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ESE 2017 - PRELIMS

MECHANICAL ENGINEERING

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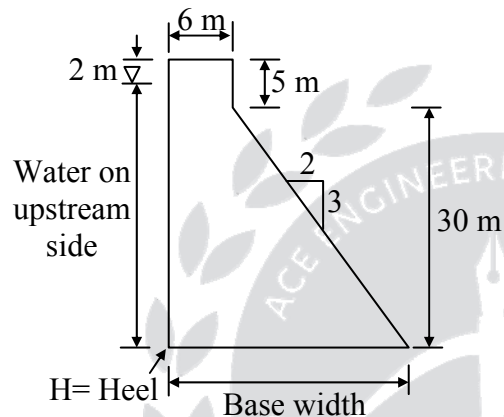
SET - A



UPSC Engineering Services - 2017 (Prelims)

Mechanical Engineering [SET - A]

01. A section of a dam made of concrete, $\rho = 2.6$, total height = 35 m, with top walkway width of 6 m, is shown. The upstream bottommost point is called the Heel of the dam. The sloped part on downstream side is 3 vertical on 2 horizontal. Water stands till 2m short of the top of the dam section. The net resultant force acting on the base level of the dam is nearly



- (a) 1370 k kgf (b) 1385 k kgf (c) 1400 k kgf (d) 1433 k kgf

01. Ans: (d)

- Sol: 1. Assume 2.6 specific gravity of concrete
2. Width Perpendicular to plane of paper is 1

$$F_H = P_c \cdot A = \left(1000 \times 9.81 \times \frac{33}{2} \right) \times (33 \times 1)$$

$$= 5341.5 \text{ kN}$$

$$= 544.5 \text{ k kgf}$$

Total weight of concrete dam = F_V

$$F_V = mg = \rho Vg$$

$$= 2600 \times \left(6 \times 35 + \frac{1}{2} \times 20 \times 30 \right) \times 9.81$$

$$= 13008.1 \text{ kN}$$

$$= 1326 \text{ k kgf}$$

$$\text{Resultant force, } F = \sqrt{F_H^2 + F_V^2} = 1433.4 \text{ k kgf}$$



02. A spherical water drop of 1 mm in diameter splits up in air into 64 smaller drops of equal size. The surface tension coefficient of water in air is 0.073 N/m. The work required in splitting up the drop is

- (a) 0.96×10^{-6} J (b) 0.69×10^{-6} J
(c) 0.32×10^{-6} J (d) 0.23×10^{-6} J

02. Ans: (b)

Sol: $\frac{4}{3}\pi(R^3) = 64 \times \frac{4}{3}\pi r^3$

$$\frac{r^3}{R^3} = \frac{1}{64}$$

$$r = \frac{R}{4} = \frac{(1/2)}{4}$$

$$r = \frac{1}{8} \text{ mm}$$

Work = (surface tension) \times (increase in surface area)

$$= \sigma \times (64 \times 4\pi r^2 - 4\pi R^2) = 0.073 \left(64 \times \left(\frac{1}{8}\right)^2 - \left(\frac{1}{2}\right)^2 \right) \times 4\pi \times 10^{-6} = 0.69 \times 10^{-6} \text{ J}$$

03. Consider the following statements pertaining to stability of floating bodies:

1. A floating body will be stable when the centre of gravity is above the centre of buoyancy.
2. The positions of metacentres corresponding to different axes of rotation are generally different for the same floating object.
3. For cargo ships, the metacentric height varies with loading.

Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

03. Ans: (d)

04. Water is coming out from a tap and falls vertically downwards. At the tap opening, the stream diameter is 20 mm with uniform velocity of 2 m/s. Assuming steady inviscid flow, constant pressure atmosphere everywhere and neglecting curvature and surface tension effects, the diameter of the stream 0.5m below the tap opening is nearly.

- (a) 11.7 mm (b) 14.6 mm
(c) 17.5 mm (d) 20.4 mm



04. Ans: (b)

Sol: $\frac{V_1^2}{2g} + Z_1 = \frac{V_2^2}{2g}$

$$V_2 = \sqrt{V_1^2 + 2gz_1}$$
$$= \sqrt{2^2 + 2 \times 9.81 \times 0.5} = 3.72 \text{ m/s}$$

$$A_1 V_1 = A_2 V_2$$

$$d_2^2 = d_1^2 \times \frac{V_1}{V_2} = 20^2 \times \frac{2}{3.72}$$

$$d_2 = 14.67 \text{ mm}$$

05. Consider the following statements regarding Bernoulli’s equation:

1. It is assumed that no energy has been supplied.
2. The velocity of a steady stream of fluid flow will depend on the cross-sectional area of the stream.
3. Consider two sections 1 and 2 along a flow stream. In this reach, if q is work done by a pump, w is work absorbed by turbine, ρ is density of water and g is acceleration of gravity, with p, v and z carrying standard meanings, Bernoulli’s equation will read

$$\frac{p_1}{\rho} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho} + \frac{v_2^2}{\rho} + z_2 + w + q$$

Which of the above statements are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

05. Ans: (a)

06. An oil flows through a pipe at a velocity of 1.0 m/s. The pipe is 45 m long and has 150 mm diameter. What is the head loss due to friction, if ρ = 869 kg/m³ and μ = 0.0814 kg/m s?

- (a) 0.61m
- (b) 0.51m
- (c) 0.41 m
- (d) 0.31m

06. Ans: (a)

Sol: $h_f = \frac{\Delta P}{\rho g}$

$$R_e = \frac{\rho V D}{\mu} = \frac{869 \times 1 \times 0.15}{0.0814} = 1601 < 2000$$



∴ Laminar flow

$$h_f = \frac{\left(\frac{32\mu VL}{D^2}\right)}{\rho g} = \frac{32 \times 0.0814 \times 45}{869 \times 9.81 \times 0.15^2} = 0.61\text{m}$$

07. Consider the following statements:

1. At low Reynolds numbers of any flow, viscous forces dominate over inertial forces.
2. Transition from laminar to turbulent flow occurs over a range of Reynolds numbers depending on the surface presented to the flow.

Which of the following statements is/are correct?

