

Technical Abilities (Mechanical): 100 MCQs

- Target Exam: RRB Junior Engineer (RRB JE)
- Study Notes Prepared for: Entri App Users

1. Thermodynamics & Heat Transfer

Q1. A process in which no heat enters or leaves the system is called an:

- A) Isothermal process
- B) Isobaric process
- C) Adiabatic process
- D) Isochoric process

Correct Answer: C) Adiabatic process

Explanation: In an adiabatic process, heat transfer $Q = 0$. The First Law of Thermodynamics reduces to $dW = -dU$.

Q2. According to Kelvin-Planck statement, it is impossible to construct a heat engine that operates in a cycle and produces:

- A) Network equal to heat supplied from a single reservoir
- B) Heat transfer from a cold body to a hot body without work input
- C) Network with 100% mechanical efficiency
- D) Zero entropy change

Correct Answer: A) Network equal to heat supplied from a single reservoir

Explanation: Kelvin-Planck statement asserts that no heat engine can convert all heat absorbed from a single thermal reservoir completely into work without rejecting heat.

Q3. The dryness fraction (x) of saturated dry steam is equal to:

- A) 0
- B) 0.5
- C) 1.0
- D) Greater than 1

Correct Answer: C) 1.0

Explanation: Dryness fraction is the ratio of mass of dry vapor to total mass of mixture ($x = m_v / (m_v + m_l)$). For dry saturated steam, $x = 1$.

Q4. Critical point of water occurs at a pressure of:

- A) 1.013 bar
- B) 100 bar
- C) 220.6 bar (or 22.1 MPa)
- D) 374 bar

Correct Answer: C) 220.6 bar (or 22.1 MPa)

Explanation: At the critical point (22.06 MPa, 374.14°C), liquid and vapor phases become indistinguishable and latent heat of vaporization becomes zero.

Q5. Fourier's Law of heat conduction states that heat flux is directly proportional to:

- A) Temperature difference
- B) Area perpendicular to heat flow
- C) Temperature gradient
- D) Thermal diffusivity

Correct Answer: C) Temperature gradient

Explanation: Fourier's law is $q = -kA \frac{dT}{dx}$, where $\frac{dT}{dx}$ is the temperature gradient in the direction of heat flow.

Q6. Stefan-Boltzmann law states that total emissive power of a black body is proportional to:

- A) T
- B) T^2
- C) T^3
- D) T^4

Correct Answer: D) T^4

Explanation: According to Stefan-Boltzmann law, $E_b = \sigma T^4$, where T is absolute temperature in Kelvin and σ is $5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$.

Q7. The ratio of kinematic viscosity to thermal diffusivity is known as:

- A) Prandtl number
- B) Nusselt number
- C) Reynolds number
- D) Grashof number

Correct Answer: A) Prandtl number

Explanation: Prandtl number ($Pr = \frac{\nu}{\alpha} = \frac{\mu C_p}{k}$) connects momentum diffusivity to thermal diffusivity.

Q8. In a counter-flow heat exchanger, logarithmic mean temperature difference (LMTD) compared to parallel flow for same temperatures is:

- A) Lower
- B) Higher
- C) Equal
- D) Zero

Correct Answer: B) Higher

Explanation: Counter-flow heat exchangers yield higher LMTD, maximizing thermal effectiveness and requiring less surface area than parallel-flow heat exchangers.

Q9. Entropy remains constant during a process that is:

- A) Reversible isothermal
- B) Reversible adiabatic (Isentropic)
- C) Irreversible adiabatic
- D) Free expansion

Correct Answer: B) Reversible adiabatic (Isentropic)

Explanation: Entropy change $dS = \frac{dQ_{rev}}{T}$. For a reversible (dQ_{rev}) adiabatic ($dQ = 0$) process, $dS = 0$.

Q10. Triple point of a pure substance is a point where:

- A) Liquid and vapor exist in equilibrium
- B) Solid, liquid, and gas phases coexist in equilibrium
- C) Latent heat of vaporization is maximum
- D) Specific volume of liquid equals specific volume of gas

Correct Answer: B) Solid, liquid, and gas phases coexist in equilibrium

Explanation: For water, the triple point occurs at 0.01°C (273.16K) and 0.61165kPa .

2. IC Engines & Power Plant

Q11. The air standard efficiency of an Otto cycle depends on its:

- A) Pressure ratio
- B) Cut-off ratio
- C) Compression ratio
- D) Expansion ratio

Correct Answer: C) Compression ratio

Explanation: Otto cycle efficiency is $\eta = 1 - \frac{1}{r^{\gamma-1}}$, governed purely by compression ratio r and adiabatic index γ .

Q12. Diesel cycle consists of the following processes:

- A) Two reversible isentropics and two reversible isochorics
- B) Two reversible isentropics, one constant pressure, and one constant volume
- C) Two constant pressure and two constant volume
- D) Two reversible isothermals and two isentropics

Correct Answer: B) Two reversible isentropics, one constant pressure, and one constant volume

Explanation: Heat addition in a Diesel cycle occurs at constant pressure, and heat rejection occurs at constant volume.

