

# Mechanical Engineering

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1. The moment of inertia of a circular area with diameter 'd' about an axis perpendicular to the area and passing through its center is:

- A)  $\pi d^4/64$
- B)  $\pi d^4/32$
- C)  $\pi d^4/128$
- D)  $\pi d^4/16$

Answer: B)  $\pi d^4/32$

Explanation: This is the polar moment of inertia ( $J$ ), which is the sum of the moments of inertia about two perpendicular diametral axes ( $I_x + I_y$ ), where  $I_x = I_y = \pi d^4/64$ .

2. The ratio of the ultimate stress to the allowable stress is known as the:

- A) Factor of safety
- B) Stress factor
- C) Strain factor
- D) Modulus of resilience

Answer: A) Factor of safety

Explanation: The factor of safety is a design criterion that ensures the designed component will operate safely by keeping the working stress well below the material's failure stress.

3. The ability of a material to absorb energy when deformed elastically and release it upon unloading is called:

- A) Toughness
- B) Resilience
- C) Hardness
- D) Creep

Answer: B) Resilience

Explanation: Resilience is represented by the area under the elastic portion of the stress-strain curve. The modulus of resilience is the maximum energy that can be absorbed per unit volume without creating a permanent distortion.

4. When a thin cylindrical shell is subjected to internal pressure, the circumferential stress is:

- A) Half the longitudinal stress.
- B) Equal to the longitudinal stress.
- C) Twice the longitudinal stress.
- D) Four times the longitudinal stress.

Answer: C) Twice the longitudinal stress.

Explanation: The circumferential (or hoop) stress is given by  $\sigma_h = pr/t$ , and the longitudinal stress is given by  $\sigma_l = pr/2t$ , where  $p$  is pressure,  $r$  is radius, and  $t$  is thickness.

5. A point of contraflexure is a point where:

- A) Shear force is maximum.
- B) Bending moment is maximum.
- C) Shear force changes sign.
- D) Bending moment changes sign.

Answer: D) Bending moment changes sign.

Explanation: At a point of contraflexure, the bending moment is zero, and the beam changes its curvature from sagging to hogging or vice-versa.

6. The slenderness ratio of a column is the ratio of its:

- A) Length to its least radius of gyration.
- B) Length to its cross-sectional area.
- C) Least radius of gyration to its length.
- D) Cross-sectional area to its length.

Answer: A) Length to its least radius of gyration.

Explanation: The slenderness ratio is a key parameter used in Euler's column formula to determine the critical buckling load.

7. The study of fluid motion without considering the forces causing the motion is known as:

- A) Fluid statics
- B) Fluid dynamics
- C) Fluid kinematics
- D) Hydrodynamics

Answer: C) Fluid kinematics

Explanation: Kinematics deals with the geometry of motion (velocity, acceleration, streamlines) without reference to the forces involved.

8. The buoyant force on a submerged body acts through the:

- A) Center of gravity of the body.
- B) Centroid of the displaced volume of fluid.
- C) Metacenter of the body.
- D) Center of pressure.

Answer: B) Centroid of the displaced volume of fluid.

Explanation: This is the principle of Archimedes. The point through which the buoyant force acts is called the center of buoyancy.

9. A Pitot tube is used to measure:

- A) Pressure at a point.
- B) Discharge in a pipe.
- C) Velocity at a point.
- D) Viscosity of a fluid.

Answer: C) Velocity at a point.

Explanation: It measures the stagnation pressure at a point, and by applying Bernoulli's equation, the local flow velocity can be calculated.

10. The velocity profile for laminar flow in a circular pipe is:

- A) Linear
- B) Parabolic
- C) Hyperbolic
- D) Logarithmic

Answer: B) Parabolic

Explanation: The velocity is zero at the pipe wall and maximum at the centerline, following a parabolic distribution as described by the Hagen-Poiseuille equation.

11. The main function of a hydraulic accumulator is to:

- A) Store water at high pressure.
- B) Store energy in the form of pressurized fluid.
- C) Increase the pressure of the fluid.
- D) Measure the flow rate.

Answer: B) Store energy in the form of pressurized fluid.

Explanation: An accumulator absorbs pressure shocks and supplies fluid to the system during peak demand, thus storing hydraulic energy temporarily.

12. In a centrifugal pump, the casing is designed to:

- A) Convert kinetic energy of the water into pressure energy.
- B) Convert pressure energy into kinetic energy.
- C) Increase the velocity of the water.
- D) Guide the water to the impeller eye.

Answer: A) Convert kinetic energy of the water into pressure energy.

