01. In terms of Poisson's ratio (m) the ratio of Young's Modulus (E) to Shear Modulus (G) of elastic materials is

(a) $2(1 + m)$ (b) $2(1 - m)$

(c) $\frac{1}{2}(1+\mu)$ (d) $\frac{1}{2}(1-\mu)$

02. The most suitable bearing for carrying very heavy loads with low speed is
(a) hydrodynamic bearing
(b) ball bearing
(c) roller bearing
(d) hydrostatic bearing

03. Two forces A and B are acting at an angle θ. Their resultant 'R' will make an angle α with the force A, such that cos α is equal to

(a) $\frac{A + B\sin\theta}{\sqrt{A^2 + B^2 - 2AB\cos\theta}}$

(b) $\frac{B\sin\theta}{\sqrt{A^2 + B^2 + 2AB\cos\theta}}$

(c) $\frac{A + B\cos\theta}{\sqrt{A^2 + B^2 + 2AB\cos\theta}}$

(d) $\frac{B\cos\theta}{\sqrt{A^2 + B^2 - 2AB\cos\theta}}$

04. The dimension of surface tension is
(a) N/m^2 (b) J/m (c) J/m^2 (d) W/m

05. A draft tube is used in a reaction turbine
(a) To guide water downstream without splashing
(b) To convert residual pressure energy into kinetic energy
(c) To convert residual kinetic energy into pressure energy
(d) To streamline the flow in the tail race

06. The number of degrees of freedom for a diatomic molecule
(a) 2 (b) 3 (c) 4 (d) 5

07. The sensitivity of an isochronous governor is
(a) zero (b) one
(c) two (d) infinity

08. The two reference fuels used for cetane rating are
(a) cetane and isooctane
(b) cetane and tetraethyl lead
(c) cetane and n-heptane
(d) cetane and -methyl naphthalene.

09. In which type of shaper, constant speed is possible and any stroke length can be set?
(a) Crank shaper (b) Geared shaper
(c) Hydraulic shaper (d) None of the above

10. Which one of the following statements is CORRECT regarding Rockwell hardness test?
(a) A sphere made of steel or tungsten carbide is used as indenter.
(b) A spheroconical diamond cone of 120° angle is used.
(c) A square base pyramid diamond indentor is used.
(d) Its principle is based on rebound height of a ball from the specimen.

11. A free bar of length l m is uniformly heated from 0°C to a temperature of t°C. α is the coefficient of linear expansion and E the modulus of elasticity. The stress in the bar is
(a) αtE (b) αtE/2
(c) zero (d) none

12. Starting friction is low in
(a) hydrostatic lubrication
(b) hydrodynamic lubrication
(c) mixed (or semi-fluid) lubrication
(d) boundary lubrication

13. Which one of the following statements is correct?
(a) Energy and work are scalars.
(b) Force and work are vectors.
(c) Energy, momentum and velocity are vectors.
(d) Force, momentum and velocity are scalars.

14. Surface tension is due to
(a) viscous forces
(b) cohesion
(c) adhesion
(d) the difference between adhesive and cohesive forces.

15. Zeroth Law of thermodynamic systems state that
(a) two thermodynamic systems are always in thermal equilibrium with each other.
(b) if two systems are in thermal equilibrium, then the third system will also be in thermal equilibrium.
(c) two systems not in thermal equilibrium with a third system, are also not in thermal equilibrium with each other.
(d) when two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other.

16. For a governor running at constant speed, what is the value of the force acting on the sleeve?
(a) Zero
(b) Variable depending upon the load
(c) Maximum
(d) Minimum

17. The discharge of hydrocarbons from petrol automobile exhaust is minimum when the vehicle is
(a) Idling (b) Cruising
(c) Accelerating (d) Decelerating

18. In submerged arc welding, the flux is in the form of
(a) Coating on the electrodes
(b) Core wires
(c) Granules
(d) An inert gas

19. The unit of elastic modulus is the same as those of
(a) stress, shear modulus and pressure
(b) strain, shear modulus and force
(c) shear modulus, stress and force
(d) stress, strain and pressure

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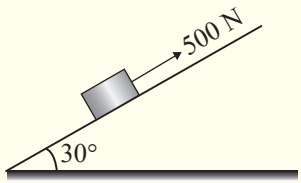
20. The block shown in the given figure is kept in equilibrium and prevented from sliding down by applying a force of 500 N. The coefficient of friction is $\frac{\sqrt{3}}{5}$. The weight of the block would be



(a) 4000 N (b) 2500 N
(c) 1000 N (d) 500 N

21. A beam of uniform cross section is loaded as cantilever as shown in the figure. If the load at the end is increased, where will the failure occur?

(a) At the middle
(b) At the tip below the load
(c) At the support
(d) Anywhere

22. In a journal bearing P = average bearing pressure, Z = absolute viscosity of the lubricant, N = rotational speed of the journal. The bearing characteristic number is given by
(a) ZN/P (b) P/ZN
(c) Z/PN (d) N/ZP

23. The normal stress is the same in all directions at a point in a fluid only when
(a) The fluid is frictional
(b) The fluid is frictionless and incompressible
(c) The fluid has zero viscosity and is at rest
(d) One fluid layer has no motion relative to an adjacent layer

24. Consider the following statements:
1. A draft may be fitted to the tail end of a Pelton turbine to increase the available head.
2. Kaplan turbine is an axial flow reaction turbine with adjustable vanes on the hub.
3. Modern Francis turbine is a mixed flow reaction turbine.

Which of the above statements are correct?
(a) 1, 2 and 3 (b) 1 and 2
(c) 2 and 3 (d) 1 and 3

25. The value of an extensive property is essentially dependent on
(a) mass of the system
(b) interaction of the system with its surroundings
(c) path followed by the system in going from one state to another
(d) nature of boundaries, rigid or flexible

26. When the speed of the engine fluctuates continuously above and below the mean speed, then the governor is said to be:
(a) Stable (b) Unstable
(c) Isochronous (d) Hunting

27. The efficiency of Rankine cycle is lower than that corresponding Carnot cycle because
(a) the average temperature at which heat is supplied in Rankine cycle is lower than corresponding Carnot cycle.
(b) the Carnot cycle has gas as working substance and Rankine cycle has steam has working substance
(c) the Rankine cycle efficiency depends upon properties of working substance where as Carnot cycle efficiency is independent of the properties of working substances.
(d) the temperature range of Carnot cycle is greater than that for Rankine cycle.

28. Consider the following pairs regarding relative motion of workpiece and tool, which pair (s) is/are correctly matched.