Q13. Knocking in a Petrol (SI) engine can be reduced by:

- A) Increasing compression ratio
- B) Retarding spark timing
- C) Supercharging
- D) Increasing inlet air temperature

Correct Answer: B) Retarding spark timing

Explanation: Retarding the spark prevents peak cylinder pressures from reaching extreme levels prematurely, suppressing auto-ignition tendency.

Q14. The anti-knock property of CI engine fuels (Diesel) is evaluated using:

- A) Octane Number
- B) Cetane Number
- C) Calorific Value
- D) Viscosity Index

Correct Answer: B) Cetane Number

Explanation: Cetane rating measures ignition delay in Diesel fuels; higher cetane numbers correspond to shorter ignition delays.

Q15. Scavenging in an IC engine refers to:

- A) Removing exhaust gases from the cylinder using fresh charge
- B) Injecting fuel into combustion chamber
- C) Supplying compressed air to intake manifold
- D) Lubricating piston rings

Correct Answer: A) Removing exhaust gases from the cylinder using fresh charge

Explanation: Scavenging pushes residual burnt gases out of 2-stroke engine cylinders during intake/exhaust port overlapping.

Q16. The essential component of a Rankine cycle power plant that converts high-pressure steam energy into mechanical work is the:

- A) Boiler
- B) Condenser
- C) Steam Turbine
- D) Economizer

Correct Answer: C) Steam Turbine

Explanation: Steam turbines expand high-pressure, high-temperature steam generates shaft work drives electrical generators.

Q17. In a steam power plant, the function of an Economizer is to preheat:

- A) Air entering furnace using flue gases
- B) Feedwater entering boiler using flue gases
- C) Steam entering turbine
- D) Fuel oil before combustion

Correct Answer: B) Feedwater entering boiler using flue gases

Explanation: Economizers extract waste heat from chimney flue gases to raise incoming boiler feedwater temperatures, increasing thermal efficiency.

Q18. Supercharging an IC engine leads to an increase in:

- A) Indicated power output per unit displacement
- B) Engine weight per kW
- C) Specific fuel consumption at full load
- D) Exhaust smoke density

Correct Answer: A) Indicated power output per unit displacement

Explanation: Superchargers force denser air into combustion chambers, allowing more fuel to burn cleanly per stroke.

Q19. Pelton wheel is classified as a:

- A) Low head reaction turbine
- B) High head impulse turbine
- C) Medium head mixed flow turbine
- D) Axial flow reaction turbine

Correct Answer: B) High head impulse turbine

Explanation: Pelton turbines convert hydraulic head into velocity jets striking double-hemispherical buckets under atmospheric pressure.

Q20. In a gas turbine operating on an ideal Brayton cycle, heat addition occurs at constant:

- A) Volume
- B) Temperature
- C) Pressure
- D) Entropy

Correct Answer: C) Pressure

Explanation: The Brayton cycle comprises two reversible isentropics (compression/expansion) and two constant-pressure processes (heat addition/rejection).

3. Fluid Mechanics & Hydraulic Machinery

Q21. The property of a fluid by virtue of which it offers resistance to shear stress is called:

- A) Surface tension
- B) Viscosity
- C) Capillarity
- D) Compressibility

Correct Answer: B) Viscosity

Explanation: Shear stress $\tau = \mu \frac{du}{dy}$, where dynamic viscosity μ acts as proportional resistance constant.

Q22. Fluid in which shear stress is directly proportional to velocity gradient is known as a:

- A) Ideal fluid
- B) Newtonian fluid
- C) Non-Newtonian fluid
- D) Thixotropic fluid

Correct Answer: B) Newtonian fluid

Explanation: Water, air, and light oils obey Newton's law of viscosity linearly and are termed Newtonian fluids.

Q23. The unit of dynamic viscosity in CGS units is Poise. One Poise is equal to:

- A) $10Pa \cdots$
- B) $0.1Pa \cdots$ (or $0.1N \cdots/m^2$)
- C) $1Pa \cdots$
- D) $0.01Pa \cdots$

Correct Answer: B) $0.1Pa \cdots$ (or $0.1N \cdots/m^2$)

Explanation: $1Poise = 1dyne \cdots/cm^2 = 0.1N \cdots/m^2 = 0.1Pa \cdots$.

Q24. The gauge pressure at a depth of 10 m in water (take $g = 9.81m/s^2$) is:

- A) $9.81kPa$
- B) $98.1kPa$
- C) $981kPa$
- D) $0.981kPa$

Correct Answer: B) $98.1kPa$

Explanation: $P = \rho gh = 1000 \times 9.81 \times 10 = 98100Pa = 98.1kPa$.

Q25. Continuity equation for an incompressible fluid flow in 1D is based on conservation of:

- A) Energy
- B) Momentum
- C) Mass
- D) Force

Correct Answer: C) Mass

Explanation: Mass balance for steady 1D incompressible fluid stream yields $A_1V_1 = A_2V_2 = \text{Constant}$.

Q26. Pitot tube is used to measure:

- A) Discharge in a pipe
- B) Local flow velocity at a point
- C) Viscosity of a fluid

- D) Static pressure head

Correct Answer: B) Local flow velocity at a point

Explanation: Pitot tube converts local kinetic energy of flow into stagnation pressure head, yielding velocity $V = \sqrt{2g\Delta h}$.

