Mechanical Engineering

1. Lami's theorem is applicable for a system of forces that are:

A) Concurrent and coplanar.

B) Non-concurrent and parallel.

C) In equilibrium, concurrent, and coplanar.

D) In equilibrium and parallel.

Answer: C) In equilibrium, concurrent, and coplanar.

Explanation: The theorem states that if three concurrent, coplanar forces are in equilibrium, then each force is proportional to the sine of the angle between the other two forces.

2. The maximum frictional force that can be developed between two surfaces at rest is called:

A) Kinetic friction

B) Static friction

C) Limiting friction

D) Rolling friction

Answer: C) Limiting friction

Explanation: Limiting friction is the maximum value of static friction that occurs just before the object begins to slide.

3. The radius of gyration (k) is related to the moment of inertia (I) and area (A) by the formula:

A) $k = \sqrt{(I/A)}$

B) $k = \sqrt{(IA)}$

C) $k = I/A$

D) $k = A/I$

Answer: A) $k = \sqrt{(I/A)}$

Explanation: The radius of gyration represents the distance from the axis of rotation at which the entire area could be concentrated to have the same moment of inertia.

4. The property of a material to regain its original shape after the removal of an external load is called:

A) Plasticity

B) Elasticity

C) Ductility

D) Malleability

Answer: B) Elasticity

Explanation: Elasticity is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed.

5. The stress induced in a body due to a sudden applied load is _____ the stress induced when the same load is applied gradually.

A) Half

B) Equal to

C) Twice

D) Four times

Answer: C) Twice

Explanation: For a suddenly applied load, the maximum stress is 2P/A, whereas for a gradually applied load, it is P/A. This is due to the dynamic effect of the load application.

6. A beam which is fixed at one end and supported by a roller at the other end is called a:

A) Cantilever beam

B) Simply supported beam

C) Overhanging beam

D) Propped cantilever beam

Answer: D) Propped cantilever beam

Explanation: This type of beam is statically indeterminate, as it has more unknown reactions than available static equilibrium equations.

7. The shear force diagram for a cantilever beam carrying a uniformly distributed load over its entire length is a:

A) Rectangle

B) Triangle

C) Parabola

D) Cubic curve

Answer: B) Triangle

Explanation: The shear force is zero at the free end and increases linearly to a maximum value at the fixed end.

8. The ratio of the shear stress to the shear strain is called the:

A) Modulus of elasticity

B) Bulk modulus

C) Modulus of rigidity

D) Poisson's ratio

Answer: C) Modulus of rigidity

Explanation: Also known as the Shear Modulus (G), it is a measure of a material's resistance to shearing deformation.

9. Metacentric height is the distance between the metacenter and the:

A) Center of buoyancy

B) Center of gravity

C) Waterline

D) Keel

Answer: B) Center of gravity

Explanation: The metacentric height (GM) is a crucial measure of a floating body's initial static stability. A positive GM indicates stability.

10. A streamline is a line in a fluid flow that is:

A) Always a straight line.

B) Tangent to the velocity vector at every point.

C) Normal to the velocity vector at every point.

D) Represents the path of a single fluid particle.

Answer: B) Tangent to the velocity vector at every point.

Explanation: At any instant in time, the velocity vector of the fluid at any point on a streamline is tangent to the streamline at that point.

11. The Darcy-Weisbach equation is used to calculate the:

A) Head loss due to friction in pipe flow.

B) Velocity of flow in an open channel.

C) Buoyant force on a submerged object.

D) Pressure drop across a nozzle.

Answer: A) Head loss due to friction in pipe flow.

Explanation: The equation $h_f = f(L/D)(V^2/2g)$ relates the major head loss to the friction factor, pipe length, pipe diameter, and flow velocity.

12. The operating characteristic curve of a centrifugal pump is a plot of:

A) Head vs. Speed

B) Discharge vs. Speed

C) Head vs. Discharge at a constant speed.

D) Power vs. Efficiency

Answer: C) Head vs. Discharge at a constant speed.

Explanation: This curve shows the performance of a pump, indicating the head it can generate for a given flow rate at its design speed.