- (a) 1 only (b) 2 only (c) both 1 and 2 (d) neither 1 nor 2

07. **Ans: (c)**

08. In a steady laminar flow of a given discharge through a circular pipe of diameter D, the head loss is proportional to

- (a) D^{-1} (b) D^{-2} (c) D^{-3} (d) D^{-4}

08. **Ans: (d)**

Sol: For laminar flow, $h_f = \frac{128\mu Q^2}{\pi \rho g D^4}$ $h_f \propto \frac{1}{D^4}$

09. A two-dimensional flow field is defined as $\vec{V} = \vec{i}x - \vec{j}y$. The equation of the stream line passing through the point (1,2) is

- (a) $xy+2 = 0$ (b) $x^2y+2 = 0$
(c) $xy-2 = 0$ (d) $x^2y-2 = 0$

09. **Ans: (c)**

Sol: $\frac{dx}{x} = \frac{dy}{-y}$

$$\ln x = -\ln y + c_1$$

$$\ln xy = c_1$$

$$xy = e^{c_1} = c$$

$$\text{at } (1,2) \quad c = 1 \times 2$$

$$\therefore xy - 2 = 0$$



10. The centre-line velocity in a pipe flow is 2 m/s. What is the average flow velocity in the pipe if the Reynolds number of the flow is 800?

- (a) 2 m/s (b) 1.5 m/s (c) 1 m/s (d) 0.5 m/s

10. Ans: (c)

Sol: For laminar flow $V_{avg} = \frac{V_{max}}{2} = \frac{2}{2} = 1 \text{ m/s}$

11. During a constant pressure expansion of a gas, 33.3% heat is converted into work while the temperature rises by 20 K. The specific heat of the gas at constant pressure as a proportion of work, W is

- (a) 8% (b) 10% (c) 12% (d) 15%

11. Ans: (d)

Sol: In a constant pressure process, $dQ = c_p dT$

$$dW = 0.33 \times dQ$$

$$\frac{dQ}{dW} = \frac{1}{0.33} = 3$$

or

$$dQ = 3 dW$$

$$C_p = \frac{dQ}{dT} = \frac{3dW}{20} = 0.15 dW$$

$$C_p \text{ as a percentage of work is } \frac{0.15dW}{dW} \times 100 = 15\%$$

12. A cylinder contains 10 m^3 of an ideal gas at a pressure of 2 bar. This gas is compressed in a reversible isothermal process till its pressure increases to 15 bar. What quantum of work will be required for this process? (You can use the table given herewith)

| | | | | | |
|-------------------|-------|-------|-------|-------|-------|
| Number | 2 | 2.5 | 3 | 5 | 7 |
| Log ₁₀ | 0.301 | 0.397 | 0.475 | 0.698 | 0.845 |

- (a) 4500 kJ (b) 4030 kJ
(c) 450 kJ (d) 403 kJ



12. Ans: (b)

Sol: Compressive work = ${}_1W_2 = P_1 V_1 \ln\left(\frac{P_1}{P_2}\right)$

$$= 200 \times 10 \times \ln\left(\frac{2}{15}\right) = 200 \times 10 \times \left[2.303 \times \log_{10}\left(\frac{2}{15}\right)\right]$$

$$= 200 \times 10 \times (2.303 \times (\log_{10} 2 - \log_{10} 15))$$

$$= 200 \times 10 \times 2.303 (\log_{10} 2 - \log_{10} (5 \times 3))$$

$$= 200 \times 10 \times 2.303 (\log_{10} 2 - \log_{10} 5 - \log_{10} 3)$$

$$= 200 \times 10 \times 2.303 (0.301 - 0.475 - 0.698)$$

$$= 200 \times 10 \times 2.303 (0.872)$$

$$= 4030 \text{ kJ}$$

13. A system of 100 kg mass undergoes a process in which its specific entropy increases from 0.3 kJ/kgK to 0.4 kJ/kgK. At the same time, the entropy of the surroundings decreases from 80 kJ/kgK to 75 kJ/kgK. The process is

- (a) reversible and isothermal (b) irreversible
(c) reversible only (d) isothermal only

13. Ans: (b)

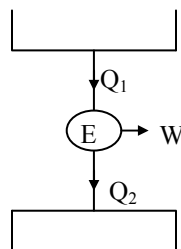
Sol: $(dS)_{\text{system}} = m (s_2 - s_1)$
 $= 100 (0.4 - 0.3) = 10 \text{ kJ/K}$
 $(dS)_{\text{surroundings}} = 75 - 80 = -5 \text{ kJ/K}$ (error in units in the given problem)
 $(dS)_{\text{universe}} = (dS)_{\text{sys}} + (dS)_{\text{surr}} = 5 \text{ kJ/K} > 0$

14. A reversible heat engine rejects 80% of the heat supplied during a cycle of operation. If the engine is reversed and operates as a refrigerator, then its coefficient of performance shall be

- (a) 6 (b) 5 (c) 4 (d) 3

14. Ans: (c)

Sol: $W = Q_1 - Q_2$
 $Q_2 = 0.8 Q_1$
 $W = Q_1 - 0.8 Q_1 = 0.2 Q_1$
 $\eta_E = \frac{W}{Q_1} = \frac{0.2 Q_1}{Q_1} = 0.2$
 $(\text{COP})_R = \frac{1 - \eta_E}{\eta_E} = \frac{1 - 0.2}{0.2} = 4$



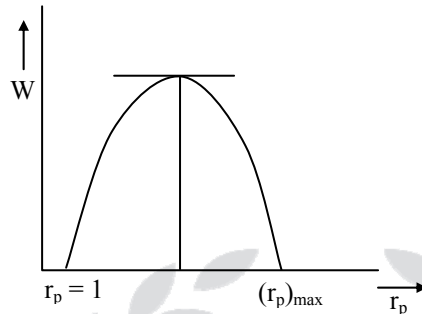


15. For the same efficiency of the Brayton cycle and the Carnot cycle working between temperature limits of T_{\max} and T_{\min} , the power contribution of the Brayton cycle will be

- (a) zero (b) maximum
(c) minimum (d) 50% of the Carnot cycle

15. Ans: (a)

Sol:

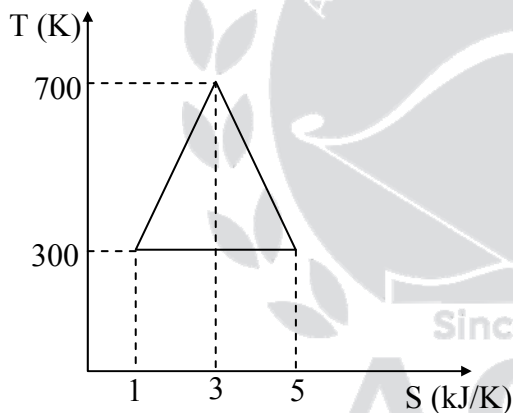


At $(r_p)_{\max}$

$$\eta_{\text{brayton}} = \eta_{\text{carnot}}$$

Network is zero as turbine work = compressor work

16. The thermal efficiency of the hypothetical cycle shown is



- (a) 0.6 (b) 0.5 (c) 0.4 (d) 0.3

16. Ans: (c)

Sol: $W = \frac{1}{2}(dS) \times (dT)$

$$W = \frac{1}{2}(5 - 1)(700 - 300) = 800 \text{ kJ}$$

Heat rejected, $Q_R = \text{lowest temperature} (dS)$

$$Q_R = 300(5 - 1) = 1200 \text{ kJ}$$

$$Q_S = W + Q_R = 800 + 1200 = 2000 \text{ kJ}$$

$$\eta = \frac{W}{Q_S} = \frac{800}{2000} = 0.4$$

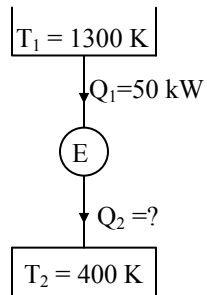


17. A heat engine working on the Carnot cycle receives heat at the rate of 50 kW from a source at 1300 K and rejects it to a sink at 400 K. The heat rejected is

- (a) 20.3 kW (b) 15.4 kW
(c) 12.4 kW (d) 10.8 kW

17. Ans: (b)

Sol:



$$\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$$

$$Q_2 = \frac{Q_1}{T_1} \times T_2 = 50 \times \frac{400}{1300} = 15.38 \text{ kW}$$

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18. An ideal gas is flowing through an insulated pipe at the rate of 3.3 kg. There is a pressure drop of 15% from the inlet to the outlet of the pipe. What is the rate of energy loss because of this pressure drop due to friction, given that $R_{\text{gas}} = 0.287 \text{ kJ/kgK}$ and the reference temperature T_0 is 300 K?

- (a) 42.62 kW (b) 40.26 kW
(c) 38.14 kW (d) 35.13 kW

18. Ans: (a)

Sol:



$$P_1 - P_2 = \Delta P_1 = 0.15 P_1$$

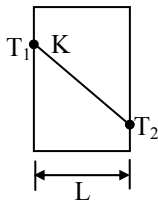
$$\text{Energy loss} = \dot{m} R T_0 \frac{\Delta P_1}{P_1} = 3.3 \times 0.287 \times 300 \times \frac{0.15 P_1}{P_1} = 42.62 \text{ kW}$$

19. A furnace is provided with an insulating refractory lining. The overall thermal conductivity of the material is 0.03 W/m K. The thickness of the lining is 100 mm. The inner and outer temperatures are 250°C and 50°C, respectively. The heat loss to the surroundings will be

- (a) 30 J/m²/s (b) 60 J/m²/s
(c) 60 J/s (d) 30 J/s

19. Ans: (b)

Sol:



Given data:

$$K = 0.03 \text{ W/mK}, \quad L = 0.1 \text{ m}$$

$$T_1 = 250^\circ\text{C}, \quad T_2 = 50^\circ\text{C}, \quad Q = ?$$

$$Q = \frac{T_1 - T_2}{\frac{L}{KA}}$$

$$\frac{Q}{A} = 60 \text{ J/m}^2/\text{s}$$



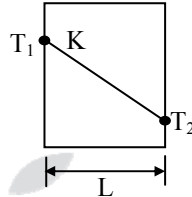
20. A wall of 0.6m thickness has normal area of 1.5 m² and is made up of material of thermal conductivity 0.4 W/m K. If the temperatures on the two sides of the wall are 800°C and 1000°C, the thermal resistance of the wall is

- (a) 1.8 K/W (b) 1.8 W/K
(c) 1 K/W (d) 1 W/K

20. Ans: (c)

Sol: Given Data:

- L = 0.6 m,
A = 1.5 m²,
K = 0.4 W/mK
T₁ = 800°C,
T₂ = 100°C



$$R_{th} = \frac{L}{KA} = \frac{0.6}{0.4 \times 1.5} = 1 \text{ K/W}$$

21. Heat is lost from a 100 mm diameter steam pipe placed horizontally in ambient air at 30°C. If the Nusselt number is 25 and the thermal conductivity of the air is 0.3 W/m K, then the heat transfer coefficient will be

- (a) 7.5 W/m²K (b) 15 W/m²K
(c) 25 W/m² K (d) 35 W/m² K

21. Ans: (a)

Sol: D = 0.1 m ,

T_∞ = 30°C ,

Nu = 25

K = 0.03 W/mK

$$Nu = 25 = \frac{hD}{K}$$

h = 7.5 W / m²K

22. Air at 1 atmospheric pressure and 27°C blows across a 12 mm diameter sphere at a free stream velocity of 4 m/s. A small heater inside the sphere maintains the surface temperature at 77°C. With k = 0.026 W/m (Kelvin) and with (Nu) = 31.4, the heat loss by the sphere would be

- (a) 1.93 J/s (b) 1.76 J/s
(c) 1.65 J/s (d) 1.54 J/s



22. Ans: (d)

Sol: $T_\infty = 27^\circ\text{C}$; $A = 4\pi r^2$
 $D = 0.012 \text{ m}$; $A = 4.52 \times 10^{-4} \text{ m}^2$
 $u_\infty = 4 \text{ m/s}$; $T_s = 77^\circ\text{C}$
 $K = 0.026 \text{ W/mK}$; $Nu = 31.4$

$$Nu = \frac{hD_h}{K}$$

$$31.4 = \frac{h \times 0.012}{0.026}$$

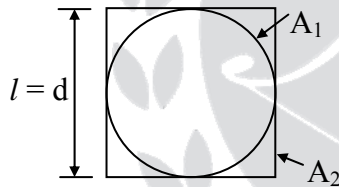
$$h = 68.03 \text{ W/m}^2\text{K}$$

$$Q_{\text{loss}} = hA(T_s - T_\infty)$$

$$Q_{\text{loss}} = 68.03 \times 4.52 \times 10^{-4} \times (77 - 27)$$

$$Q_{\text{loss}} = 1.54 \text{ W}$$

23. The view factors F_{12} and F_{21} , for the sphere of diameter d and a cubical box of length $l = d$ as shown in the figure, respectively, are



(a) 1 and $\frac{\pi}{3}$

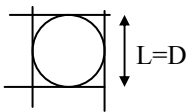
(b) $\frac{\pi}{3}$ and 1

(c) 1 and $\frac{\pi}{6}$

(d) $\frac{\pi}{6}$ and 1

23. Ans: (c)

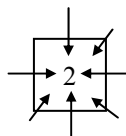
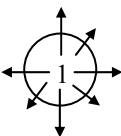
Sol:



(1) sphere

(2) cube

$$A_1 = \pi D^2 \quad ; \quad A_2 = 6D^2$$





$$F_{11} = 0, \quad F_{22} \neq 0$$

$$F_{11} + F_{12} = 1$$

$$F_{12} = 1$$

$$A_1 F_{12} = A_2 F_{21}$$

$$F_{21} = \frac{A_1}{A_2} (1)$$

$$F_{21} = \frac{\pi D^2}{6D^2} = \frac{\pi}{6}$$

24. Knocking in a spark ignition engine can be reduced by

1. retarding the spark
2. supercharging
3. increasing the engine speed
4. using a fuel of long straight chain structure

Select the correct answer using the code given below:

- (a) 1 and 4 (b) 1 and 3 (c) 2 and 3 (d) 2 and 4

24. **Ans: (b)**

25. A 4-cylinder diesel engine running at 1200 rpm developed 18.6 kW. The average torque when one cylinder was cut out was 105 N-m. If the calorific value of the fuel was 42000 kJ/kg and the engine used 0.34 kg of diesel/kW hr, the indicated thermal efficiency was nearly

- (a) 29% (b) 26% (c) 31% (d) 23%

25. **Ans: (a)**

Sol: 4 cylinders :

$$N = 1200 \text{ rpm}; \quad BP = 18.6$$

$$BP/\text{cylinder} = \frac{18.6}{4} = 4.65 \text{ kW}$$

$$BP \text{ with one cylinder cut off} = \frac{2\pi NT}{60000}$$

$$= \frac{\pi \times 1200 \times 105}{30000} = 13.188 \text{ kW}$$

$$(IP)_{1 \text{ cylinder}} = (BP)_{4 \text{ cylinders}} - (BP)_{3 \text{ cylinders}}$$

$$(IP)_{1 \text{ cylinder}} = (18.6 - 13.188) = 5.412$$

$$(IP)_{4 \text{ cylinder}} = 5.412 \times 4 = 21.648 \text{ kW}$$



$$\text{bsfc} = \frac{\dot{m}_f (\text{kg/h})}{\text{BP}(\text{kW})}$$

$$0.34 = \frac{\dot{m}_f (\text{kg/h})}{18.6(\text{kW})}$$

$$\dot{m}_f = 0.34 \times 18.6 (\text{kg/h})$$

$$\begin{aligned} \text{Indicate Thermal efficiency} &= \frac{\text{IP}(\text{kW}) \times 3600}{\dot{m}_f (\text{kg/h}) \times \text{CV}(\text{kJ/kg})} \\ &= \frac{21.648 \times 3600}{0.34 \times 18.6 \times 42000} = 0.2933 \text{ or } 29.33 \% \end{aligned}$$

26. In a Morse test on a 2-cylinder, 2-stroke SI engine, the brake power is 9 kW and the BHP of individual cylinders with spark cutoff are 4.25 kW and 3.75 kW, respectively. The mechanical efficiency of the engine is

- (a) 90% (b) 80% (c) 52.5% (d) 45.5%

26. **Ans: (a)**

Sol: $I = nB - (B_I + B_{II} + \dots + B_n)$

Where, B is brake power with all cylinders firing

B_I is brake power with first cylinders cutoff

B_{II} is brake power with second cylinders cutoff

n is no. of cylinders

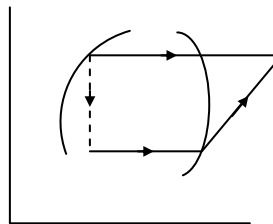
Indicated power of engine

$$I = nB - (B_I + B_{II}) = 2 \times 9 - (4.25 + 3.75) = 18 - 8 = 10 \text{ kW}$$

$$\text{Mechanical efficiency, } \eta_m = \frac{B}{I} = \frac{9}{10} = 0.9$$

27. The ordinates and abscissae of the diagram given for the vapour-compression refrigeration cycle represent

- (a) pressure and volume
(b) temperature and entropy
(c) enthalpy and entropy
(d) pressure and enthalpy



27. **Ans: (d)**



28. Consider the following statements for refrigeration and air-conditioning:
1. In a refrigerating machine, the heat exchanger that absorbs heat is connected to a conditioned space.
 2. A refrigerating cycle operating reversibly between two heat reservoirs has the highest coefficient of performance.
 3. The lower the refrigeration required and the higher the temperature of heat rejection to the surroundings, the larger the power consumption

Which of the above statements are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

28. **Ans: (d)**

29. In a refrigerator, the evaporator and condenser coil temperatures are -33°C and 27°C , respectively. Assuming that the maximum COP is realized, the required power input for a refrigerating effect of 4 kW is

- (a) 8 kW
- (b) 4 kW
- (c) 2 kW
- (d) 1 kW

29. **Ans: (d)**

Sol: $(\text{COP})_R = \frac{T_2}{T_1 - T_2} = \frac{Q_2}{W}$

$$\Rightarrow \frac{240}{300 - 240} = \frac{4}{W}$$
$$\Rightarrow W = 1 \text{ kW}$$

30. Consider the following statements:

The volumetric efficiency of a reciprocating compressor can be improved by

1. decreasing the clearance volume
2. cooling the intake air
3. heating the intake air

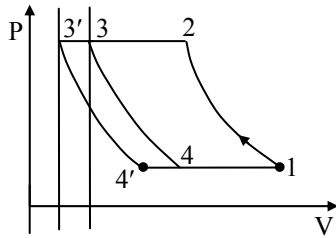
Which of the above statements is/are correct?

- (a) 2 only
- (b) 3 only
- (c) 1 and 2
- (d) 1 and 3



30. Ans: (c)

Sol:



$$\eta_{\text{vol}} = 1 + C - C \left(\frac{P_2}{P_1} \right)^{\frac{1}{n}}$$

C decreases, η_{vol} increases

C increases, η_{vol} decreases

Cooling intake air density increases

Hence more mass flow rate and η_{vol} increases.

31. Consider the following statements:

The presence of air inside condensers

1. remains as a non-condensable gas

2. reduces the condensing coefficient

3. tends to cling to the surface

4. introduces large thermal resistance

Which of the above statements are correct?

(a) 1, 2, 3 and 4

(b) 1, 2 and 3 only

(c) 3 and 4 only

(d) 1, 2 and 4 only

31. Ans: (d)

Sol: The feed water contains air in dissolved condition. Air is an insulator hence heat transfer rate is greatly reduced and their higher resistance to heat flow.