Q27. Minor head loss in pipe flow due to sudden enlargement is given by:

- A) $\frac{(V_1 - V_2)^2}{2g}$
- B) $\frac{V_1^2 - V_2^2}{2g}$
- C) $0.5 \frac{V_2^2}{2g}$
- D) $\frac{V_1 V_2}{2g}$

Correct Answer: A) $\frac{(V_1 - V_2)^2}{2g}$

Explanation: Sudden expansion creates turbulent eddies causing a head loss equal to $\frac{(V_1 - V_2)^2}{2g}$.

Q28. Kaplan turbine is classified as a:

- A) High head axial flow impulse turbine
- B) Low head axial flow reaction turbine
- C) Medium head radial flow turbine
- D) High head impulse bucket turbine

Correct Answer: B) Low head axial flow reaction turbine

Explanation: Kaplan turbine uses adjustable runner blades, ideal for low heads (< 30m) and large volumetric flow rates.

Q29. Cavitation in hydraulic turbines or centrifugal pumps takes place when pressure drops below:

- A) Atmospheric pressure
- B) Saturated vapor pressure of liquid
- C) Gauge pressure
- D) Absolute zero pressure

Correct Answer: B) Saturated vapor pressure of liquid

Explanation: When local liquid pressure falls below vapor pressure, bubbles form and collapse violently against metal surfaces, causing pitting.

Q30. Priming is required in centrifugal pumps to:

- A) Fill pump casing and suction pipe with liquid to eliminate air pockets
- B) Lubricate mechanical shaft seals
- C) Cool down impeller bearings

- D) Reduce motor starting current

Correct Answer: A) Fill pump casing and suction pipe with liquid to eliminate air pockets

Explanation: Air trapped inside casings yields negligible head development because air density is roughly 1/800th that of water.

4. Strength of Materials (SOM)

Q31. Tensile stress is defined as force per unit:

- A) Deformed area
- B) Original cross-sectional area
- C) Length of member
- D) Volume of member

Correct Answer: B) Original cross-sectional area

Explanation: Engineering stress $\sigma = F/A_0$, where A_0 is the un-deformed cross-sectional area before loading.

Q32. Modulus of rigidity (G) is defined as the ratio of:

- A) Direct stress to direct strain
- B) Shear stress to shear strain
- C) Volumetric stress to volumetric strain
- D) Lateral strain to linear strain

Correct Answer: B) Shear stress to shear strain

Explanation: Shear modulus $G = \tau/\gamma$ governs resistance against angular deformation caused by shearing action.

Q33. Point of contraflexure is a point in a bent beam where:

- A) Bending moment is maximum
- B) Shear force is zero
- C) Bending moment changes sign (becomes zero)
- D) Deflection is maximum

Correct Answer: C) Bending moment changes sign (becomes zero)

Explanation: At points of contraflexure, beam curvature changes direction, causing bending moment to pass through zero.

Q34. Euler's crippling load (P_{cr}) for a column hinged (pinned) at both ends is:

- A) $\frac{\pi^2 EI}{L^2}$
- B) $\frac{4\pi^2 EI}{L^2}$
- C) $\frac{2\pi^2 EI}{L^2}$

- D) $\frac{\pi^2 EI}{4L^2}$

Correct Answer: A) $\frac{\pi^2 EI}{L^2}$

Explanation: Effective length $L_e = L$ for double-pinned columns; Euler buckling formula gives $P_{cr} = \frac{\pi^2 EI}{L_e^2} = \frac{\pi^2 EI}{L^2}$.

Q35. The maximum shear stress (τ_{max}) induced in a solid circular shaft subjected to torque T is:

- A) $\frac{16T}{\pi d^3}$
- B) $\frac{32T}{\pi d^3}$
- C) $\frac{64T}{\pi d^4}$
- D) $\frac{8T}{\pi d^3}$

Correct Answer: A) $\frac{16T}{\pi d^3}$

Explanation: From elastic torsion equation $\frac{T}{J} = \frac{\tau}{R}$, substituting $J = \frac{\pi d^4}{32}$ and $R = d/2$ gives $\tau_{max} = \frac{16T}{\pi d^3}$.

Q36. Thin cylindrical shell of internal diameter d and thickness t subjected to internal pressure p develops circumferential (hoop) stress equal to:

- A) $\frac{pd}{4t}$
- B) $\frac{pd}{2t}$
- C) $\frac{pd}{8t}$
- D) $\frac{pd}{t}$

Correct Answer: B) $\frac{pd}{2t}$

Explanation: Hoop stress $\sigma_h = \frac{pd}{2t}$, whereas longitudinal stress $\sigma_l = \frac{pd}{4t}$.

Q37. Strain energy stored in a solid member subjected to axial force P over length L is:

- A) $\frac{P^2 L}{2AE}$
- B) $\frac{PL}{AE}$
- C) $\frac{P^2 L}{AE}$
- D) $\frac{PL^2}{2AE}$

Correct Answer: A) $\frac{P^2 L}{2AE}$

Explanation: Work done by gradually applied axial load $U = \frac{1}{2} P \delta = \frac{1}{2} P \left(\frac{PL}{AE} \right) = \frac{P^2 L}{2AE}$.