13. The Zeroth Law of Thermodynamics deals with the concept of:

A) Internal energy

B) Entropy

C) Enthalpy

D) Thermal equilibrium

Answer: D) Thermal equilibrium

Explanation: It states that if two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other. This is the basis for temperature measurement.

14. For an irreversible process, the change in entropy of the universe is:

A) Negative

B) Zero

C) Positive

D) Constant

Answer: C) Positive

Explanation: The second law of thermodynamics dictates that for any real (irreversible) process, the total entropy of an isolated system (or the universe) must increase.

15. Avogadro's number represents the number of:

A) Molecules in one mole of a substance.

B) Atoms in one gram of a substance.

C) Moles in one liter of a substance.

D) Electrons in a single atom.

Answer: A) Molecules in one mole of a substance.

Explanation: Its value is approximately 6.022×10^{23} particles per mole.

16. The critical point is the point at which:

A) The solid and liquid phases coexist in equilibrium.

B) The solid, liquid, and vapor phases coexist in equilibrium.

C) The liquid and vapor phases are indistinguishable.

D) A substance melts.

Answer: C) The liquid and vapor phases are indistinguishable.

Explanation: Above the critical point (critical temperature and pressure), a substance exists as a supercritical fluid.

17. A Benson boiler is a type of:

A) Fire-tube boiler.

B) Natural circulation boiler.

C) Forced circulation, once-through boiler.

D) Low-pressure boiler.

Answer: C) Forced circulation, once-through boiler.

Explanation: It has no steam drum and operates at supercritical pressures, converting water directly into steam in a single pass through the tubes.

18. The function of a steam trap is to:

A) Stop the flow of steam.

B) Drain condensed water from steam lines without letting steam escape.

C) Purify the steam.

D) Measure the steam flow rate.

Answer: B) Drain condensed water from steam lines without letting steam escape.

Explanation: This is essential for maintaining the efficiency and safety of a steam system by preventing water hammer and ensuring dry steam is delivered.

19. The degree of supersaturation in a nozzle is the ratio of the:

A) Actual pressure to the saturation pressure.

B) Saturation pressure to the actual pressure.

C) Actual temperature to the saturation temperature.

D) Supersaturated temperature to the actual temperature.

Answer: A) Actual pressure to the saturation pressure.

Explanation: Supersaturated or metastable flow occurs when steam expands so rapidly that condensation lags behind, and it exists as a vapor at a temperature below its normal saturation temperature.

20. A Rateau turbine is a type of:

A) Velocity-compounded impulse turbine.

B) Pressure-compounded impulse turbine.

C) Simple reaction turbine.

D) Axial flow reaction turbine.

Answer: B) Pressure-compounded impulse turbine.

Explanation: It consists of multiple stages, with each stage comprising a set of nozzles and a row of moving blades, where the pressure drop occurs in stages across the nozzles.

21. The fatigue life of a material is the number of stress cycles it can withstand before:

A) Yielding

B) Elastic deformation

C) Failure occurs.

D) Buckling

Answer: C) Failure occurs.

Explanation: Fatigue is a failure mechanism that occurs under repeated or fluctuating loads, even if the maximum stress is below the material's ultimate tensile strength.

22. A Woodruff key is a key that is:

A) Rectangular in cross-section.

B) Square in cross-section.

C) Semi-circular or segmental in shape.

D) Tapered in shape.

Answer: C) Semi-circular or segmental in shape.

Explanation: It fits into a semi-circular keyseat in the shaft, which makes it easy to install and allows it to accommodate some taper on the shaft.

23. Oldham's coupling is used to connect two shafts which are:

A) Co-axial.

B) Intersecting.

C) Parallel but not co-axial.

D) Non-parallel and non-intersecting.

Answer: C) Parallel but not co-axial.

Explanation: It is a type of coupling that can accommodate a lateral offset between the input and output shafts.

24. In a Diesel engine, the fuel is ignited by:

A) A spark plug.

B) The heat of the compressed air.

C) A glow plug.

D) An external flame.

Answer: B) The heat of the compressed air.