	Work	Tool
I. Shaper	Translation	Translation
II. Drilling	Translation	Rotation

(a) I only (b) II only
(c) Both I and II (d) Neither I nor II

29. Hyper-eutectoid steel is a steel containing carbon
(a) less than 0.8% (b) equal to 0.8%
(c) from 0.8 to 2.0% (d) zero percent

30. Which one of the following is the preferable cross-section of a beam for bending loads?
(a) Circular (b) Annular Circular
(c) Rectangular (d) I section

31. Which theory of failure will you use for aluminium components under steady loading
(a) principal stress theory
(b) principal strain theory
(c) strain energy theory
(d) maximum shear stress theory

32. A rectangular water tank, full to the brim, has its length, breadth and height in the ratio of 2:1:2. The ratio of hydrostatic forces at the bottom to that at any larger vertical surface is
(a) 1/2 (b) 1 (c) 2 (d) 4

33. The heat absorbed or rejected during a polytropic process is equal to
(a) $\left(\frac{\gamma - n}{\gamma - 1}\right)^{\frac{1}{2}} \times$ work done
(b) $\left(\frac{\gamma - n}{n - 1}\right)^{\frac{1}{2}} \times$ work done
(c) $\left(\frac{\gamma - n}{\gamma - 1}\right) \times$ work done
(d) $\left(\frac{\gamma - n}{\gamma - 1}\right)^{2} \times$ work done

34. Which one of the following statements is correct? If the size of a flywheel in a punching machine is increased
(a) then the fluctuation of speed and fluctuation of energy will both decrease
(b) then the fluctuation of speed will decrease and the fluctuation of energy will remain same
(c) then the fluctuation of speed will increase and the fluctuation of energy will decrease

(d) then the fluctuation of speed and fluctuation of energy both will increase

35. Consider the following statements :
1. The thermal efficiency of a regenerative Rankine cycle is always higher than that of a cycle without regeneration.
2. In regeneration cycle the work output is more.
Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) 1 and 2 (d) neither 1 nor 2

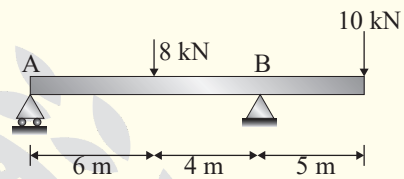
36. During welding process, oxidation of plates will takes place at high temperature, which can be avoided by using
(a) ACHF (b) DCRP
(c) Flux (d) Filler metal

37. The crystal structure of Austenite stainless steels at room temperature is
(a) Face centered cubic
(b) Diamond cubic
(c) Hexagonal close packed
(d) Simple cubic

38. If two shafts of the same length, one of which is hollow, transmit equal torque and have equal maximum stress, then they should have equal
(a) polar moment of inertia
(b) polar modulus of section
(c) polar moment of inertia
(d) angle of twist

39. A solid shaft can resist a bending moment of 3.0 kNm and a twisting moment of 4.0 kNm together, then the maximum torque that can be applied is
(a) 7.0 kNm (b) 3.5 kNm
(c) 4.5 kNm (d) 5.0 kNm

40. The reaction (in kN) at the support 'A' for the beam shown in the given figure is



(a) 18 ↑ (b) 1.8 ↓
(c) 1.8 ↑ (d) 0.8 ↓

41. In order to increase sensitivity of U – tube manometer, one leg is usually inclined by an angle θ. What is the sensitivity of inclined tube compared to sensitivity of U – tube?
(a) $\sin\theta$ (b) $\frac{1}{\sin\theta}$
(c) $\frac{1}{\cos\theta}$ (d) $\tan\theta$

42. In a reversible isothermal expansion process, the fluid expands from 10 bar and 2 m^3 to 2 bar and 10 m^3, during the process the heat supplied is 100 kW. What is the work done during the process?
(a) 33.3 kW (b) 100 kW
(c) 80 kW (d) 20 kW

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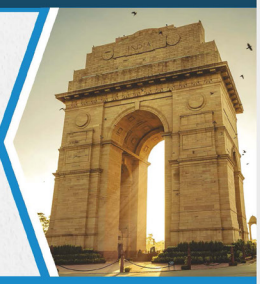

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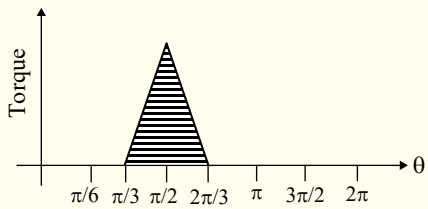


Crank angle

The crank of a slider crank punching press has a mass moment of inertia of 1 kgm^2. The above figure shows the torque demand per revolution for a punching operation. If the speed of crank is found to drop from 30 rad/s to 20 rad/s during punching, what is the maximum torque demand during the punching operation?

(a) 95.4 Nm (b) 104.7 Nm
(c) 477.2 Nm (d) 523.8 Nm

44. Why is multi-staging in centrifugal pumps used?
(a) For high head (b) For high speed
(c) For high efficiency (d) none of them

45. Consider the following
1. Safety valve.
2. Steam trap.
3. Steam separator.
4. Economizer
Among these boiler accessories would include
(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1 and 4 (d) 1, 2, 3 and 4

46. Which one of the following materials can be difficult to weld by resistance welding process?
(a) Aluminum (b) Mild steel
(c) Copper (d) High carbon steels

47. The ratio of equivalent length of the column to the minimum radius of gyration of the cross-sectional area of the column is called
(a) Buckling factor (b) Slenderness ratio
(c) Column factor (d) Crippling factor

48. Spherical roller bearings are normally used
(a) for increased radial load
(b) for increased thrust load
(c) when there is less radial load
(d) to compensate for angular misalignment

49. A 70 kg person walks on snow with a total foot implant area of 500 cm^2. What pressure does he exert on snow?
(a) 0.5 kPa (b) 12.5 kPa
(c) 13.73 kN/m^2 (d) 137.3 kN/m^2

50. The expression $\int_1^2 Pdv$ gives the measure of work during
(a) non flow reversible process
(b) steady flow reversible process
(c) open system and any process
(d) any system and any process

51. If the speed of the engine varies between 390 and 410 rpm in a cycle of operation, the co-efficient of fluctuation of speed will be.
(a) 0.01 (b) 0.02
(c) 0.04 (d) 0.05

52. The output of a boiler is normally stated as
(a) evaporative capacity in tonnes of steam that can be produced from and at 100°C
(b) weight of steam actually produced at rated pressure in tonnes per hour
(c) boiler horse power
(d) weight of steam produced per kg of fuel

53. Which of the following assumptions is not valid for merchant circle diagram?
(a) continuous chips
(b) discontinuous chips
(c) cutting edge remains sharp
(d) no built up edge

54. Which one of the following is true for torsional shear stress at the axis of a circular shaft?
(a) Minimum (b) Maximum
(c) Negative (d) Zero

55. The S-N curve for steel becomes asymptotic nearly at
(a) 10^3 cycles (b) 10^4 cycles
(c) 10^6 cycles (d) 10^9 cycles

56. Which one of the following is the condition for stable equilibrium for a floating body?
(a) The metacenter coincides with the centre of gravity
(b) The metacentre is above the centre of gravity.
(c) The metacentre is below the centre of gravity.
(d) The centre of buoyancy is below the centre of gravity

57. Two Pelton wheels A and B have the same specific speed, and are working under, the same head. A produces 400 kW at 1000 rpm. If B produces 100 kW, then its rpm is
(a) 4000 (b) 2000
(c) 1500 (d) 1250