32. The refrigeration system of an ice plant working between temperatures of -5°C and 25°C produces 20 kg of ice per minute from water at 20°C . The specific heat of water is 4.2 kJ/kg and latent heat of ice is 335 kJ/kg. The refrigeration capacity of the refrigeration plant is

(a) 9040 kJ/min

(b) 8750 kJ/min

(c) 8380 kJ/min

(d) 8010 kJ/min



32. Ans: (c)

$$\begin{aligned} \text{Sol: NRE(kJ/min)} &= \frac{m}{t} [C_{P_w} (\Delta T)_w + L_{ice} + C_{P_i} (\Delta T)_{ice}] \\ &= \frac{20}{60} [4.2(20) + 335 + 2.1 \times 5] = 8380 \text{ kJ/min} \end{aligned}$$

33. Consider the following statements in respect of a vapour-absorption refrigeration cycle:

1. The absorption refrigeration cycle is generally used when waste heat is available from an existing source or when free energy like solar energy is to be used.
2. There are no moving parts in the absorption refrigeration plant except a small liquid pump.
3. The value of the coefficient of performance is nearly the same in both vapour-absorption and vapour-compression refrigeration plants.

Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

33. Ans: (b)

Sol: Vapor absorption COP is closer to one.

Vapor compression COP is many times greater than one.

Hence, statement 3 is wrong.

34. Air at 30°C and 1 bar has a specific humidity of 0.016 kg/kg of dry air. By considering the saturation pressure of water vapour at 30°C as 4.246 kPa, the relative humidity of the air will be

- (a) 66.1 % (b) 60.2% (c) 58.8% (d) 56.8%

34. Ans: (c)

Sol: $T_{sat} = 30^\circ\text{C}$

↓

$$P_{sat} = 4.246 \text{ kPa}$$

$$\omega = 0.622 \frac{P_v}{P_{atm} - P_v}$$

$$0.016 = 0.622 \frac{P_v}{100 - P_v}$$

$$P_v = 2.5078 \text{ kPa}$$

$$\text{Relative humidity, } \phi = \frac{P_v}{P_{sat}} = \frac{2.5078}{4.246} = 0.5906 = 59.06\%$$



35. Consider the following statements in respect of an evaporative cooling process :
1. The wet-bulb temperature remains constant.
 2. The dew-point temperature remains constant.
 3. The enthalpy remains constant.

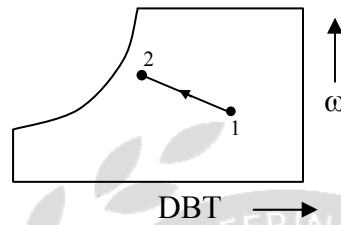
Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

35. **Ans: (d)**

Sol:

- h = constant
- WBT = constant
- DPT increases



36. For a steady process, the conditions at stage 1 and stage 2 are, respectively, $h_1 = 300$ kJ/kg, $h_2 = 150$ kJ/kg, $s_1 = 1.25$ kJ/kgK and $s_2 = 0.8$ kJ/kgK. The availability at the ambient temperature 300 K will be
- (a) 15 kJ (b) 20 kJ (c) 25 kJ (d) 35 kJ

36. **Ans: (a)**

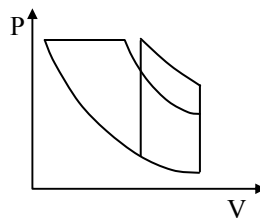
Sol: Availability, $a = (h_1 - h_2) - T_0 (s_1 - s_2)$
 $= (300 - 150) - 300 (1.25 - 0.8)$
 $= 150 - 300 \times 0.45 = 15$ kJ/kg

37. If the maximum pressure in both air-standard Otto and Diesel cycles is the same, then the relations for compression ratio r and the efficiency η between the two cycles are
- (a) $r_{\text{Diesel}} > r_{\text{Otto}}$ and $\eta_{\text{Diesel}} > \eta_{\text{Otto}}$
(b) $r_{\text{Otto}} > r_{\text{Diesel}}$ and $\eta_{\text{Diesel}} > \eta_{\text{Otto}}$
(c) $r_{\text{Diesel}} > r_{\text{Otto}}$ and $\eta_{\text{Otto}} > \eta_{\text{Diesel}}$
(d) $r_{\text{Otto}} > r_{\text{Diesel}}$ and $\eta_{\text{Otto}} > \eta_{\text{Diesel}}$

37. **Ans: (a)**

Sol:

$(r_k)_{\text{Diesel}} > (r_k)_{\text{Otto}}$
 $(\eta)_{\text{Diesel}} > (\eta)_{\text{Otto}}$












38. Which of the following statements are correct ?
1. The specific speed of a turbine is the speed at which a homologous turbine develops 1 mhp under unit head at its maximum efficiency.
 2. The specific speed is a dimensionless parameter used for the selection of turbines.
 3. The function of guide vanes in reaction turbines is to minimize shock at entry of the fluid onto the runner blades.

Select the correct answer using the code given below.

- (a) 1, 2 and 3 (b) 2 and 3 only
(c) 1 and 2 only (d) 1 and 3 only

38. Ans: (a)

OUR ESE 2016 TOP 10 RANKERS IN ALL STREAMS

| E&T | EE | CE | ME |
|--|---|--|--|
| 1  E&T | 2  EE | 2  CE | 1  ME |
| 2  E&T | 3  EE | 4  CE | 2  ME |
| 3  E&T | 4  EE | 6  CE | 3  ME |
| 4  E&T | 5  EE | 8  CE | 8  ME |
| 5  E&T | 6  EE | 9  CE | 9  ME |
| 6  E&T | 8  EE | 10  CE | |
| 7  E&T | 9  EE | | |
| 8  E&T | 10  EE | | |
| 9  E&T | | | |
| 10  E&T | | | |

6 IN
TOP 10 RANKS

5 IN
TOP 10 RANKS

72% OF STUDENTS
IN TOP 10
ARE FROM
ACE
and many more...