Explanation: Air is compressed to a high temperature and pressure, and when fuel is injected into the cylinder, it auto-ignites.

25. The process of removing fins and flashes from a forged part is called:

A) Swaging

B) Trimming

C) Coining

D) Piercing

Answer: B) Trimming

Explanation: After the forging operation, the excess material (flash) that squeezed out between the die halves is sheared off in a trimming press.

26. Eutectoid steel is a steel with a carbon content of:

A) 0.025%

B) 0.83%

C) 2.1%

D) 4.3%

Answer: B) 0.83%

Explanation: At the eutectoid composition, austenite transforms directly into pearlite (a lamellar mixture of ferrite and cementite) upon slow cooling.

27. The ability of a material to resist indentation or scratching is called:

A) Strength

B) Stiffness

C) Toughness

D) Hardness

Answer: D) Hardness

Explanation: Hardness is often measured using tests like the Rockwell, Brinell, or Vickers tests, which press a specific indenter into the material's surface.

28. The purpose of a regenerator in a gas turbine is to:

A) Heat the compressed air using exhaust gases.

B) Cool the air before compression.

C) Reheat the gas between turbine stages.

D) Cool the exhaust gas.

Answer: A) Heat the compressed air using exhaust gases.

Explanation: A regenerator is a heat exchanger that improves the thermal efficiency of the Brayton cycle by recovering waste heat from the turbine exhaust.

29. A higher pair in a mechanism has:

A) Surface contact between the two elements.

B) Line or point contact between the two elements.

C) No relative motion between the elements.

D) Fixed contact.

Answer: B) Line or point contact between the two elements.

Explanation: Examples of higher pairs include a cam and follower or a pair of meshing gear teeth.

30. A pantograph is a mechanism that is used to:

A) Draw circles.

B) Generate a straight line.

C) Reproduce a path to an enlarged or reduced scale.

D) Convert rotary motion to linear motion.

Answer: C) Reproduce a path to an enlarged or reduced scale.

Explanation: It is a four-bar linkage configured as a parallelogram and is used in applications like drawing instruments and electric train power collectors.

31. The term "module" in gear terminology is defined as the ratio of the:

A) Pitch circle diameter to the number of teeth.

B) Number of teeth to the pitch circle diameter.

C) Circular pitch to π.

D) Addendum to the dedendum.

Answer: A) Pitch circle diameter to the number of teeth.

Explanation: Module ($m = d/T$) is a fundamental parameter in metric gear systems; two gears must have the same module to mesh correctly.

32. The natural frequency of a simple spring-mass system is given by (where k is stiffness and m is mass):

A) $\sqrt{(m/k)}$

B) $\sqrt{(k/m)}$

C) $2\pi\sqrt{(k/m)}$

D) $(1/2\pi)\sqrt{(m/k)}$

Answer: B) √(k/m)

Explanation: This is the angular natural frequency (ωn) in radians per second. The natural frequency in Hz is f = (1/2π)√(k/m).

33. Prandtl number (Pr) is the ratio of:

A) Momentum diffusivity to thermal diffusivity.

B) Thermal diffusivity to momentum diffusivity.

C) Inertial forces to viscous forces.

D) Buoyant forces to viscous forces.

Answer: A) Momentum diffusivity to thermal diffusivity.

Explanation: It connects the velocity boundary layer thickness to the thermal boundary layer thickness and is a key parameter in convection heat transfer.

34. A grey body in radiation heat transfer is one whose emissivity:

A) Is equal to 1.

B) Is equal to 0.

C) Is constant and does not vary with wavelength.

D) Varies with temperature.

Answer: C) Is constant and does not vary with wavelength.

Explanation: A grey body is an idealized surface that has a constant emissivity, simplifying radiation calculations.

35. The Coefficient of Performance (COP) of a heat pump is always:

A) Less than 1.

B) Equal to 1.

C) Greater than 1.

D) Equal to its efficiency.

Answer: C) Greater than 1.

Explanation: The COP of a heat pump is given by (Desired Effect)/(Work Input) = QH/W. Since QH = W + QL, the COP is always greater than 1.