Explanation: The volute or diffuser casing has a gradually increasing area, which slows down the high-velocity water leaving the impeller, causing a pressure rise.

13. A closed system is one in which:

- A) Only energy can cross the boundary.
- B) Only mass can cross the boundary.
- C) Both energy and mass can cross the boundary.
- D) Neither energy nor mass can cross the boundary.

Answer: A) Only energy can cross the boundary.

Explanation: A closed system has a fixed mass, but energy in the form of heat or work can be transferred across its boundary.

14. The Kelvin-Planck statement of the Second Law of Thermodynamics states that it is impossible to construct a device that operates in a cycle and:

- A) Produces no effect other than the transfer of heat from a cooler body to a hotter body.
- B) Produces no effect other than the production of work and exchange of heat with a single reservoir.
- C) Transfers heat from a hotter body to a cooler body.
- D) Consumes work and transfers heat from a cooler body to a hotter body.

Answer: B) Produces no effect other than the production of work and exchange of heat with a single reservoir.

Explanation: This statement essentially means that a heat engine cannot have 100% thermal efficiency; some heat must always be rejected to a low-temperature sink.

15. An isochoric process is one in which the:

- A) Pressure remains constant.
- B) Temperature remains constant.
- C) Volume remains constant.
- D) Entropy remains constant.

Answer: C) Volume remains constant.

Explanation: In a constant-volume process, no work is done by or on the system ( $W=0$ ), so the heat transferred is equal to the change in internal energy ( $Q = \Delta U$ ).

16. The efficiency of an Otto cycle depends on:

- A) The compression ratio only.
- B) The heat addition only.
- C) The pressure ratio only.
- D) Both compression ratio and specific heat ratio.

Answer: D) Both compression ratio and specific heat ratio.

Explanation: The thermal efficiency of the ideal Otto cycle is given by  $\eta = 1 - (1 / r^{\gamma-1})$ , where  $r$  is the compression ratio and  $\gamma$  is the specific heat ratio.

17. The amount of heat required to raise the temperature of 1 kg of a substance by 1 degree Celsius is called:

- A) Specific heat
- B) Latent heat
- C) Enthalpy
- D) Entropy

Answer: A) Specific heat

Explanation: Specific heat is an intensive property of a substance that quantifies its ability to store thermal energy.

18. A fusible plug in a boiler is a safety device designed to protect against:

- A) Excessive pressure
- B) Low water level
- C) High steam temperature
- D) Poor water circulation

Answer: B) Low water level

Explanation: If the water level drops too low, the plug, made of a low-melting-point alloy, melts and allows steam and water to rush into the furnace, extinguishing the fire.

19. Natural circulation in a water-tube boiler occurs due to:

- A) A pump
- B) The difference in density between hot and cold water.
- C) Capillary action
- D) The venturi effect

Answer: B) The difference in density between hot and cold water.

Explanation: The less dense mixture of steam and water in the heated tubes rises, while the denser, cooler water from the drum flows down to replace it, creating a natural circulation loop.

20. A compound steam engine involves:

- A) A single cylinder for expansion.
- B) Expansion of steam in two or more cylinders in succession.
- C) Two engines driving the same shaft.
- D) The use of a condenser.

Answer: B) Expansion of steam in two or more cylinders in succession.

Explanation: Compounding reduces the temperature range in each cylinder, which minimizes condensation losses and improves thermal efficiency.

21. The maximum efficiency for a reaction turbine is given by (where  $\alpha$  is the nozzle angle):

- A)  $2\cos^2\alpha / (1 + \cos^2\alpha)$
- B)  $\cos^2\alpha / (1 + \cos^2\alpha)$
- C)  $2\sin^2\alpha / (1 + \sin^2\alpha)$
- D)  $\sin^2\alpha$

Answer: A)  $2\cos^2\alpha / (1 + \cos^2\alpha)$

Explanation: This is the theoretical maximum blade efficiency for a single-stage reaction turbine, derived from the velocity triangles.

22. Reheating in a steam turbine cycle is done to:

- A) Increase the turbine work output.
- B) Decrease the condenser pressure.
- C) Increase the moisture content in the final stages.
- D) Decrease the boiler pressure.

Answer: A) Increase the turbine work output.

Explanation: Reheating the steam after partial expansion increases its temperature, which increases the average temperature of heat addition and also reduces moisture in the low-pressure stages, thus improving both efficiency and turbine life.

23. Bleeding in steam turbines refers to the process of:

- A) Extracting steam for feedwater heating.
- B) Removing condensed water from the casing.
- C) Leaking of steam through seals.
- D) Injecting water to cool the blades.

Answer: A) Extracting steam for feedwater heating.