58. When the valve of an evacuated bottle is opened, the atmospheric air rushes into it. If the atmospheric pressure is 101.325 kPa and 0.6 m^3 of air enters into the bottle, then the work done by the air will be
(a) 80.8 kJ (b) 70.8 kJ
(c) 60.8 kJ (d) 50.8 kJ

59. The primary function of the flywheel is
(a) To limit the fluctuations of speed during each cycle
(b) To absorb energy during those periods of crank rotation when turning moment is less than the resisting moment
(c) To maintain constant speed of rotation of the crank shaft when the load on the engine increases.
(d) To maintain constant speed of rotation of the crank shaft when the load on the engine decreases

60. Reciprocating compressors are provided with
(a) simple disc/plate valve
(b) poppet valve
(c) spring-loaded disc valve
(d) solenoid valve

61. In shaping and planning operation, the work table feed is maintained by
(a) Quick-return mechanism
(b) Rack and pinion mechanism
(c) Cams mechanism
(d) Ratchet-pawl mechanism

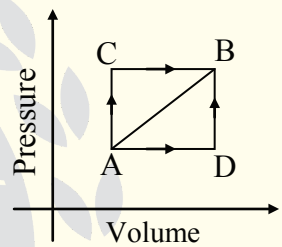
62. The ratio of circumferential stress to longitudinal stress in a thin cylinder subjected to internal hydrostatic pressure is
(a) 1/2 (b) 1
(c) 2 (d) 4

63. The bolts in a rigid flanged coupling connecting two shafts transmitting power are subjected to
(a) shear force and bending moment
(b) axial force
(c) torsion
(d) torsion and bending moment

64. The velocity components for a two dimensional incompressible flow of a fluid are $u = x - 4y$ and $v = -y - 4x$. It can be concluded that
(a) the flow does not satisfy the continuity equation
(b) the flow is rotational
(c) the flow is irrotational
(d) none of the above

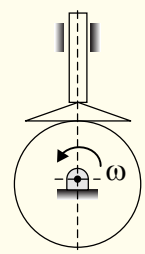
65. Which one of the following statements is relevant to the specific speed of a centrifugal pump?
(a) Head developed is unity and discharge is unity
(b) Head developed is unity and power absorbed is unity
(c) Discharge is unity and power absorbed is unity
(d) Each of head developed, power absorbed and discharge is equal to unity

66. When a system is taken from state A to state B along the path A-C-B, 180 kJ of heat flows into the system and it does 130 kJ of work (see figure given) :



How much heat will flow into the system along the path A-D-B if the work done by it along the path is 40 kJ?
(a) 40 kJ (b) 60 kJ
(c) 90 kJ (d) 135 kJ

67. The below diagram shows a cam with a circular profile, rotating with a uniform angular velocity of ω rad/s. What is the nature of displacement of the follower ?



(a) Uniform
(b) Parabolic
(c) Simple harmonic
(d) Cycloidal

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		08th & 23rd June 2020		

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68. The main aim of compounding steam turbine is to
(a) improve efficiency
(b) reduce steam consumption
(c) reduce rotor speed
(d) reduce turbine size

69. A column of length 'L' is fixed at its both ends. The equivalent length of the column is
(a) L/4 (b) L/2
(c) $L/\sqrt{2}$ (d) 2L

70. Maximum shear stress in a Mohr's Circle
(a) is equal to radius of Mohr's circle
(b) is greater than radius of Mohr's circle
(c) is less than radius of Mohr's circle
(d) could be any of the above

71. The general form of expression for the continuity equation in a Cartesian coordinate system for incompressible or compressible flow is given by
(a) $\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$
(b) $\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$
(c) $\frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$
(d) $\frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=1$

72. A closed system undergoes a process 1-2 for which the values of Q_{1-2} and W_{1-2} are +20 kJ and +50 kJ, respectively. If the system is returned to state 1, and Q_{2-1} is –10 kJ, what is the value of the work W_{2-1}?
(a) + 20 kJ (b) – 40 kJ
(c) – 80 kJ (d) + 40 kJ

73. What is the maximum acceleration of a cam follower undergoing simple harmonic motion?
(a) $\frac{h}{2}\left(\frac{\pi\omega}{\phi}\right)^2$ (b) $4h\left(\frac{\omega^2}{\phi^2}\right)$
(c) $4h\left(\frac{\omega^2}{\phi}\right)$ (d) $\frac{2h\pi\omega^2}{\phi^2}$

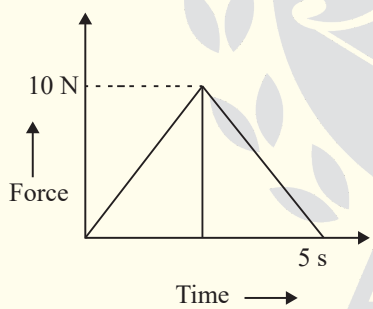
74. Which one of the following stream functions is a possible irrotational flow field?
(a) $\psi = x^3 y$
(b) $\psi = 2xy$
(c) $\psi = Ax^2y^2$
(d) $\psi = Ax + By^2$

75. A gas is flowing through an insulated nozzle. If the inlet velocity of gas is negligible and there is an enthalpy drop of 45 kJ/kg, the velocity of gas leaving the nozzle is
(a) 100 m/s
(b) 200 m/s
(c) 300 m/s
(d) 350 m/s

76. Consider the following statements regarding radial cam nomenclature:
1. Motion of the trace point describes movement of the follower.
2. The curve generated by the locus of trace point is called cam profile.
3. Actual working curve of cam is called pitch curve.
4. Smallest circle that can be drawn tangential to cam profile is called base circle.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 1 and 4 only (d) 3 and 4 only

77. Variation of force acting on a particle of mass 5 kg is shown in the figure below. What is the final velocity of the particle if it is initially at rest?



(a) 2 m/s (b) 2.5 m/s
(c) 5 m/s (d) 10 m/s

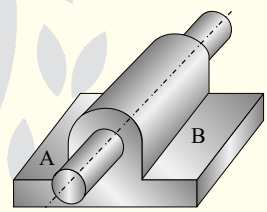
78. A steady incompressible flow field is given by $u = 2x^2 + y^2$ and $v = -4xy$. The convective acceleration along x-direction at point (1, 2) is
(a) 6 units (b) 24 units
(c) –8 units (d) –24 units

79. A thermodynamic cycle is composed of four processes. The heat added and the work done in each process are as follows:

Process	Heat transfer (J)	Work done (J)
1 - 2	0	50 (by the gas)
2 - 3	50 (from the gas)	0
3 - 4	0	20 (on the gas)
4 - 1	80 (to the gas)	0

The thermal efficiency of the cycle is
(a) 20.3% (b) 37.5%
(c) 40.3% (d) 62.5%

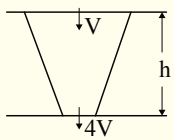
80. A round bar A passes throughout the cylindrical hole in B as shown in the given figure. Which one of the following statements is correct in this regard?