Q38. Slenderness ratio of a compression member is the ratio of its effective length to its:

- A) Total area
- B) Least radius of gyration (k)
- C) Outer diameter
- D) Moment of inertia

Correct Answer: B) Least radius of gyration (k)

Explanation: Slenderness ratio $\lambda = L_e/k_{\min}$, where $k_{\min} = \sqrt{I_{\min}/A}$.

Q39. Section modulus (Z) of a circular section of diameter d is:

- A) $\frac{\pi d^3}{32}$
- B) $\frac{\pi d^3}{64}$
- C) $\frac{\pi d^4}{32}$
- D) $\frac{\pi d^2}{6}$

Correct Answer: A) $\frac{\pi d^3}{32}$

Explanation: Section modulus $Z = I/y_{\max} = \left(\frac{\pi d^4}{64}\right) / \left(\frac{d}{2}\right) = \frac{\pi d^3}{32}$.

Q40. The maximum bending moment for a cantilever beam of length L carrying a uniformly distributed load (UDL) of w per unit length is:

- A) wL
- B) $\frac{wL^2}{2}$
- C) $\frac{wL^2}{8}$
- D) $\frac{wL^2}{12}$

Correct Answer: B) $\frac{wL^2}{2}$

Explanation: Cantilever root fixed end experiences maximum moment $M_{\max} = (w \cdot L) \times (L/2) = \frac{wL^2}{2}$.

5. Theory of Machines & Machine Design

Q41. The number of degrees of freedom (F) for a planar mechanism with N links and P_1 lower pairs (1 DOF) and P_2 higher pairs (2 DOF) is given by Kutzbach criterion:

- A) $3(N - 1) - 2P_1 - P_2$
- B) $2(N - 1) - 3P_1 - P_2$
- C) $3(N + 1) - 2P_1 - P_2$

- D) $N - 2P_1 - 1$

Correct Answer: A) $3(N - 1) - 2P_1 - P_2$

Explanation: Kutzbach mobility equation determines spatial/planar freedom counts based on link constraints.

Q42. A higher pair link mechanism involves contact between elements over a:

- A) Surface or area
- B) Line or point
- C) Threaded engagement
- D) Spherical ball joint

Correct Answer: B) Line or point

Explanation: Lower pairs involve surface contact (e.g., revolute joints); higher pairs involve line/point contact (e.g., cam-follower, gear mesh).

Q43. In a four-bar chain mechanism, Grashof's law states that continuous relative motion occurs if the sum of shortest (s) and longest (l) links is:

- A) Greater than the sum of other two links ($p + q$)
- B) Less than or equal to the sum of other two links ($s + l \leq p + q$)
- C) Equal to product of remaining links
- D) Zero

Correct Answer: B) Less than or equal to the sum of other two links ($s + l \leq p + q$)

Explanation: $s + l \leq p + q$ ensures at least one link can rotate fully through 360° relative to fixed frame.

Q44. The main function of a flywheel in an engine is to:

- A) Control mean speed over long variations in load
- B) Minimize speed fluctuations within each thermodynamic cycle
- C) Control fuel injection timing
- D) Balance primary reciprocating masses

Correct Answer: B) Minimize speed fluctuations within each thermodynamic cycle

Explanation: Flywheels store energy during expansion strokes and release energy during idle strokes, smoothing cyclic output speed.

Q45. Governor sensitivity is defined as the ratio of:

- A) Mean speed to range of speed
- B) Range of speed to mean speed
- C) Sleeve lift to maximum load
- D) Maximum speed to minimum speed

Correct Answer: B) Range of speed to mean speed

Explanation: Sensitivity = $\frac{N_2 - N_1}{N_{mean}}$. Sensitive governors react with appreciable sleeve movement for small speed shifts.

Q46. Isochronous governor is one whose equilibrium speed is:

- A) Constant for all positions of sleeve movement within working range
- B) Directly proportional to height squared
- C) Zero under zero load
- D) Fluctuating widely

Correct Answer: A) Constant for all positions of sleeve movement within working range

Explanation: An isochronous governor maintains identical equilibrium operating speed regardless of sleeve lift height.

Q47. The profile of gear teeth commonly used in industrial power transmission to maintain constant velocity ratio is:

- A) Cycloidal
- B) Involute
- C) Epicycloidal
- D) Parabolic

Correct Answer: B) Involute

Explanation: Involute tooth profiles satisfy the fundamental law of gearing and maintain constant velocity ratios even if center distances vary slightly.

Q48. Interference in involute spur gears can be eliminated by:

- A) Decreasing center distance
- B) Increasing pressure angle or using stub teeth
- C) Decreasing number of teeth on gear wheel
- D) Reducing module size

Correct Answer: B) Increasing pressure angle or using stub teeth

Explanation: Interference occurs when teeth tips undercut mating flanks; larger pressure angles or reduced addendums eliminate non-involute contact.

Q49. A key that transmits torque through friction between shaft flat surface and key is a:

- A) Sunk key
- B) Flat saddle key
- C) Feather key
- D) Woodruff key

Correct Answer: B) Flat saddle key

Explanation: Saddle keys fit into keyways cut on the hub only, relying on clamping friction against shaft flats without shaft keyway cuts.