Explanation: Bleeding steam from intermediate turbine stages to preheat the boiler feedwater is a key feature of the regenerative Rankine cycle, significantly increasing its efficiency.

24. A self-locking screw is one in which the efficiency of the screw is:

- A) More than 50%
- B) Less than 50%
- C) Equal to 50%
- D) Equal to 100%

Answer: B) Less than 50%

Explanation: If the efficiency is less than 50%, the friction angle is greater than the helix angle, and the load cannot overhaul or drive the screw in reverse.

25. The material commonly used for machine tool beds is cast iron due to its:

- A) High tensile strength
- B) High ductility
- C) High damping capacity
- D) Low weight

Answer: C) High damping capacity

Explanation: Cast iron is excellent at absorbing vibrations, which is crucial for maintaining accuracy and surface finish during machining operations.

26. The Lewis equation in gear design is used to calculate the:

- A) Bending strength of the tooth.
- B) Wear strength of the tooth.
- C) Pitch line velocity.
- D) Contact ratio.

Answer: A) Bending strength of the tooth.

Explanation: The Lewis equation models the gear tooth as a cantilever beam and is used to determine the maximum stress at the root of the tooth due to bending.

27. The function of a clutch is to:

- A) Connect and disconnect a driving shaft to a driven shaft.
- B) Change the speed ratio between two shafts.
- C) Convert rotary motion to linear motion.
- D) Absorb shocks and vibrations.

Answer: A) Connect and disconnect a driving shaft to a driven shaft.

Explanation: A clutch allows for the engagement and disengagement of power transmission, essential in applications like automobiles for changing gears.

28. The knocking tendency in a Compression Ignition (CI) engine is reduced by using a fuel with a:

- A) High octane number
- B) Low octane number
- C) High cetane number
- D) Low cetane number

Answer: C) High cetane number

Explanation: Cetane number is a measure of a diesel fuel's ignition delay. A higher cetane number means a shorter ignition delay, which promotes smoother combustion and reduces diesel knock.

29. A gas-cooled nuclear reactor commonly uses which substance as the coolant?

- A) Water
- B) Heavy water
- C) Liquid sodium
- D) Carbon dioxide or Helium

Answer: D) Carbon dioxide or Helium

Explanation: Gases like CO<sub>2</sub> and Helium are used as coolants because they have good thermal properties and low neutron absorption, though their heat transfer capabilities are lower than liquids.

30. Scavenging in a two-stroke engine is the process of:

- A) Mixing fuel and air.
- B) Igniting the charge.
- C) Removing burnt gases from the cylinder and filling it with a fresh charge.
- D) Lubricating the cylinder walls.

Answer: C) Removing burnt gases from the cylinder and filling it with a fresh charge.

Explanation: Scavenging is a critical process in two-stroke engines where the incoming fresh charge is used to push out the exhaust gases.

31. The crystal structure of Alpha-iron (Ferrite) at room temperature is:

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

Answer: A) Body-Centred Cubic (BCC)

Explanation: Ferrite, the primary phase in mild steel, has a BCC structure, which is relatively soft and ductile.

32. The heat treatment process of rapidly cooling steel from the austenitic range to produce a very hard and brittle structure is called:

- A) Annealing

B) Normalizing

C) Tempering

D) Quenching

Answer: D) Quenching

Explanation: Quenching in water or oil traps the carbon in a supersaturated solid solution, forming martensite, the hardest constituent of steel.

33. A composite material is a material:

A) That is a pure element.

B) Made from two or more constituent materials with significantly different properties.

C) That is a metallic alloy.

D) That is a polymer.

Answer: B) Made from two or more constituent materials with significantly different properties.

Explanation: Composites, like carbon fiber reinforced polymer, are designed to have combined properties superior to those of the individual components.

34. The primary purpose of adding lead to steels is to improve their:

A) Strength

B) Hardness

C) Machinability

D) Corrosion resistance

Answer: C) Machinability

Explanation: Lead acts as a solid lubricant, reducing friction between the tool and chip, leading to easier machining and better surface finish.

35. A slip system in a crystal structure is a combination of a:

A) Slip plane and slip direction.

B) Grain boundary and dislocation.

C) Lattice point and unit cell.

D) Vacancy and interstitial atom.

Answer: A) A slip plane and slip direction.

Explanation: Plastic deformation in crystalline materials occurs by the movement of dislocations along specific crystallographic planes and directions, known as slip systems.