(a) The two links shown form a kinematic pair
(b) The pair is completely constrained
(c) The pair has incomplete constraint
(d) The pair is successfully constraint

81. In a multiple disc clutch if N_1 and N_2 are the number of discs on the driving and driven shafts, respectively, the number of pairs of contact surfaces will be
(a) $N_1 + N_2$ (b) $N_1 + N_2 - 1$
(c) $N_1 + N_2 + 1$ (d) $\frac{N_1 + N_2}{2}$

82. A liquid flows downward through a tapered vertical portion of pipe. At the entrance and exit of the pipe, the static pressures are equal. If for a vertical height 'h' the velocity becomes four times, then the ratio of 'h' to the velocity head at entrance will be



(a) 3 (b) 8 (c) 15 (d) 24

83. The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at
(a) the centre of the disc
(b) an infinite distance on the plane surface
(c) the point of contact
(d) the point on the circumference situated vertically opposite to the contact point.

84. A refrigerating machine working on reversed Carnot cycle takes out 2 kW of heat from the system while operating between temperature limits of 300 K and 200 K. C.O.P and Power consumed by the cycle will be respectively:
(a) 1 and 1 kW (b) 1 and 2 kW
(c) 2 and 1 kW (d) 2 and 2 kW

85. Which of the following statements are true for Ammonia as a refrigerant?
1. It has higher compressor discharge temperature compared to fluorocarbons.
2. It is toxic to mucous membranes.
3. It requires larger displacement per TR compared to fluorocarbons.
4. It reacts with copper and it's alloys
Select the correct answer using the codes given below.
(a) 1 and 2 (b) 1, 2 and 3
(c) 1, 2 and 4 (d) 2, 3 and 4

86. While measuring the velocity of air (ρ = 1.2 kg/m^3), the difference in the stagnation and static pressure of a Pitot-static tube was found to be 380 Pa. The velocity at that location is
(a) 24.03 m/s (b) 4.02 m/s
(c) 17.8 m/s (d) 25.17 m/s

87. The minimum number of links in a constrained planer mechanism involving revolute pairs and two higher pairs is:
(a) 3 (b) 4 (c) 5 (d) 6

88. A Carnot refrigerator requires 1.5 kW/ton of refrigeration to maintain a region at a temperature of –30°C. The C.O.P of Carnot refrigerator is
(a) 1.42 (b) 2.33 (c) 2.87 (d) 3.26

89. In a single slider chain, when the slider is fixed, it forms a mechanism of
(a) Hand pump (b) Rolling
(c) Quick return (d) Oscillating cylinder

90. For a cantilever beam dM/dx = constant for its whole length. What is the shape of SF diagram for the beam?
(a) A rectangle (b) A triangle
(c) A parabola (d) A hyperbola

91. The angle of V-belt is
(a) 30° (b) 85° (c) 40° (d) 45°

92. Bernoulli's equation is applicable between any two points located in
(a) Rotational flow of an incompressible fluid
(b) Irrotational flow of compressible or incompressible fluid
(c) Steady, rotational flow of an incompressible fluid
(d) Steady, irrotational flow of an incompressible fluid

93. In M-L-T system, what is the dimension of specific speed for a Rotodynamic pump?
(a) $L^{-3/4} T^{3/2}$ (b) $M^{1/2} L^{1/4} T^{-5/2}$
(c) $L^{3/4} T^{-3/2}$ (d) $L^{3/4} T^{3/2}$

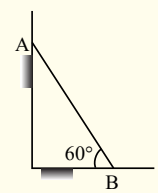
94. For a heat engine operating on the Carnot cycle, the work output is ¼th of the heat transferred to the sink. The efficiency of the engine is
(a) 20 % (b) 33.3 % (c) 40 % (d) 50 %

95. The number of instantaneous centers of rotation for a 10 link kinematic chain is
(a) 36 (b) 90 (c) 120 (d) 45

96. Consider the following statements:
In a vapour compression system, a thermometer placed in the liquid line can indicate whether the
1. Refrigerant flow is too low
2. Water circulation is adequate.
3. Condenser is fouled.
4. Pump is functioning properly.
(a) 1, 2 & 3 (b) 1, 2 & 4
(c) 1, 3 & 4 (d) 2, 3 & 4

97. Chip equivalent is increased by
(a) An increase in side cutting edge angle of tool
(b) An increase in nose radius
(c) Decrease in plan area of cut
(d) All of the above

98. A rod of length 1 m is sliding in a corner as shown in the figure above. At an instant when the rod makes an angle of 60° with the horizontal plane, the downward velocity of point A is 1 m/s. What is the angular velocity of the rod at this instant?
(a) 2.0 rad/s
(b) 1.5 rad/s
(c) 0.5 rad/s
(d) 0.75 rad/s



99. The critical cooling rate required for getting the complete martensitic structure in steel depends on the
(a) percentage of silicon
(b) percentage of phosphorous
(c) percentage of carbon
(d) percentage of chromium

100. If the number of turns in a spring are halved, its stiffness is
(a) halved (b) doubled
(c) increased four times (d) not changed

Detailed Solutions

01. Ans: (a)

Sol: We know that, $E = 2G(1 + m)$

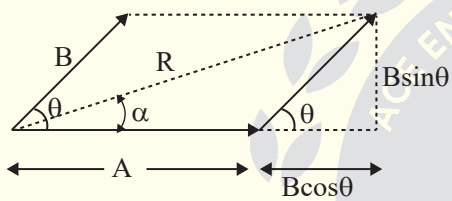
$$E/G = 2(1 + m)$$

02. Ans: (d)

Sol: Most suitable bearing for carrying heavy load at low speed is hydrostatic bearing because it has very low starting torque and no friction due to the absence of metal to metal contact.

03. Ans: (c)

Sol:



$$\cos\alpha = \frac{A + B\cos\theta}{R}$$

where $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

04. Ans: (c)

Sol: Surface tension $= \dfrac{\text{Surface Energy}}{\text{Area}}$

$$\therefore \sigma = \frac{J}{m^2} \text{ or N/m}$$

05. Ans: (c)

Sol: Draft tube has following functions:

- It allows installation of turbine above tail race without appreciable loss in net head.
- It minimizes K.E loss at the exit of turbine by converting into useful head.

06. Ans: (d)

Sol:

- Monoatomic gases have 3 degrees of freedom.
  3 – Translational motions
- Diatomic molecules have 5 degrees of freedom.
  3 – Translational motions
  2 – Rotational motions

07. Ans: (d)

Sol: Isochronous governors are infinitely sensitive.

08. Ans: (d)

Sol: Cetane – 100

The reference fuel $\Rightarrow$ Normal cetane (C_{16} H_{34}) which is arbitrarily assigned in cetane number of 100 and α - methyl Naphthalene is 0.

09. Ans: (c)

Sol:

- Crank shaper and geared shaper are the types of mechanical shapers which are stroke limited. The speed varies during the cutting operation. So, (a) and (b) are incorrect.
- Hydraulic shapers have the advantage over mechanical shapers that they can maintain constant speed during cutting operation. So, (c) is correct.

10. Ans: (b)

Sol:

- In rockwell test, a spheroconical diamond cone of 120° angle and spherical apex of 0.2 mm radius is used to make the indentation.

- The depth of indentation is used as a criterion to calculate the hardness number.