Q50. Under Soderberg failure criterion for fatigue design, endurance limit is combined with material:

- A) Ultimate tensile strength
- B) Yield strength
- C) Shear modulus
- D) Plastic limit

Correct Answer: B) Yield strength

Explanation: Soderberg line connects endurance limit (σ_e) on alternating stress axis with yield strength (σ_y) on mean stress axis.

6. Engineering Mechanics

Q51. Lami's theorem is applicable for three concurrent forces that are in equilibrium and are:

- A) Coplanar
- B) Non-coplanar
- C) Parallel
- D) Collinear

Correct Answer: A) Coplanar

Explanation: Lami's theorem states that $\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$ for 3 coplanar, concurrent forces in equilibrium.

Q52. The coefficient of friction (μ) depends on:

- A) Area of contact surfaces
- B) Nature and rough state of contact surfaces
- C) Sliding speed exclusively
- D) Shape of sliding block

Correct Answer: B) Nature and rough state of contact surfaces

Explanation: Friction force $F = \mu N$, where μ depends on surface texture and material composition, independent of contact surface area.

Q53. The center of gravity of a solid right circular cone of height h from its base along its axis is located at:

- A) $h/2$
- B) $h/3$
- C) $h/4$
- D) $2h/3$

Correct Answer: C) $h/4$

Explanation: Centroid of a solid cone lies at distance $\frac{h}{4}$ from base; for a hollow cone shell it lies at $\frac{h}{3}$.

Q54. Parallel axis theorem for moment of inertia states:

- A) $I_{xx} = I_G + Ah^2$
- B) $I_{xx} = I_G - Ah^2$
- C) $I_{xx} = I_G / Ah^2$
- D) $I_{xx} = I_y + I_z$

Correct Answer: A) $I_{xx} = I_G + Ah^2$

Explanation: Moment of inertia about any parallel axis equals centroidal moment of inertia plus product of area and square of distance (Ah^2).

Q55. In a simple machine, mechanical advantage (MA) is defined as the ratio of:

- A) Distance moved by effort to distance moved by load
- B) Load lifted (W) to Effort applied (P)
- C) Work output to Work input
- D) Ideal effort to Actual effort

Correct Answer: B) Load lifted (W) to Effort applied (P)

Explanation: Mechanical Advantage $MA = W/P$; Velocity Ratio $VR = d_P/d_W$. Efficiency $\eta = MA/VR$.

Q56. A truss framework is called mathematically "perfect" if its number of members (m) and joints (j) satisfy:

- A) $m = 2j - 3$
- B) $m = 3j - 2$
- C) $m = 2j + 3$
- D) $m = j - 3$

Correct Answer: A) $m = 2j - 3$

Explanation: For 2D pin-jointed trusses, $m = 2j - 3$ provides static determinacy without redundancy or instability.

Q57. The rate of change of linear momentum of a body is directly proportional to applied force by Newton's:

- A) First Law
- B) Second Law
- C) Third Law
- D) Law of Gravitation

Correct Answer: B) Second Law

Explanation: Newton's 2nd Law states $F = \frac{d(mv)}{dt} = ma$.

Q58. A projectile reaches maximum horizontal range on flat ground when angle of projection (θ) is:

- A) 30°

- B) 45°
- C) 60°
- D) 90°

Correct Answer: B) 45°

Explanation: Range $R = \frac{u^2 \sin(2\theta)}{g}$. Max range occurs when $\sin(2\theta) = 1$, giving $\theta = 45^\circ$.

Q59. Period of simple harmonic motion (SHM) executed by a mass m suspended on a spring of stiffness k is:

- A) $2\pi \sqrt{\frac{k}{m}}$
- B) $2\pi \sqrt{\frac{m}{k}}$
- C) $\frac{1}{2\pi} \sqrt{\frac{k}{m}}$
- D) $2\pi \frac{m}{k}$

Correct Answer: B) $2\pi \sqrt{\frac{m}{k}}$

Explanation: Natural angular frequency $\omega_n = \sqrt{k/m}$; time period $T = \frac{2\pi}{\omega_n} = 2\pi \sqrt{\frac{m}{k}}$.

Q60. Coefficient of restitution (e) for a perfectly elastic collision between two impacting bodies is:

- A) 0
- B) 0.5
- C) 1.0
- D) Infinity

Correct Answer: C) 1.0

Explanation: $e = \frac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}}$. For perfectly elastic impacts $e = 1$; for perfectly plastic impacts $e = 0$.

7. Production & Manufacturing Engineering

Q61. Taylor's tool life equation relating cutting speed (V) and tool life (T) is expressed as:

- A) $VT^n = C$
- B) $V^n T = C$
- C) $V/T^n = C$
- D) $VT = C^n$

Correct Answer: A) $VT^n = C$

Explanation: Taylor's law links velocity and tool durability, where exponent n depends on tool material and C is machining constant.

Q62. Continuous chips with built-up edge (BUE) are typically formed during machining of:

- A) Ductile materials at high cutting speeds with effective coolant
- B) Ductile materials at low-to-medium cutting speeds with high friction
- C) Brittle materials like cast iron at high speeds
- D) Hardened tool steel at slow feeds

Correct Answer: B) Ductile materials at low-to-medium cutting speeds with high friction

Explanation: High pressure and friction cause localized micro-welding of chip particles onto tool faces at lower speeds.