36. A psychrometric chart is a graphical representation of the thermodynamic properties of:

A) Refrigerants

B) Dry air

C) Moist air

D) Steam

Answer: C) Moist air

Explanation: It plots properties like dry-bulb temperature, wet-bulb temperature, relative humidity, and enthalpy, and is an essential tool for air conditioning calculations.

37. The operation of cutting a sheet of metal in a straight line is called:

A) Piercing

B) Blanking

C) Slitting

D) Shearing

Answer: D) Shearing

Explanation: Shearing uses two straight-edged blades to cut sheet metal, similar to the action of a pair of scissors.

38. Sintering is a process used in:

A) Casting

B) Forging

C) Welding

D) Powder metallurgy

Answer: D) Powder metallurgy

Explanation: Sintering is the process of heating compacted metal powders to a temperature below their melting point to cause the particles to bond together, forming a solid piece.

39. A vernier caliper is a measuring instrument used to measure:

A) Angles

B) Time

C) Linear dimensions

D) Temperature

Answer: C) Linear dimensions

Explanation: It provides more precise measurements of length, diameter, or depth than a standard ruler by using a sliding vernier scale.

40. An interference fit is a type of fit where the:

A) Shaft is always smaller than the hole.

B) Shaft is always larger than the hole.

C) Shaft may be larger or smaller than the hole.

D) Clearance is zero.

Answer: B) Shaft is always larger than the hole.

Explanation: This type of fit requires force (e.g., press-fitting) to assemble and is used to create a permanent or semi-permanent joint.

41. The anti-lock braking system (ABS) in a vehicle is designed to:

A) Prevent the wheels from locking up during braking.

B) Increase the braking force.

C) Apply the brakes automatically.

D) Reduce the wear on the brake pads.

Answer: A) Prevent the wheels from locking up during braking.

Explanation: By preventing the wheels from skidding, ABS allows the driver to maintain steering control during an emergency stop.

42. The cetane rating of diesel fuel is a measure of its:

A) Viscosity

B) Volatility

C) Ignition delay

D) Heating value

Answer: C) Ignition delay

Explanation: A higher cetane number indicates a shorter delay between fuel injection and auto-ignition, which is desirable for smooth diesel engine operation.

43. A torque converter is a type of fluid coupling that can also:

A) Multiply torque.

B) Disconnect the engine from the transmission.

C) Function as a brake.

D) Change the gear ratio.

Answer: A) Multiply torque.

Explanation: It is commonly used in automatic transmissions to transfer power from the engine to the transmission, providing torque multiplication at low speeds.

44. A six-sigma quality level means that the number of defects per million opportunities is:

A) 3.4

B) 233

C) 6,210

D) 308,537

Answer: A) 3.4

Explanation: Six Sigma is a disciplined, data-driven methodology for eliminating defects and aiming for near-perfection in any process.

45. The Hawthorne studies are most closely associated with which field of management?

A) Scientific management

B) Operations research

C) Human relations and behavioral management

D) Total Quality Management

Answer: C) Human relations and behavioral management

Explanation: These studies famously concluded that productivity improvements were often due to the social and psychological factors of being observed, rather than changes in the physical work environment.

46. In a simply supported beam, the bending moment at the supports is always:

A) Maximum

B) Minimum

C) Zero

D) Dependent on the load

Answer: C) Zero

Explanation: By definition, a simple support (pin or roller) cannot resist a moment, so the bending moment must be zero at these points.

47. Power is transmitted by a shaft at a certain angular speed. To transmit the same power at double the speed, the required shaft diameter would be:

A) The same.

B) Halved.

C) Doubled.

D) Reduced by a factor of the cube root of 2.

Answer: D) Reduced by a factor of the cube root of 2.

Explanation: Power (P) is proportional to Torque (T) times speed (ω). If ω is doubled, T is halved for the same power. Since shear stress is proportional to T/d^3, the required diameter 'd' decreases.

48. Cavitation is the formation and collapse of vapor bubbles in a liquid. It is more likely to occur if the:

A) Pressure is high.

B) Temperature is low.

C) Fluid velocity is high.

D) Fluid is highly viscous.

Answer: C) Fluid velocity is high.

