min (D) 22 welds/min, 55 mm/min
2. A drill bit of 20 mm diameter rotating at 500 r.p.m. with a feed rate of 0.2 mm/revolution is used to drill a through hole in a mild steel plate 20 mm thickness. The depth of cut in this drilling operation is
 (A) 0.2 mm (B) 10 mm (C) 20 mm (D) 100 mm
3. A single degree of freedom spring mass system with viscous damping has a spring constant of 10 kN/m. The system is excited by a sinusoidal force of amplitude 100 N. If the damping factor (ratio) is 0.25, the amplitude of steady state oscillation at resonance is
 a)19.8:20.2 b)19.7:20.3 c)19.9:20.1 d)19.6:20.5
4. A cantilever beam having square cross-section of side a is subjected to an end load. If a is increased by 19%, the tip deflection decreases approximately by
 (a) 19% (b) 29% (c) 41% (d) 50%
5. A car is moving on a curved horizontal road of radius 100 m with a speed of 20 m/s. The rotating masses of the engine have an angular speed of 100 rad/s in clockwise direction when viewed from the front of the car. The combined moment of inertia of the rotating masses is 10 kg-m². The magnitude of the gyroscopic moment (in N-m) is
 a) 188:200 b)220:187 c)201:187 d)199:201

6. A rigid horizontal rod of length $2L$ is fixed to a circular cylinder of radius R as shown in the figure. Vertical forces of magnitude P are applied at the two ends as shown in the figure. The shear modulus for the cylinder is G and the Young's modulus is E .



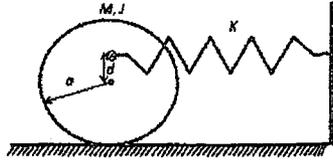
The vertical deflection at point A is

- (A) $PL^3/(\pi R^4 G)$ (B) $PL^3/(\pi R^4 E)$ (C) $2PL^3/(\pi R^4 E)$ (D) $4PL^3/(\pi R^4 G)$
7. The rod AB, of length 1 m, shown in the figure is connected to two sliders at each end through pins. The sliders can slide along QP and QR. If the velocity V_A of the slider at A is 2 m/s, the velocity of the midpoint of the rod at this instant is _____ m/s.



8. In a structural member under fatigue loading, the minimum and maximum stresses developed at the critical point are 50 MPa and 150 MPa, respectively. The endurance, yield, and the ultimate strengths of the material are 200 MPa, 300 MPa and 400 MPa, respectively. The factor of safety using modified Goodman criterion is
- (A) $\frac{3}{2}$ (B) $\frac{8}{5}$ (C) $\frac{12}{7}$ (D) 2
9. In a binary system of A and B, a liquid of 20% A (80% B) is coexisting with a solid of 70% A (30% B). For an overall composition having 40% A, the fraction of solid is
- (A) 0.40 (B) 0.50 (C) 0.60 (D) 0.75

10. A solid disc with radius ' a ' is connected to a spring at a point d above the center of the disc. The other end of the spring is fixed to the vertical wall. The disc is free to roll without slipping on the ground. The mass of the disc is M and the spring constant is K . The polar moment of inertia for the disc about its centre is $J = Ma^2/2$.



The natural frequency of this system in rad/s is given by

- (A) $\sqrt{\frac{2K(a+d)^2}{3Ma^2}}$ (B) $\sqrt{\frac{2K}{3M}}$ (C) $\sqrt{\frac{2K(a+d)^2}{Ma^2}}$ (D) $\sqrt{\frac{K(a+d)^2}{Ma^2}}$