29 RANKS IN TOP 10 IN ESE-2016



39. A centrifugal pump lifts $0.0125 \text{ m}^3/\text{s}$ of water from a well with a static lift of 30m. If the brake power of the driving electric motor is 5 kW, what is the overall efficiency of the pump-set ?
 (a) 57.6% (b) 63.9% (c) 65.3% (d) 73.6%

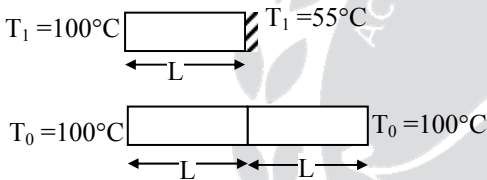
39. **Ans: (d)**

Sol: $\eta_0 = \frac{\rho g Q H}{P_{in}} = \frac{9810 \times 0.0125 \times 30}{5 \times 10^3} = 73.6\%$

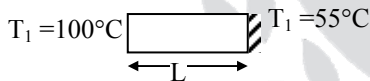
40. Two rods, one of length l and the other of length $2l$, are made of the same material and have same diameter. Both ends of the longer rod are maintained at 100°C , One end of the shorter rod is maintained at 100°C while the other end is insulated. Both rods are exposed to the same environment at 40°C . The temperature at the insulated end is measured to be 55°C . The temperature at the midpoint of the longer rod would be
 (a) 45°C (b) 50°C (c) 55°C (d) 60°C

40. **Ans: (c)**

Sol:



Shorter rod



$$\frac{T_L - T_\infty}{T_0 - T_\infty} = \frac{1}{\cosh mL}$$

$$\cosh mL = \frac{T_0 - T_\infty}{T_L - T_\infty}$$

$$\cosh mL = \frac{100 - 40}{55 - 40}$$

$$\cosh mL = \frac{60}{15} = 4$$

Longer rod

$$T_{\min} = T_\infty + \frac{T_0 - T_\infty}{\cosh mL} = 40 + \frac{100 - 40}{4}$$

$$= 40 + 15$$

$$T_{\min} = 55^\circ\text{C} \text{ at center (midpoint temperature)}$$



41. Consider the following statements in respect of ideal and practical gas turbine cycles :
1. In the ideal cycle case, the cycle efficiency depends on the pressure ratio only.
 2. In the practical cycle case (with irreversibilities in the compression and expansion processes), the cycle efficiency depends on the maximum temperature as well as on the pressure ratio.
 3. In the practical cycle case, at a given maximum temperature, the maximum efficiency and the maximum work done occur at a same pressure ratio.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

41. Ans: (a)

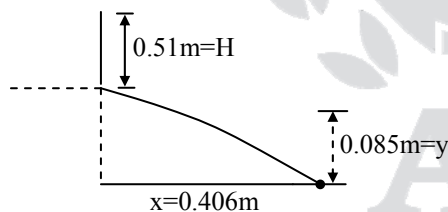
Sol: Maximum efficiency occurs at $(r_p)_{max}$
Maximum work occurs at $(r_p)_{opt}$
Hence, statement 3 is wrong.

42. A jet of water issues from a sharp-edged vertical orifice under a constant head of 0.51 m. At a certain point of the issuing jet, the horizontal and vertical coordinates measured from vena contracta are 0.406 m and 0.085 m, respectively. What is the value of the coefficient of velocity?

- (a) 0.975 (b) 0.925 (c) 0.875 (d) 0.825

42. Ans: (a)

Sol:



Let V = actual velocity of water at orifice

Using relation for projectile motion

$$y = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2y}{g}}$$

$$V = \frac{x}{t} = \frac{x}{\sqrt{\frac{2y}{g}}}$$



$$= \frac{0.406}{\sqrt{\frac{2 \times 0.085}{9.81}}} = 3.084 \text{ m/s}$$

$$c_v = \frac{V}{\sqrt{2gH}} = \frac{3.084}{\sqrt{2 \times 9.81 \times 0.51}} = 0.975$$

43. In the working of a vapour-compression refrigeration plant, the following enthalpies are recorded at salient points in the cycle :

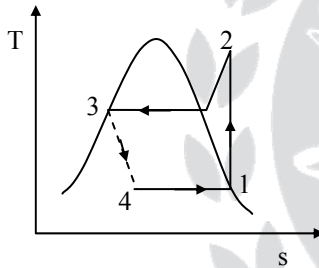
1. Enthalpy at inlet to compressor (saturated vapour), $h_1 = 300 \text{ kJ/kg}$
2. Enthalpy at outlet of compressor (after isentropic compression), $h_2 = 330 \text{ kJ/kg}$
3. Enthalpy at exit of condenser (saturated liquid), $h_3 = 150 \text{ kJ/kg}$

What is the COP of the plant?

- (a) 3 (b) 4 (c) 5 (d) 6

43. Ans: (c)

Sol:



$$h_1 = 300 \text{ kJ/kg,}$$

$$h_2 = 330 \text{ kJ/kg}$$

$$h_1 = h_4 = 150 \text{ kJ/kg}$$

$$\text{COP} = \frac{h_1 - h_4}{h_2 - h_1} = \frac{300 - 150}{330 - 300} = 5$$

44. Consider the following statements for single-stage reciprocating compressors :

1. Isothermal process is the most desirable process for compression.
2. The size of clearance volume provided in the compressor has no effect on work done per kg of air delivered.
3. The volumetric efficiency of the compressor decreases with increasing pressure.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3



44. Ans: (d)

Sol:

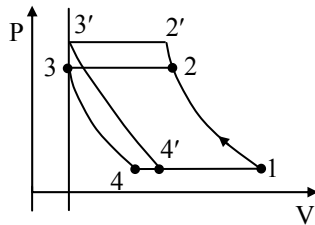


Figure is for volumetric efficiency decreasing with increase in pressure.

45. Consider the following statements in respect of regenerative Rankine cycle :

1. Regeneration increases the efficiency of the cycle
2. The boiler capacity is increased for a given output.
3. The capacity of the condenser is reduced.

Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

45. Ans: (a)

Sol: Due to regeneration, turbine work decreases, pump work constant, network decreases

Steam rate = $3600 / \text{network}$

\therefore Steam rate increases, heat supplied decreases, as less mass flow through the condenser the condenser load is decreased.

46. Consider the following statements in respect of (l) the temperature of the medium, (m) the refrigerant and (n) the condenser and absorption system in a refrigeration unit :

1. Temperature of the medium being cooled must be below that of the evaporator.
2. Refrigerant leaves the condenser as liquid.
3. Any solar thermally operated absorpotion system is capable only of intermittent operation.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

46. Ans: (c)



47. Volumetric analysis of a certain flue gas gave CO_2 15%, O_2 5% and rest as N_2 . The gas was at a temperature of 200°C and pressure of 5 bar. The partial pressure of N_2 in the flue gas is
- (a) 250 kN/m^2 (b) 300 kN/m^2
(c) 350 kN/m^2 (d) 400 kN/m^2

47. **Ans: (d)**

Sol: $(PP)_{\text{N}_2} = \frac{\text{No. of moles of N}_2}{\text{total no. of moles}} \times P$

$$= \frac{0.8}{0.8 + 0.15 + 0.5} \times 500 = 400 \text{ kPa}$$

48. Consider the following statement :

1. The efficiency of heat transfer in a condenser will improve by increase of the overall heat transfer coefficient
2. The efficiency of heat transfer in a condenser will improve by increase of the velocity of flow of water in the tube.
3. The difference between the temperature of steam entering the condenser and the inlet water temperature should be maximum for maximum efficiency.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3

48. **Ans: (a)**

Sol: The use of increase quantity of cooling water is required to maintain the heat transfer rates as dissolved air present in the condensing water offers high resistance to heat flow.

$$\text{Condenser efficiency} = \frac{T_{w_o} - T_{w_i}}{T_s - T_{w_i}}$$

T_{w_i} = temperature of cooling water at inlet

T_{w_o} = temperature of cooling water at outlet

T_s = temperature steam corresponding to the actual absolute pressure in the condenser

If $(T_s - T_{w_i})$ is maximum denominator increases hence condenser efficiency decreases.