11. Ans: (c)

Sol: As the bar is free to expand, there will not be any thermal stress induced in the bar.

12. Ans: (a)

Sol: Hydrodynamic bearings exhibit high starting friction due to metal to metal contact during starting up. Hydrostatic bearings exhibit low starting friction compare to hydrodynamic bearings.

13. Ans: (a)

Sol: Energy and work are scalar quantities.
Force, momentum and velocity are vector quantities.

14. Ans: (b)

Sol: Surface tension forces are due to inter-molecular forces between the liquid molecules at the liquids outer boundaries. So, it is due to cohesion.

15. Ans: (d)

Sol: When a body A is in thermal equilibrium with a body B, and also separately with a body C, then B and C will be in thermal equilibrium with each other. This is known as zeroth law of thermodynamics.

16. Ans: (a)

Sol: At constant speed, no sleeve movement. Therefore zero force.

17. Ans: (b)

Sol: Best economy mixtures ensure proper combustion and less HC emissions.
During acceleration and idling rich mixtures give high HC emissions.

18. Ans: (c)

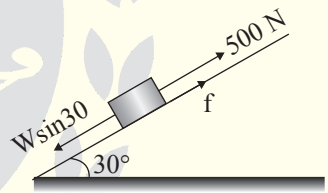
Sol: In SAW, the flux is in the form of Granules.

19. Ans: (a)

Sol: Stress, shear modulus and pressure have same unit (N/m^2 or N/mm^2)

20. Ans: (b)

Sol: If the block is prevented from sliding down then friction force will act up the inclined plane.



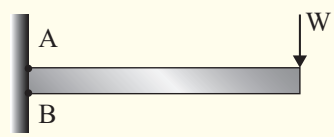
$$W \sin 30° = 500\ N + f$$

$$= 500 + \frac{\sqrt{3}}{5} \times W \cos 30$$

$$W = 2500\ N$$

21. Ans: (c)

Sol:



For the loading shown in the diagram the tensile bending stress is maximum at point A and

compressive bending stress is maximum at point B. The beam will fail either at A or B depending upon whether material is weak in tension or compression.

22. Ans: (a)

Sol: Bearing characteristic number for journal bearing is given by $C = \frac{ZN}{P}$

23. Ans: (d)

Sol: Normal stress is same in all directions at a point only if shear stress is zero. Shear stress is zero for both ideal fluids and real fluids in the state of rest.

Shear Stress, $\tau = \mu \frac{dV}{dy}$,

$\frac{dV}{dy}$ = Velocity gradient

μ = Viscosity

V = 0 i.e at rest, Hence, $\tau = 0$

In motion:

For ideal fluids, viscosity, $\tau = 0$

$\therefore \quad \tau = 0$

For real fluids in rigid body motion, one layer has no relative motion to another layer, then dV = 0

As dV = 0, $\frac{dV}{dy} = 0$

$\therefore \tau = 0$

Hence, of all the options, most appropriate answer is (d).

24. Ans: (c)

Sol: Statement (1) is wrong: The draft tube is not used in case of Pelton wheel.

Statements (2) & (3) are correct.

25. Ans: (a)

Sol: Extensive property is dependant on mass.

E.g. Volume, Energy

26. Ans: (d)

Sol: When speed of the engine fluctuate rapidly above and below the mean speed between maximum and minimum position, the governor is said to be hunting.

27. Ans: (a)

Sol: Heat supply process in Rankine cycle is a variable temperature process where as it is isothermal in Carnot cycle.

28. Ans: (a)

Sol: In drilling, work is fixed and tool does both rotation and translation.

29. Ans: (c)

Sol: Hyper-eutectoid steel contain 0.8%C to 2.1%C

30. Ans: (d)

Sol: Bending stress

$$\sigma = \frac{M}{I_{N.A}} \times y_{max} = \frac{M}{Z}$$

$[(I)_{N.A}]_{I\text{-section}} > [(I)_{N.A.}]_{Rectangular,circular \& annular circular}$

[Because, more mass is far away from the neutral axis in I-section]

$\therefore \quad (\sigma_b)_{I\text{-Sectoon}} < [(\sigma_b)]_{Rectangular,\ circular,\ Annular}$

$\therefore$ I-Section is preferable cross-section for bending loads

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31. Ans: (d)

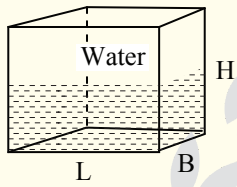
Sol: For ductile materials like aluminium maximum shear stress and distortion energy theories can be used.

32. Ans: (b)

Sol: Let L = 2x

B = x

H = 2x



$$\frac{F_{Bottom}}{F_{Large\ wall}} = \frac{(\rho.g.H)(B.L)}{\left(\rho.g.\frac{H}{2}\right)(L.H)}$$

$$= \frac{2B}{H} = \frac{2 \times x}{2x} = 1$$

33. Ans: (c)

Sol: $Q_R = \left(\frac{\gamma - n}{\gamma - 1}\right) \times$ work done

34. Ans: (b)

Sol:

- Fluctuation of energy depends on the nature of turning moment and not on the size of the flywheel.
- For a given maximum fluctuation of energy, If size of flywheel increases, moment of inertia increases and therefore fluctuation of speed decreases.

35. Ans: (A)

Sol: As steam is drained out for feed water heating, work output decreases. As feed water temperature increases heat supply is less and thermal efficiency increases.

36. Ans: (c)

Sol: Flux functions:

1. To deoxidize the melt.
2. To absorb gases present in weld pool.
3. To form slag layer over weld bead.

37. Ans: (a)

Sol: The Austenite iron is face centered cubic structure material.

Note: Austenitic stainless steel contains between 16 to 26% Cr and 8% nickel. They have the FCC crystal structure of austenitic that retained at room temperature because of the large amount of austenitizing elements, such as nickel, manganese and nitrogen used in making the steel alloy.

38. Ans: (b)

Sol: $\tau_H = \frac{T.r}{J}$

Both hollow and solid shaft have equal torque and equal maximum stress.

$\tau_H = \tau_S$

$$\left(\frac{T \times r}{J}\right)_H = \left(\frac{T \times r}{J}\right)_S$$

$$\left(\frac{J}{r}\right)_H = \left(\frac{J}{r}\right)_S$$

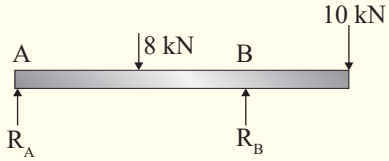
So, they have equal polar modulus of section.

39. Ans: (d)

Sol: $T_e = \sqrt{M^2 + T^2} = \sqrt{3^2 + 4^2} = 5$ kNm

40. Ans: (b)

Sol: F.B.D of beam is shown below:



$\Sigma M_B = 0$

$R_A \times 10 - 8 \times 4 + 10 \times 5 = 0$

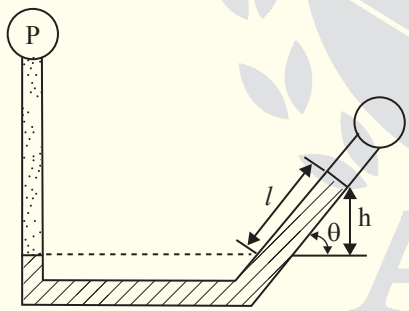
$R_A = -1.8$ kN

41. Ans: (b)

Sol:

$$\ell = \frac{h}{\sin\theta} = h \times \left(\frac{1}{\sin\theta}\right)$$

Pressure = ρ g.h



The factor $\left(\frac{1}{\sin\theta}\right)$ is called sensitivity of inclined manometer.