Q63. In orthogonal metal cutting, shear angle (ϕ) increases when chip velocity and rake angle (α):

- A) Decrease
- B) Increase
- C) Remain zero
- D) Become negative

Correct Answer: B) Increase

Explanation: Higher positive rake angle reduces cutting force requirements, widening shear plane angle and thinning chips.

Q64. Resistance spot welding is a process falling under:

- A) Fusion arc welding
- B) Pressure welding (Solid-state/Resistance family)
- C) Thermit welding
- D) Gas fusion welding

Correct Answer: B) Pressure welding (Solid-state/Resistance family)

Explanation: Electric current passing through lap joint interface generates resistance heat (I^2Rt) combined with mechanical electrode pressure.

Q65. The flame used in oxy-acetylene welding of steel sections is usually adjusted to be:

- A) Carburizing flame
- B) Neutral flame
- C) Oxidizing flame
- D) Reducing gas flame

Correct Answer: B) Neutral flame

Explanation: Equal volume proportions of oxygen and acetylene (1: 1) generate a neutral flame ($\text{C}_2\text{H}_2 + \text{O}_2 \rightarrow 2\text{CO} + \text{H}_2\text{O}$) that neither oxidizes nor carburizes steel.

Q66. The primary purpose of providing a riser in sand casting molds is to:

- A) Trap sand impurities

- B) Supply liquid metal to compensate for volumetric solidification shrinkage
- C) Vent trapped combustion gases
- D) Speed up cooling rate

Correct Answer: B) Supply liquid metal to compensate for volumetric solidification shrinkage

Explanation: Risers act as liquid reservoirs, solidifying last to feed shrinking casting cavities during phase change.

Q67. Chills are used in sand molds to:

- A) Produce directional solidification in critical regions
- B) Soften core surfaces
- C) Increase core permeability
- D) Prevent mold wall erosion

Correct Answer: A) Produce directional solidification in critical regions

Explanation: High thermal conductivity metallic inserts (chills) accelerate cooling locally to avoid shrinkage voids.

Q68. Draft allowance on casting patterns is provided to:

- A) Account for liquid metal contraction
- B) Enable easy pattern removal from sand molds without damaging cavity walls
- C) Compensate for machining operations
- D) Prevent distortion during shakeout

Correct Answer: B) Enable easy pattern removal from sand molds without damaging cavity walls

Explanation: Tapering vertical pattern surfaces ($1^\circ - 2^\circ$) minimizes friction during pattern withdrawal.

Q69. In a rolling process, neutral point (no-slip point) refers to the position along roll arc where:

- A) Strip velocity equals roll surface velocity
- B) Strip velocity is maximum
- C) Roll pressure drops to zero
- D) Metal deformation ceases

Correct Answer: A) Strip velocity equals roll surface velocity

Explanation: At the neutral point, roll and strip surface speeds match. Strip speed is lower at entry and higher at exit.

Q70. Deep drawing operation on sheet metal converts flat blanks into cylindrical cups through:

- A) Shearing action
- B) Tensile stress in wall and circumferential compressive stress in flange
- C) Pure compression bending

- D) High velocity impact forces

Correct Answer: B) Tensile stress in wall and circumferential compressive stress in flange

Explanation: Punch forces pull metal into die cavities, generating wall tension while drawing flange areas inward under hoop compression.

Q71. Punching an 18 mm hole in a 2 mm sheet metal plate requires blanking/punching die clearance provided on the:

- A) Punch diameter
- B) Die opening diameter
- C) Both equally
- D) Neither

Correct Answer: A) Punch diameter

Explanation: For hole punching operations, die size determines hole diameter; clearance is deducted from punch size.

Q72. Electrochemical Machining (ECM) operates on the principle of:

- A) Thermal erosion via electrical sparks
- B) Faraday's laws of electrolysis
- C) High velocity abrasive particle slurry erosion
- D) Chemical etching without current

Correct Answer: B) Faraday's laws of electrolysis

Explanation: ECM removes metal atom-by-atom via anodic dissolution without tool wear or direct thermal stresses.

Q73. Electric Discharge Machining (EDM) requires tool and workpiece materials to be:

- A) Electrically non-conductive
- B) Electrically conductive
- C) Extremely soft metals
- D) Non-magnetic polymers

Correct Answer: B) Electrically conductive

Explanation: Spark erosion in EDM relies on controlled dielectric breakdown between conductive electrodes.

Q74. In CNC machine tools, linear motion feedback control is measured using:

- A) Tachometer
- B) Optical linear encoder / resolver
- C) Piezoelectric transducer
- D) Pitot static transducer

Correct Answer: B) Optical linear encoder / resolver

Explanation: Encoders convert slide movements into digital pulse trains to confirm closed-loop axis positioning.

Q75. The process of finishing cylindrical hole bores to extremely high dimensional accuracy and fine surface finish using abrasive stones is:

- A) Broaching
- B) Honing
- C) Lapping
- D) Reaming

Correct Answer: B) Honing

Explanation: Honing uses bonded abrasive sticks rotating and reciprocating inside cylindrical bores to create cross-hatched surfaces.