36. For a compressible fluid, a normal shock wave can only occur when the flow is:

- A) Subsonic ( $M < 1$ )
- B) Sonic ( $M = 1$ )
- C) Supersonic ( $M > 1$ )
- D) Hypersonic ( $M > 5$ )

Answer: C) Supersonic ( $M > 1$ )

Explanation: A normal shock is a sudden, irreversible change in fluid properties where a supersonic flow abruptly becomes subsonic.

37. The volumetric efficiency of a reciprocating compressor is defined as the ratio of:

- A) Actual volume of gas delivered to the swept volume.
- B) Swept volume to the actual volume of gas delivered.
- C) Clearance volume to the swept volume.
- D) Total cylinder volume to the swept volume.

Answer: A) Actual volume of gas delivered to the swept volume.

Explanation: It is a measure of how effectively the compressor fills its swept volume with fresh gas during the suction stroke.

38. Choking in a nozzle means that for a given inlet condition, the mass flow rate is:

- A) Minimum
- B) Zero
- C) Maximum
- D) Variable

Answer: C) Maximum

Explanation: Choking occurs when the velocity at the throat reaches the speed of sound (Mach 1), and the mass flow rate will not increase further even if the exit pressure is reduced.

39. The degree of reaction in an axial flow compressor stage is the ratio of the static enthalpy rise in the:

- A) Rotor to the static enthalpy rise in the stator.

- B) Stator to the static enthalpy rise in the stage.
- C) Rotor to the static enthalpy rise in the stage.
- D) Stage to the static enthalpy rise in the rotor.

Answer: C) Rotor to the static enthalpy rise in the stage.

Explanation: It indicates the proportion of the stage's pressure rise that occurs in the moving rotor blades versus the stationary stator vanes.

40. An inversion of a mechanism is obtained by:

- A) Fixing different links of the kinematic chain.
- B) Changing the number of links.
- C) Changing the type of pairs.
- D) Reversing the direction of motion.

Answer: A) Fixing different links of the kinematic chain.

Explanation: By fixing different links in a kinematic chain, different mechanisms with distinct motions can be created from the same set of links.

41. The Coriolis component of acceleration exists whenever a point moves along a path that has:

- A) Linear motion
- B) Rotational motion
- C) Curvilinear translation
- D) Both linear and rotational motion simultaneously

Answer: B) Rotational motion

Explanation: Specifically, it exists when a block is sliding along a link that is itself rotating. The Coriolis component is given by  $2\omega V$ .

42. In a simple gear train, if the number of idle gears is odd, the direction of rotation of the driven gear will be:

- A) The same as the driving gear.
- B) Opposite to the driving gear.
- C) Perpendicular to the driving gear.
- D) Unpredictable.

Answer: B) Opposite to the driving gear.

Explanation: Each pair of external gears reverses the direction. An even number of idlers results in the same direction, while an odd number results in the opposite direction.

43. The pitch point on a cam is a point on the pitch curve that has the:

- A) Minimum pressure angle.
- B) Maximum pressure angle.
- C) Maximum velocity.
- D) Zero acceleration.

Answer: B) Maximum pressure angle.

Explanation: The pressure angle is a critical parameter in cam design, and its maximum value, which occurs at the pitch point, should be kept low to avoid jamming.

44. Dynamic balancing of a rotating shaft involves balancing:

- A) Forces only.
- B) Couples only.
- C) Both forces and couples.
- D) Neither forces nor couples.

Answer: C) Both forces and couples.

Explanation: For complete dynamic balance, the net resultant force (for static balance) and the net resultant couple must both be zero to eliminate vibrations at operating speed.

45. The Stefan-Boltzmann law states that the total emissive power of a blackbody is proportional to:

- A) Its absolute temperature ( $T$ ).
- B) The square of its absolute temperature ( $T^2$ ).
- C) The cube of its absolute temperature ( $T^3$ ).
- D) The fourth power of its absolute temperature ( $T^4$ ).

Answer: D) The fourth power of its absolute temperature ( $T^4$ ).

Explanation: The law is expressed as  $E = \sigma T^4$ , where  $\sigma$  is the Stefan-Boltzmann constant.

46. A fin is a surface extended from an object to:

- A) Increase the rate of heat transfer.
- B) Decrease the rate of heat transfer.

C) Increase the strength of the object.

D) Reduce the weight of the object.

Answer: A) Increase the rate of heat transfer.

Explanation: Fins increase the surface area available for convection, thereby enhancing the heat transfer between the object and the surrounding fluid.

47. The Nusselt number (Nu) is a dimensionless number that represents the ratio of:

A) Convective heat transfer to conductive heat transfer.

B) Inertial forces to viscous forces.

C) Buoyancy forces to viscous forces.

D) Heat conduction to thermal energy storage.

Answer: A) Convective heat transfer to conductive heat transfer.