42. Ans: (b)

Sol: In an isothermal process $\delta Q = \delta W$

43. Ans: (c)

Sol: $\Delta E = \frac{1}{2} I(\omega_2^2 - \omega_1^2)$

$$\frac{1}{2} \times T_{max} \times \frac{\pi}{3} = \frac{1}{2} \times I \times (30^2 - 20^2)$$

$T_{max} = 477.2$ Nm

44. Ans: (a)

Sol: If multiple pumps are connected to parallel they will increase discharge and if they are connected in series they will increase head. However, the meaning of multi staging is generally considered as pumps in series. Therefore, option (a) is more appropriate.

45. Ans: (b)

Sol: Safety valve is boiler mounting. Steam strap, steam separator and economizer are boiler accessories.

46. Ans : (c)

Sol:

- The resistance welding process can be successfully used for welding of mild steel, high carbon steels, alloy steels, stainless steel, aluminium and its alloys, magnesium and its alloys and large combination of other dissimilar metals.
- The resisting of material influences the heat generation in resistance welding. Silver and copper has low resistivity and high thermal conductivity. So a little amount of heat is generated even with high welding current and also transferred away quickly. So they are difficult to weld with resistance welding. But they can be good materials for electrodes.

47. Ans: (b)

Sol: $P_e = \dfrac{\pi^2 EI_{min}}{L_e^2}$

$$\sigma = \frac{P_e}{A} = \frac{\pi^2 EI_{min}}{L_e^2 A} = \frac{\pi^2 EAK^2}{L_e^2 A}$$

$I_{min} = AK^2$

$A \rightarrow$ Area of cross section

$K \rightarrow$ radius of gyration

$$\sigma = \frac{\pi^2 EK^2}{L_e^2} = \frac{\pi^2 E}{(Le/K)^2} = \frac{\pi^2 E}{S^2}$$

$$S = \frac{L_e}{K} = \text{slenderness ratio}$$

48. Ans: (d)

Sol: Spherical roller bearings support a rotating shaft in the bore of the inner ring that may be misaligned with respect to the outer ring.

49. Ans: (c)

Sol: Pressure exerted by a person on snow

$$P = \frac{W}{A} = \frac{70 \times 9.81(N)}{500 \times 10^{-4}(m^2)}$$

$= 13.73 \times 10^3$ N/m^2

$= 13.73$ kN/m^2

50. Ans: (a)

Sol: $W = \int Pdv$ is valid for quasistatic i.e frictionless, reversible and non flow processes.

51. Ans: (d)

Sol: Coefficient of fluctuation of speed

$$= \frac{\omega_2 - \omega_1}{\left(\frac{\omega_1 + \omega_2}{2}\right)}$$

$$= \frac{2 \times (410 - 390)}{(410 + 390)} = \frac{40}{800} = \frac{1}{20} = 0.05$$

52. Ans: (a)

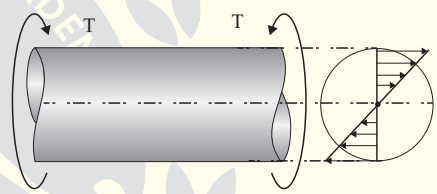
Sol: The output of a boiler is normally stated as evaporative capacity in tonnes of steam that can be produced from and at 100°C.

53. Ans: (b)

Sol: The machining analysis can not be done with discontinuous chips.

54. Ans: (d)

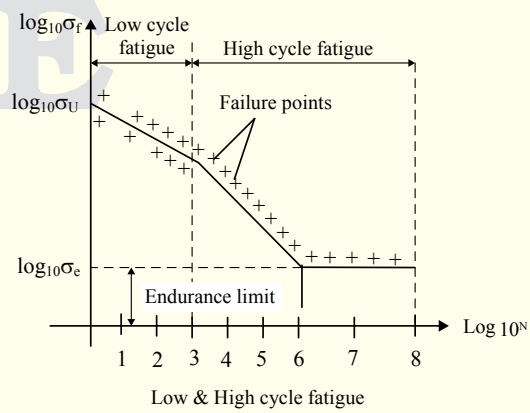
Sol:



$(\tau) = 0$ at the axis of shaft

55. Ans: (c)

Sol: S-N curve for ferrous material like steel is represented below.



Low & High cycle fatigue

Low and High cycle fatigue [stresses amplitude (σ_f) versus the number of stress cycles (N)].

For Ferrous metals like steel, S-N curve becomes asymptotic at 10^6 cycles, represents endurance limit.

56. Ans: (b)

Sol:

- Floating body is in stable equilibrium if its metacentre is above its centre of gravity.
- Submerged body is in stable equilibrium if its centre of buoyancy is above its centre of gravity.

57. Ans: (b)

Sol: $N_{S_A} = N_{S_B}$

$H_A = H_B$

$P_A = 400$ kW

$N_A = 1000$ rpm

$P_B = 100$ kW

$N_B = ?$

$$\frac{N_A \cdot \sqrt{P_A}}{(H_A)^{5/4}} = \frac{N_B \sqrt{P_B}}{(H_B)^{5/4}}$$

$$\frac{1000\sqrt{400}}{(H_A)^{5/4}} = \frac{N_B \sqrt{100}}{(H_B = H_A)^{5/4}}$$

$1000 \times 20 = N_B \times 10$

$\therefore N_B = 2000$ rpm.

58. Ans: (c)

Sol: ${}_1W_2 = Pdv$

$= 101.325 \times 0.6 = 60.8$ kJ

59. Ans: (a)

Sol:

- To keep the maximum fluctuation of speed within specified limits for a given maximum fluctuation of kinetic energy a flywheel is attached to the crank shaft.
- Primary function of flywheel is to limit the fluctuation of speed during each cycle

60. Ans: (a)

Sol: Plate type valves; Read type valves

61. Ans: (d)

Sol:

- Quick-Return mechanism is used to maintain cutting and reverse strokes. So, (a) is incorrect.
- Rack and pinion mechanism provides the bi-directional continuous feed which is not the requirement of intermittent table feed in shaping or planning. So, (b) is incorrect.
- Cam mechanism is not used because of its high cost relative to alternative mechanisms. So, (c) is incorrect.
- A Ratchet is a device that allows linear or rotary motion in only one direction. So, (d) is correct.

62. Ans: (c)

Sol: $\sigma_h = \frac{PD}{2t}, \sigma_L = \frac{PD}{4t}$

$$\frac{\sigma_h}{\sigma_L} = 2$$

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ME	6	60
EE	7	71
EC	9	74
CS	5	28
IN	10	74
PI	10	49

63. Ans: (a)

Sol: The bolts in rigid coupling are subjected to transverse shear and bending.