Q76. A lathe bed is manufactured primarily using:

- A) Mild steel
- B) Gray cast iron
- C) Aluminum alloy
- D) Forged structural steel

Correct Answer: B) Gray cast iron

Explanation: Gray cast iron exhibits high compressive strength, excellent damping capacity against vibrations, and low friction due to flake graphite.

Q77. In grinding wheels, structure refers to the:

- A) Type of abrasive grain
- B) Relative spacing of abrasive grains and pores
- C) Type of bonding matrix
- D) Hardness grade

Correct Answer: B) Relative spacing of abrasive grains and pores

Explanation: Structure ranges from dense (close grain spacing) to open (wide spacing for chip clearance).

Q78. In a sine bar used for angle measurements, the angle is determined from:

- A) Length of sine bar and height of gauge block stack ($\sin \theta = h/L$)
- B) Diameter of rollers
- C) Width of base plate
- D) Vernier scale divisions directly

Correct Answer: A) Length of sine bar and height of gauge block stack ($\sin \theta = h/L$)

Explanation: Precision rollers resting on slip gauges set up a right triangle where $\sin \theta = \frac{\text{Height of slip gauges}}{\text{Center distance of rollers}}$.

Q79. Allowance in metrology limits and fits is defined as the:

- A) Total tolerance on hole

- B) Intended difference between maximum material limits of mating parts
- C) Difference between upper limit and lower limit of a single component
- D) Gauge clearance

Correct Answer: B) Intended difference between maximum material limits of mating parts

Explanation: Allowance defines maximum tightness (minimum clearance) or maximum loose fit specified between shaft and hole.

Q80. Up-milling (Conventional milling) differs from down-milling because cutter tooth motion at entry is:

- A) Opposite to workpiece feed direction
- B) Parallel in same direction as feed
- C) Perpendicular downwards
- D) Stationary

Correct Answer: A) Opposite to workpiece feed direction

Explanation: In up-milling, teeth move upward against feed, starting with zero chip thickness and increasing toward exit.

8. Material Science & Metallurgy

Q81. The crystal structure of pure alpha iron (α -Fe) at room temperature is:

- A) Body-Centered Cubic (BCC)
- B) Face-Centered Cubic (FCC)
- C) Hexagonal Close-Packed (HCP)
- D) Simple Cubic

Correct Answer: A) Body-Centered Cubic (BCC)

Explanation: Ferrite (α -iron) exists as BCC up to 912°C , transforming into FCC gamma iron (γ -austenite) above this temperature.

Q82. Austenite phase in Iron-Iron Carbide ($Fe - Fe_3C$) phase diagram has a crystal structure of:

- A) BCC
- B) FCC
- C) HCP
- D) Orthorhombic

Correct Answer: B) FCC

Explanation: Gamma iron (austenite) possesses an FCC structure capable of dissolving up to 2.14% carbon by weight at 1147°C .

Q83. Eutectoid reaction in $Fe - Fe_3C$ system occurs at 727°C and 0.76% C, forming:

- A) Ledeburite

- B) Pearlite (alternate layers of Ferrite + Cementite)
- C) Martensite
- D) Bainite

Correct Answer: B) Pearlite (alternate layers of Ferrite + Cementite)

Explanation: Solid austenite (γ) decomposes into two distinct solid phases: ferrite (α) and cementite (Fe_3C).

Q84. The microstructural constituent formed by rapid quenching of steel from austenitic range is:

- A) Pearlite
- B) Spheroidite
- C) Martensite
- D) Ferrite

Correct Answer: C) Martensite

Explanation: Quenching traps carbon in a supersaturated Body-Centered Tetragonal (BCT) lattice, producing hard, brittle martensite.

Q85. Normalizing heat treatment process involves heating steel into austenitic region followed by cooling in:

- A) Furnace slowly
- B) Still air at room temperature
- C) Agitated oil bath
- D) Water spray

Correct Answer: B) Still air at room temperature

Explanation: Air cooling during normalizing refines grain structure and relieves internal stresses better than slow furnace annealing.

Q86. Tempered martensite is produced by heating quenched martensitic steel below lower critical temperature (M_s) to improve:

- A) Hardness exclusively
- B) Toughness and ductility while relieving internal brittleness
- C) Carbon content
- D) Grain size dramatically

Correct Answer: B) Toughness and ductility while relieving internal brittleness

Explanation: Tempering allows trapped carbon atoms to precipitate out as fine carbides, restoring impact toughness.

Q87. Brass is an alloy consisting primarily of:

- A) Copper and Zinc
- B) Copper and Tin
- C) Copper and Nickel

- D) Aluminum and Copper

Correct Answer: A) Copper and Zinc

Explanation: Brass is a binary alloy of Copper (Cu) and Zinc (Zn); Bronze consists mainly of Copper and Tin (Sn).

Q88. Case hardening process that diffuses nitrogen into surface layers of special alloy steels is called:

- A) Carburizing
- B) Nitriding
- C) Cyaniding
- D) Flame hardening

Correct Answer: B) Nitriding

Explanation: Nitriding heats parts in ammonia gas (500°C - 550°C) to form hard alloy nitrides without requiring post-quenching.