Explanation: It is a measure of the enhancement of heat transfer from a surface that occurs in a fluid compared to the heat transfer if only conduction were present.

48. One ton of refrigeration (TR) is the rate of heat removal equivalent to melting one ton of ice in:

A) One hour

B) One minute

C) One second

D) 24 hours

Answer: D) 24 hours

Explanation: It is a standard unit in refrigeration and air conditioning, equivalent to approximately 3.517 kW or 12,000 BTU/hr.

49. In a vapor absorption refrigeration system, the component that is replaced by a generator, absorber, and pump compared to a vapor compression system is the:

A) Condenser

B) Evaporator

C) Compressor

D) Expansion valve

Answer: C) Compressor

Explanation: The vapor absorption system uses a heat source (in the generator) to drive the refrigeration cycle instead of mechanical work input to a compressor.

50. The process of removing moisture from the air is called:

- A) Humidification
- B) Dehumidification
- C) Sensible heating
- D) Sensible cooling

Answer: B) Dehumidification

Explanation: This is a key process in air conditioning, where the air temperature is lowered below its dew point, causing water vapor to condense out.

51. The rake angle of a cutting tool influences the:

- A) Direction of chip flow.
- B) Surface finish of the workpiece.
- C) Tool life.
- D) All of the above.

Answer: D) All of the above.

Explanation: The rake angle is one of the most important tool geometry parameters, affecting cutting forces, chip formation, and heat generation.

52. In a lathe, the operation of producing a cone-shaped surface by gradually feeding the tool at an angle to the axis of rotation is called:

- A) Facing
- B) Knurling
- C) Taper turning
- D) Thread cutting

Answer: C) Taper turning

Explanation: Tapers can be turned by swiveling the compound rest, offsetting the tailstock, or using a taper turning attachment.

53. Forging is a metal forming process that shapes metal by:

- A) Plastic deformation under compression.
- B) Pouring molten metal into a mold.

C) Removing material with a cutting tool.

D) Sintering metal powder.

Answer: A) Plastic deformation under compression.

Explanation: Forging is typically done at elevated temperatures and results in a refined grain structure and improved mechanical properties.

54. The size of a shaper is specified by the:

A) Maximum length of stroke.

B) Size of the table.

C) Power of the motor.

D) Weight of the machine.

Answer: A) Maximum length of stroke.

Explanation: The length of the stroke determines the maximum length of the surface that can be machined on the shaper.

55. Gear hobbing is a process for manufacturing gears that is:

A) A generating process.

B) A forming process.

C) A casting process.

D) A powder metallurgy process.

Answer: A) A generating process.

Explanation: In hobbing, the teeth of the gear are generated by the relative motion of a helical cutting tool (the hob) and the gear blank. It is a continuous and highly productive process.

56. The main purpose of using a cutting fluid during machining is to:

A) Cool the tool and workpiece, and provide lubrication.

B) Increase the friction between the tool and chip.

C) Wash away the workpiece.

D) Make the chips harder.

Answer: A) Cool the tool and workpiece, and provide lubrication.

Explanation: Cutting fluids reduce temperature and friction at the cutting zone, which improves tool life, surface finish, and dimensional accuracy.

57. An optical flat uses the principle of:

- A) Refraction of light.
- B) Interference of light waves.
- C) Polarization of light.
- D) Diffraction of light.

Answer: B) Interference of light waves.

Explanation: It is used to check the flatness of surfaces with very high precision by observing the interference fringe patterns formed between the flat and the surface being tested.

58. The fit in which the lower limit of the hole is greater than the upper limit of the shaft is known as a:

- A) Clearance fit
- B) Interference fit
- C) Transition fit
- D) Sliding fit

Answer: A) A clearance fit

Explanation: A clearance fit always provides a space or clearance between the mating parts, allowing for relative motion like rotation or sliding.

59. The material used for making slip gauges is typically:

- A) Mild steel
- B) High carbon steel
- C) High-grade alloy steel with high dimensional stability.
- D) Cast iron

Answer: C) High-grade alloy steel with high dimensional stability.

Explanation: Slip gauges (or gauge blocks) are primary standards of length, so they must be made from a hard, wear-resistant, and dimensionally stable material.

60. Non-destructive testing (NDT) is a method of testing materials and components:

- A) By destroying them to find the ultimate strength.
- B) Without causing any damage to them.

- C) By chemical analysis.
- D) By microscopic examination.

Answer: B) Without causing any damage to them.

Explanation: NDT methods like ultrasonic testing, radiography, and magnetic particle inspection are used to detect flaws and defects without impairing the part's future usefulness.