64. Ans: (c)

Sol: $u = x - 4y$ & $v = -y - 4x$

Check for continuity equation for 2–D, incompressible flow:

$$\frac{\partial u}{\partial x} = 1 - 0 = 1$$

$$\frac{\partial v}{\partial y} = -1 - 0 = -1$$

$$\therefore \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

Hence, velocity components satisfy continuity equation. Option (a) is wrong.

Check for Rotational (or) Irrotational flow:

For 2D – flow,

$$\frac{\partial v}{\partial x} = -4, \frac{\partial u}{\partial y} = -4$$

As $\frac{\partial v}{\partial x} = \frac{\partial u}{\partial y}$, so the flow is irrotational

65. Ans: (a)

Sol: It is the speed of a geometrically similar pump which would deliver unit quantity against a unit head.

66. Ans : (c)

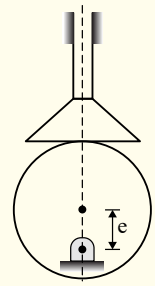
Sol:

ACB	ADB
$\delta Q - \delta W = dU$	$\delta Q - \delta W = dU$
$180 - 130 = dU$	$\delta Q - 40 = 50$
$dU = 50$ kJ	$\delta Q = 90$ kJ

As end states are same dU is same. δQ and δW are path functions.

67. Ans: (c)

Sol:



If the disc is rotated by an angle θ the follower is displaced by distance x, so that

$$x = e(1 - \cos\theta)$$

Therefore, the displacement of follower is simple harmonic motion.

68. Ans: (c)

Sol: In compounding high speeds of rotors are brought down to normal levels.

69. Ans: (b)

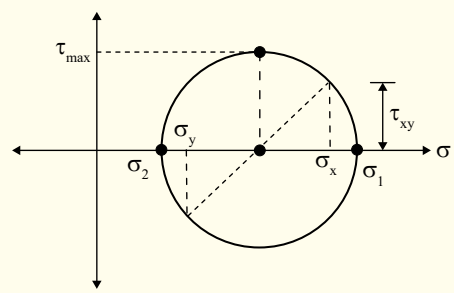
Sol: For column with both end fixed

$$P_e = \frac{4\pi^2 EI}{L^2} = \frac{\pi^2 EI}{(L/2)^2} = \frac{\pi^2 EI}{L_{ea}^2}$$

$$L_{ea} = \frac{L}{2}$$

70. Ans: (a)

Sol:



71. Ans: (c)

Sol: 3 – D, Incompressible, Un-steady continuity equation in Cartesian coordinate system (Rectangular coordinates) is given as:

$$\frac{\partial \rho}{\partial t}+\frac{\partial(\rho u)}{\partial x}+\frac{\partial(\rho v)}{\partial y}+\frac{\partial(\rho w)}{\partial z}=0$$

72. Ans: (b)

Sol: $_1Q_2 - {}_1W_2 = {}_1U_2 = U_2 - U_1$

$20 - 50 = -30 = U_2 - U_1$

$_2Q_1 - {}_2W_1 = {}_2U_1 = U_1 - U_2$

$-10 - {}_2W_1 = -(-30)$

$_2W_1 = -40$ kJ

73. Ans: (a)

Sol: Displacement of follower for simple harmonic motion if given by

$$S=\frac{h}{2}\left[1-\cos\pi\frac{\theta}{\phi}\right]$$

where, h = maximum follower displacement, θ = cam rotation angle and ϕ = cam angle for maximum follower displacement.

Velocity, $v=\frac{ds}{dt}$

$$=\frac{h\pi\omega}{2\phi}\sin\frac{\pi\omega t}{\phi} \quad [\because \theta=\omega t]$$

Acceleration, $f=\frac{dv}{dt}$

$$=\frac{h}{2}\left(\frac{\pi\omega}{\phi}\right)^2\cos\left(\frac{\pi\omega t}{\phi}\right),$$

Maximum acceleration, $f_{max}=\frac{h}{2}\left(\frac{\pi\omega}{\phi}\right)^2$

74. Ans: (b)

Sol: Condition for irrotational flow of stream function, is $\nabla^2\psi=0$

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=0$$

Given $\psi = 2xy$

$$\frac{\partial\psi}{\partial x}=2y;\ \frac{\partial\psi}{\partial y}=2x$$

$$\frac{\partial^2\psi}{\partial x^2}=0 \qquad \frac{\partial^2\psi}{\partial y^2}=0$$

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=0$$

This function satisfies $\nabla^2\psi=0$

$\therefore$ Hence $\psi = 2xy$ satisfies irrotational flow.

Options (a), (c) and (d) do not satisfy $\nabla^2\psi=0$

75. Ans: (c)

Sol: By applying steady flow energy equation to nozzle

$$h_1+\frac{V_1^2}{2000}=h_1+\frac{V_2^2}{2000}$$

$V_1 = 0$

Exit velocity, $V_2=\sqrt{2000\times\triangle h}=44.72\sqrt{\triangle h}$

$= 44.72\sqrt{45} = 300$ m/sec

76. Ans: (b)

Sol:

- Trace point is a reference point on the follower to trace the cam profile. Thus, motion of trace point describes movement of the follower.
- The curve generated by trace point assuming that the cam is fixed and the trace point of the follower rotates around the cam is called pitch curve. It is the actual working curve of cam.
- Base circle is the smallest circle that can be drawn tangential to the cam profile.

77. Ans: (c)

Sol: By Newton's second law of motion,

$$\vec{F} = m\vec{a}$$

$$m\frac{d\vec{v}}{dt} = \vec{F}$$

$$m\int dv = \int F dt$$

= Area under F − t curve

$$m[v_f - v_i] = \frac{1}{2} \times 10 \times 5$$

$\therefore \quad v_f = 5$ m/s ($\because v_i$ is zero)

78. Ans: (c)

Sol: $u = 2x^2 + y^2$

$v = -4xy$

$$a_x = u.\frac{\partial u}{\partial x} + v.\frac{\partial u}{\partial y}$$

$$= (2x^2 + y^2)(4x) + (-4xy)(2y)$$

$$= (2 + 4)(4) + (-8)(4)$$

$a_x|_{1,2} = 24 - 32 = -8$ units

79. Ans: (b)

Sol: $W_{net} = W_E - W_C = 50 - 20 = 30$ kJ

$Q_s = 80$ kJ

$$\eta = \frac{W_{net}}{Q_s} = \frac{30}{80} = 0.375 \text{ (or) } 37.5\%$$

80. Ans: (c)

Sol:

- The pair shown has two degree of freedom one is translational (motion along axis of bar and the rotation (rotation about axis). Both motion are independent. Therefore the pair has incomplete constraint.
- Kinematic pair is a joint of two links having relative motion between them. The pair shown form a kinematic pair.

  Note: Option (a) is also correct but option (c) is more correct.