Explanation: According to Bernoulli's principle, high velocity corresponds to low pressure. If the pressure drops to the vapor pressure of the liquid, cavitation bubbles will form.

49. In a Rankine cycle, the work input is required for the:

A) Turbine

B) Condenser

C) Boiler

D) Pump

Answer: D) Pump

Explanation: The pump's function is to raise the pressure of the liquid condensate before it enters the boiler, which requires a small amount of work input compared to the turbine output.

50. Case hardening is a heat treatment process that hardens the:

A) Core of the component.

B) Entire component.

C) Surface of the component only.

D) Grain boundaries.

Answer: C) Surface of the component only.

Explanation: Processes like carburizing or nitriding introduce elements into the surface layer to make it hard and wear-resistant while keeping the core tough and ductile.

51. The purpose of a gudgeon pin is to connect the:

A) Piston to the connecting rod.

B) Connecting rod to the crankshaft.

C) Piston to the cylinder.

D) Crankshaft to the flywheel.

Answer: A) Piston to the connecting rod.

Explanation: The gudgeon pin (or wrist pin) allows the connecting rod to pivot relative to the piston.

52. The included angle of a V-belt is typically:

A) 90 degrees

B) 60 degrees

C) 40 degrees

D) 20 degrees

Answer: C) 40 degrees

Explanation: The V-shape increases the frictional grip between the belt and the pulley due to a wedging action.

53. In a four-bar linkage, the link that can make a complete revolution is called a:

A) Crank

B) Rocker

C) Coupler

D) Frame

Answer: A) Crank

Explanation: If the shortest link satisfies the conditions of Grashof's law, it can rotate continuously and is called a crank.

54. The process of removing material by chemical action, typically using a corrosive fluid, is called:

A) Ultrasonic machining

B) Laser beam machining

C) Chemical machining

D) Abrasive jet machining

Answer: C) Chemical machining

Explanation: It is used to produce shallow cavities and complex shapes in a wide range of materials without inducing stresses.

55. Time study is a technique used to:

A) Determine the time required by a qualified worker to perform a specific task.

B) Plan the project schedule.

C) Analyze the methods used to perform a job.

D) Control the quality of a product.

Answer: A) Determine the time required by a qualified worker to perform a specific task.

Explanation: It is a core component of work measurement, used for setting performance standards and planning production.

56. The unit of kinematic viscosity is:

A) Pascal-second (Pa-s)

B) Poise

C) Stokes (or m^2/s)

D) Newton per meter (N/m)

Answer: C) Stokes (or m^2/s)

Explanation: Kinematic viscosity is the ratio of dynamic viscosity to the density of the fluid ($\nu = \mu/\rho$).

57. An isentropic process is one that is both:

A) Adiabatic and reversible.

B) Isothermal and reversible.

C) Adiabatic and irreversible.

D) Isothermal and irreversible.

Answer: A) Adiabatic and reversible.

Explanation: An isentropic process is a constant-entropy process. For a process to be isentropic, it must be frictionless (reversible) and have no heat transfer (adiabatic).

58. The helix angle of a screw thread is the angle made by the helix of the thread with a plane:

A) Perpendicular to the screw axis.

B) Parallel to the screw axis.

C) Containing the screw axis.

D) At 45 degrees to the screw axis.

Answer: A) Perpendicular to the screw axis.

Explanation: The helix angle is related to the lead and the diameter of the screw and is a key parameter in determining the efficiency of power screws.

59. The percentage of carbon in wrought iron is typically:

A) Less than 0.08%

B) 0.1% to 0.3%

C) 0.5% to 1.0%

D) More than 2.0%

Answer: A) Less than 0.08%

Explanation: Wrought iron is a very pure form of iron with slag inclusions, known for its corrosion resistance and weldability.

60. An epicyclic gear train is one in which the axes of some of the gears:

A) Are fixed in space.

B) Move relative to the frame.

C) Are parallel to each other.

D) Intersect each other.

Answer: B) Move relative to the frame.

Explanation: Also known as a planetary gear train, it features one or more "planet" gears revolving around a central "sun" gear.