49. The total power developed by a three-stage velocity compounded impulse steam turbine is 900 kW. The power magnitudes developed in the first and the second stages are, respectively
- (a) 500 kW and 300 kW (b) 100 kW and 300 kW
(c) 500 kW and 100 kW (d) 100 kW and 100 kW



49. Ans: (a)

Sol: In a three stage Curtis turbine the workdone is in the ratio 5:3:1. Workdone in the last stage of a three stage velocity compounded impulse turbine is $1/9^{\text{th}}$ of the total work.

Which is $\frac{1}{9} \times 900 = 100 \text{ kW}$

\therefore The work in first and second stage is 500 kW and 300 kW.

50. Consider the following statements in respect of natural-draft cooling towers :

1. Theoretically the water can be cooled to even below the dry-bulb temperature of the induced air flow.
2. Natural-draft cooling towers are 100 m or more in height.
3. The inner and outer surfaces are surfaces of revolution of a segment of a hyperbola about the vertical axis-affording improved strength rather than any thermodynamic augmentation.

Which of the above statements are correct?

- (a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

50. Ans: (b)

Sol: Technical speaking outlet water can be cooled to WBT of inlet air.

51. Consider the following statements :

1. Wind velocity at about 20 m height above the ground is taken as the rated velocity for design of wind-mills.
2. The total power of a wind stream is directly proportional to the cube of average velocity.
3. Wind turbine operates with variable load over a narrow range between cut-in and cut-out velocities.
4. Vertical wind machine operates in all wind directions, but it needs yaw adjustment.

Which of the above statement are correct?

- (a) 1 and 2 (b) 1 and 4
(c) 3 and 4 (d) 2 and 3

51. Ans: (d)

52. Which fuel cell is suitable for spacecraft applications?

- (a) Direct methanol fuel cell (b) Proton exchange membrane fuel cell
(c) Alkaline fuel cell (d) Phosphoric acid fuel cell

52. Ans: (c)



53. A flywheel on a motor speeds up from rest to 1000 rpm in 6 seconds. The number of revolutions made thereby is nearly

- (a) 200 (b) 100 (c) 50 (d) 20

53. Ans: (c)

Sol: Given, $\omega_i = 0$, $\omega_f = 1000$ rpm, $t = 6$ s

Assuming uniform angular acceleration of flywheel

$$\omega_f = \omega_i + \alpha t$$

$$\alpha = \frac{\omega_f}{t} = \frac{1000}{60 \times 6} = \frac{25}{9} \text{ rotations per s}^2$$

Number of rotations made in 6s

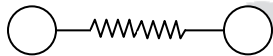
$$\begin{aligned} \theta &= \omega_i t + \frac{1}{2} \alpha t^2 \\ &= \frac{1}{2} \times \frac{25}{9} \times 6 \times 6 = 50 \end{aligned}$$

54. Two steel balls 2 kg and 4 kg mass, respectively, are pressed on the two ends of a spring, all pre-placed on a smooth surface. When released, the smaller ball moves with an acceleration of 2 m/s^2 . The simultaneous acceleration of the bigger ball will be

- (a) 0.5 m/s^2 (b) 1 m/s^2 (c) 2 m/s^2 (d) 4 m/s^2

54. Ans: (b)

Sol: Force on each mass due to spring is same.



$$m_1 = 2 \text{ kg}, \quad m_2 = 4 \text{ kg}$$

$$a_1 = 2 \text{ m/s}^2, \quad a_2 = ?$$

$$\therefore F = m_1 a_1 = m_2 a_2 \Rightarrow a_2 = \frac{m_1}{m_2} a_1$$

$$a_2 = \frac{2}{4} \times 2 = 1 \text{ m/s}^2$$

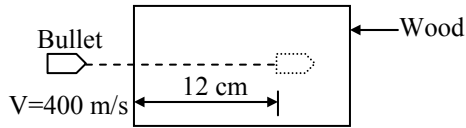
55. A bullet of mass 0.03 kg moving with speed of 400 m/s penetrates 12 cm into a fixed block of wood. The average force exerted by the wood on the bullet will be

- (a) 30 kN (b) 20 kN
(c) 15 kN (d) 10 kN



55. Ans: (b)

Sol:



Using energy conservation (work-energy principle)

KE lost by bullet = Work done by friction force of wood on bullet

$$\frac{1}{2} mV^2 = F \times s \Rightarrow F = \frac{mV^2}{2s}$$

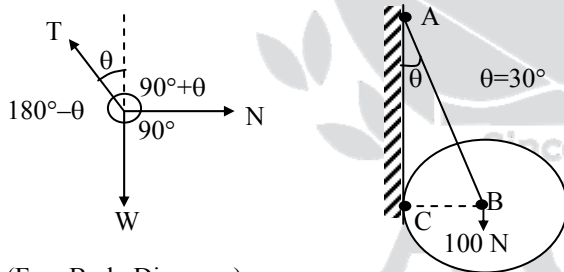
$$F = \frac{0.03 \times 400^2}{2 \times 0.12} = 20000 \text{ N} = 20 \text{ kN}$$

56. A ball of weight 100 N is tied to a smooth wall by a cord making an angle of 30° to the wall. The tension in the cord is

- (a) 200 N (b) $\frac{200}{\sqrt{3}}$ N (c) 100 N (d) $50\sqrt{3}$ N

56. Ans: (b)

Sol: Free Body Diagram of ball center B



(Free Body Diagram)

By Lami's theorem

$$\frac{T}{\sin 90^\circ} = \frac{W}{\sin(90^\circ + \theta)} \Rightarrow T = \frac{200}{\sqrt{3}} \text{ N}$$

57. The modulus of rigidity of an elastic material is found to be 38.5% of the value of its Young's modulus. The Poisson's ratio μ of the material is nearly

- (a) 0.28 (b) 0.30 (c) 0.33 (d) 0.35



57. Ans: (b)

Sol: $G = 0.385 E$

$$E = 2G(1 + \mu)$$

$$E = 2 \times (0.385E)(1 + \mu)$$

$$\mu = 0.3$$

58. A bar produces a lateral strain of magnitude 60×10^{-5} m/m when subjected to a tensile stress of magnitude 300 MPa along the axial direction. What is the elastic modulus of the material if the Poisson's ratio is 0.3?