81. Ans: (b)

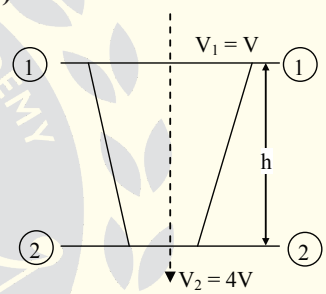
Sol: N_1 = Number of plates on driver shaft.

N_2 = Number of plates on driven shaft.

Number of active surfaces = $N_1 + N_2 - 1$

82. Ans: (c)

Sol:



Applying Bernoulli's equation (1) and (2):

$$\frac{P_1}{\rho g} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + Z_2 + \frac{V_2^2}{2g}$$

Given, $P_1 = P_2$

$V_1 = V \qquad Z_1 = h$

$V_2 = 4V \qquad Z_2 = 0$

$$h + \frac{V^2}{2g} = \frac{(4V)^2}{2g}$$

$$h = \frac{15V^2}{2g}$$

$$\frac{h}{\left(\frac{V^2}{2g}\right)} = 15$$

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83. Ans: (c)

Sol: In a pure rolling contact of the two links, the instantaneous centre lies at their point of contact. This is because the relative velocity between the two links at the point of contact is zero.

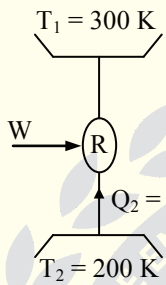
84. Ans: (c)

Sol: $(COP)_R = \dfrac{T_2}{T_1 - T_2}$

$= \dfrac{200}{300 - 200} = 2$

$\dfrac{Q_2}{W} = 2 = COP$

$W = \dfrac{Q_2}{2} = \dfrac{2}{2} = 1\ kW$



85. Ans: (c)

Sol: "γ" value of NH_3 is high hence higher compressor discharge temperatures. Only Iron and steel is used in NH_3 systems. It is toxic in nature.

86. Ans: (d)

Sol: $\rho_{Air} = 1.2\ kg/m^3$

Dynamic pressure, $P_D = 380\ N/m^2$

$P_D = \rho.g.h_D$

$\therefore\ h_D = \dfrac{P_D}{\rho g} = \dfrac{380}{1.2 \times 9.81}$

$h_{D\,Air} = 32.28$ meters of air

$\therefore V_{air} = \sqrt{2.g.h_D} = \sqrt{2 \times 9.81 \times 32.28}$

$= \sqrt{633.33} = 25.17$ m/s

(OR)

$V_{air} = \sqrt{\dfrac{2(P_o - P)}{\rho}} = \sqrt{\dfrac{2 \times 380}{1.2}} = 25.17$ m/s

87. Ans: (b)

Sol: $F = 3(n-1) - 2j - h$

$1 = 3(n-1) - 2j - 2$

$\therefore\ 2j = 3n - 6$

$j = \dfrac{3n-6}{2}$

j = Number of lower pairs

j must be positive integer

$\therefore$ n must be even

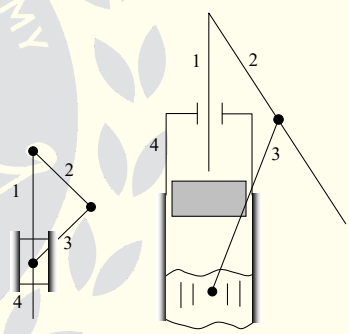
$\therefore\ n_{min} = 4$

88. Ans: (b)

Sol: $COP = \dfrac{NRE}{W} = \dfrac{1 \times 3.517\ kW}{1.5\ kW} = 2.33$

89. Ans: (a)

Sol:



If the link 4 of the slider-crank mechanism is fixed, the fourth inversion is obtained.

Application: Hand pump

90. Ans: (a)

Sol: $\dfrac{dM}{dx} = c$

Shear force = $F = \dfrac{dM}{dx}$ = constant

Shape of SF diagram should be a rectangle.

91. Ans: (c)

Sol: The angle of V-belt is generally 40°.

92. Ans: (d)

Sol: When the flow is steady, incompressible and irrotational then Bernoulli equation can be applied for any two points in the flow.

93. Ans: (c)

Sol: $N_{Spump} = \frac{N\sqrt{Q}}{(H)^{3/4}}$

$$= \frac{\frac{1}{sec}\sqrt{\frac{meter^3}{sec}}}{(meter)^{3/4}}$$

$$= T^{-1}L^{3/2}T^{-1/2}L^{-3/4} = M^0L^{3/4}T^{-\frac{3}{2}}$$

94. Ans: (a)

Sol:

$$\eta = \frac{W}{W+Q_R} = \frac{\frac{1}{4}Q_R}{\frac{1}{4}Q_R + Q_R}$$

$$\frac{\frac{1}{4}}{\frac{5}{4}} = 0.2 \text{ or } 20\%$$

95. Ans: (d)

Sol: The number of 'I' centers, $= \frac{n(n-1)}{2} = \frac{10\times 9}{2} = 45$

96. Ans : (a)

Sol: If refrigerant flow is less then designed temperature rises and same reason for inadequate water circulation and fouled condenser.

97. Ans: (d)

Sol: Chip equivalent $= \frac{\text{Engaged cutting edge length}}{\text{Plan area of cut}}$

- Used for controlling tool temperature.
- Increase in nose radius also increases the value of chip equivalent and improves tool life.

98. Ans: (c)

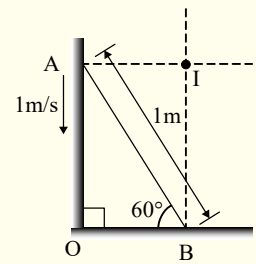
Sol:

Given:

$V_a = 1$ m/s ;

$L = 1$ m ;

$\theta = 60°$



V_a is along vertical and V_b is along horizontal. So instantaneous center of link AB will be perpendicular to A and B respectively i.e., at I

$IA = OB = I\cos\theta = 1\times\cos 60° = \frac{1}{2}$m

$IB = OA = I\sin\theta = 1\times\cos 60° = \frac{\sqrt{3}}{2}$m

$V_s = \omega \times IA$

$\Rightarrow \omega = \frac{V_a}{IA} = 2$ rad/sec

99. Ans: (c)

Sol: The critical cooling rate required for getting the complete martensite structure in steel depends on the carbon percentage as shown in figure.

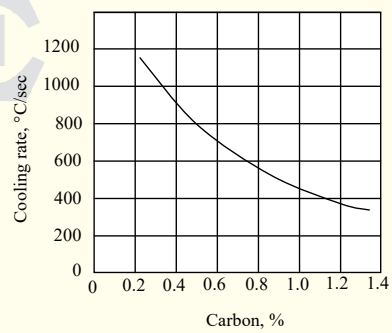


Fig: Higher the carbon, lower is the cooling rate required.

100. Ans: (b)

Sol: The deflection of a helical spring is given by

$$\delta = \frac{64PR^3N}{Gd^4}$$

where, P = load;
R = coil radius
N = Number of turns
G = Modulus of rigity
d = wire diameter

$$k = \frac{P}{\delta} = \frac{Gd^4}{64R^3N} \propto \frac{1}{N}$$

$\Rightarrow$ When N is halved, K must be doubled.