Q89. Creep deformation in structural metals becomes prominent under sustained loads at temperatures above:

- A) Absolute zero
- B) $0.4T_m$ to $0.5T_m$ (where T_m is absolute melting temperature)
- C) Room temperature for all metals
- D) 2000°C

Correct Answer: B) $0.4T_m$ to $0.5T_m$ (where T_m is absolute melting temperature)

Explanation: Creep is time-dependent plastic deformation occurring under constant load at elevated homologous temperatures.

Q90. S-N curve obtained from fatigue testing of materials plots Stress amplitude (S) against:

- A) Strain rate
- B) Number of cycles to failure (N)
- C) Temperature
- D) Notch radius

Correct Answer: B) Number of cycles to failure (N)

Explanation: S-N curves record cyclic endurance limits, showing maximum stress amplitudes materials can endure indefinitely ($> 10^6$ cycles).

9. Industrial Engineering & Management

Q91. Economic Order Quantity (EOQ) in inventory control minimizes total annual cost consisting of:

- A) Purchase cost and production cost
- B) Ordering cost and inventory holding (carrying) cost
- C) Setup cost and shortage cost only

- D) Transport cost and tax

Correct Answer: B) Ordering cost and inventory holding (carrying) cost

Explanation: EOQ balances setup/ordering costs (which drop with larger batch sizes) against holding costs (which rise linearly with batch sizes).

Q92. EOQ formula for annual demand D , ordering cost C_o , and holding cost per unit per year C_h is:

- A) $\sqrt{\frac{2DC_o}{C_h}}$
- B) $\sqrt{\frac{DC_h}{2C_o}}$
- C) $\frac{2DC_o}{C_h}$
- D) $\sqrt{\frac{2DC_h}{C_o}}$

Correct Answer: A) $\sqrt{\frac{2DC_o}{C_h}}$

Explanation: Setting annual ordering cost equal to annual holding cost yields Wilson's

EOQ formula $Q^* = \sqrt{\frac{2DC_o}{C_h}}$.

Q93. In ABC inventory classification, Class A items represent approximately:

- A) 10-20% of total items accounting for 70-80% of annual usage value
- B) 70-80% of total items accounting for 10-20% of value
- C) 50% of items accounting for 50% of value
- D) Low value non-critical items

Correct Answer: A) 10-20% of total items accounting for 70-80% of annual usage value

Explanation: Based on Pareto's 80/20 rule, Class A items receive tight inventory control due to their high monetary consumption values.

Q94. Critical Path Method (CPM) differs from PERT because CPM network activities are:

- A) Probabilistic with 3 time estimates
- B) Deterministic with single time estimate
- C) Variable in duration
- D) Used only for exploratory research projects

Correct Answer: B) Deterministic with single time estimate

Explanation: CPM applies to construction/maintenance projects with predictable task durations; PERT applies probabilistic models (t_o, t_m, t_p) to R&D projects.

Q95. In a PERT network, expected time (t_e) for an activity with optimistic (t_o), most likely (t_m), and pessimistic (t_p) times is:

- A) $\frac{t_o + t_m + t_p}{3}$
- B) $\frac{t_o + 4t_m + t_p}{6}$
- C) $\frac{t_o + 2t_m + t_p}{4}$
- D) $\frac{t_o + 6t_m + t_p}{4}$

Correct Answer: B) $\frac{t_o + 4t_m + t_p}{6}$

Explanation: Beta distribution weighted average formula places fourfold weight on most likely duration t_m .

Q96. Total float of an activity in project management represents the slack time by which an activity can be delayed without delaying the:

- A) Early start of successor activity
- B) Project completion date
- C) Late finish of predecessor
- D) Free float

Correct Answer: B) Project completion date

Explanation: Total float = $LFT - EFT = LST - EST$. Critical path activities have zero total float.

Q97. Work study consists of two main techniques:

- A) Costing and Accounting
- B) Method Study and Work Measurement (Time Study)
- C) Quality Control and Inspection
- D) Inventory Control and Forecasting

Correct Answer: B) Method Study and Work Measurement (Time Study)

Explanation: Method study streamlines operational workflows; work measurement establishes standard time allowances for tasks.

Q98. Therbligs refer to 17 fundamental micro-motions used in motion study, introduced by:

- A) F.W. Taylor
- B) Frank and Lillian Gilbreth
- C) Henry Gantt
- D) E.W. Deming

Correct Answer: B) Frank and Lillian Gilbreth

Explanation: "Therblig" (Gilbreth spelled backward) categorizes basic physical movements like reach, grasp, hold, and position.

Q99. Break-even point (BEP) in production planning is the volume where:

- A) Total Revenue equals Total Cost

- B) Fixed Cost equals Variable Cost
- C) Profit is maximum
- D) Sales drop to zero

Correct Answer: A) Total Revenue equals Total Cost

Explanation: At BEP, total sales revenue balances total operating costs (fixed + variable), yielding net zero profit/loss.

Q100. Break-even quantity (Q_{BEP}) in units is calculated using Fixed Cost (FC), Selling Price per unit (P), and Variable Cost per unit (V) as:

- A) $\frac{FC}{P-V}$
- B) $\frac{FC}{P+V}$
- C) $\frac{P-V}{FC}$
- D) $\frac{FC \times P}{V}$

Correct Answer: A) $\frac{FC}{P-V}$

Explanation: Contribution margin per unit is $(P - V)$. Dividing fixed overhead costs by unit contribution margin yields break-even volume.