(a) 200 GPa

(b) 150 GPa

(c) 125 GPa

(d) 100 GPa

58. Ans: (b)

Sol: $\epsilon_2 = \frac{1}{E} \{ \sigma_2 - \mu \sigma_1 \}, \sigma_2 = 0$

$$E = \frac{-0.3}{60 \times 10^{-5}} \times 300 \text{ MPa}$$

$$E = 150 \text{ GPa}$$

59. In the design of beams for a given strength, consider that the conditions of economy of use of the material would avail as follows:

1. Rectangular cross-section is more economical than square section of the same cross-sectional area of the beam.
2. Circular section is more economical than square section.
3. I-section is more economical than a rectangular section of the same depth.

Which of the above are correct?

(a) 1, 2 and 3

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1 and 3 only

59. Ans: (d)

60. Which one of the following statements is correct ?

(a) The strain produced per unit volume is called resilience.

(b) The maximum strain produced per unit volume is called proof resilience.

(c) The least strain energy stored in a unit volume is called proof resilience.

(d) The greatest strain energy stored in a unit volume of a material without permanent deformation is called proof resilience.

60. Ans: (d)



61. A beam of rectangular section (12 cm wide × 20 cm deep) is simply supported over a span of 12 m. It is acted upon by a concentrated load of 80 kN at the mid-span. The maximum bending stress induced is
- (a) 400 MPa (b) 300 MPa
(c) 200 MPa (d) 100 MPa

61. Ans: (b)

Sol: $M_{\max} = \frac{WL}{4} = \frac{80000 \times 12000}{4}$

$$\sigma = \frac{M y}{I}, y = \frac{200}{2} = 100 \text{ mm}$$

$$\sigma = 300 \text{ MPa}$$

NEW BATCHES FOR

ESE – 2017 Stage – II (Mains)

| BATCH - 1 | BATCH - 2 |
|---|-------------------------------------|
| 18 th Jan 2017 (E&T, EE, CE & ME) | 9 th Feb 2017 (E&T & ME) |
| | 15 th Feb 2017 (EE & CE) |

ESE - 2017 MAINS OFFLINE TEST SERIES
WILL BE CONDUCTED FROM MARCH 1ST WEEK
DETAILED SCHEDULE WILL BE ANNOUNCED SOON



62. A uniform bar, simply supported at the ends, carries a concentrated load P at mid-span. If the same load be, alternatively, uniformly distributed over the full length of the bar, the maximum deflection of the bar will decrease by
- (a) 25.5 % (b) 31.5 %
(c) 37.5 % (d) 50.0 %

62. Ans: (c)

Sol:



$$\delta_1 = \frac{WL^3}{48EI}$$

$$\delta_2 = \frac{5}{384} \frac{WL^3}{EI}$$

$$\frac{\delta_1 - \delta_2}{\delta_1} \times 100 = \frac{\frac{1}{48} - \frac{5}{384}}{\frac{1}{48}} \times 100 = 37.5 \%$$

63. A thin cylindrical pressure vessel and a thin spherical pressure vessel have the same mean radius, same wall thickness and are subjected to same internal pressure. The hoop stresses set up in these vessels (cylinder in relation to sphere) will be in the ratio
- (a) 1 : 2 (b) 1 : 1 (c) 2 : 1 (d) 4 : 1

63. Ans: (c)

Sol: For cylinder $(\sigma_h)_c = \frac{PD}{2t}$

For sphere $(\sigma_h)_s = \frac{PD}{4t}$

$$\frac{(\sigma_h)_c}{(\sigma_h)_s} = 2$$

64. A boy walks up a stalled escalator in 90 seconds. When the same escalator moves, he is carried up in 60 seconds. How much time would it take him to walk up the moving escalator?
- (a) 48 seconds (b) 36 seconds
(c) 30 seconds (d) 24 seconds

64. Ans: (b)

Sol: Velocity of boy when he walks on stalled escalator $V_1 = \frac{h}{90}$

h = height climbed



Velocity of boy when he is carried by escalator $V_2 = \frac{h}{60}$

Velocity of boy when he walks up the moving escalator = $V_1 + V_2 = \frac{h}{90} + \frac{h}{60} = \frac{5h}{180}$

Time taken to climb height 'h' = $\frac{180}{5} \text{ s} = 36 \text{ s}$

65. A 10 mm diameter bar of mild steel of elastic modulus $200 \times 10^9 \text{ Pa}$ is subjected to a tensile load of 50000 N, taking it just beyond its yield point. The elastic recovery of strain that would occur removal of tensile load will be

- (a) 1.38×10^{-3} (b) 2.68×10^{-3}
(c) 3.18×10^{-3} (d) 4.62×10^{-3}

65. **Ans: (c)**

Sol: $\epsilon^e = \frac{\sigma}{E}$

$$\sigma = \frac{F}{A} = \frac{50,000}{\frac{\pi}{4} \times 10^2} = 636.6 \text{ MPa}$$

$$E = 200 \times 10^9 \text{ Pa} = 200 \times 10^3 \text{ MPa}$$

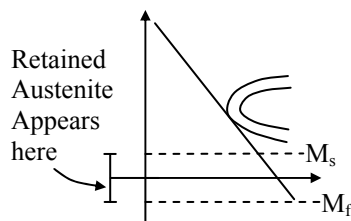
$$\epsilon^e = \frac{636.6}{200 \times 10^3} = 0.003183 = 3.183 \times 10^{-3}$$

66. On completion of heat treatment, the austenite structure would be retained if

- (a) the rate of cooling is greater than the critical cooling rate
(b) the rate of cooling is less than the critical cooling rate
(c) the initiating temperature of martensite formation is above the room temperature
(d) the finishing temperature of martensite formation is below the room temperature

66. **Ans: (d)**

Sol:



If the finishing temperature is below the room temperature total austenite will not be converted to martensite there will be refined austenite.



67. Which one of the following statements is correct?
- (a) Iron-carbon and TTT diagrams are both equilibrium diagrams.
 - (b) Iron-carbon and TTT diagrams are both non-equilibrium diagrams.
 - (c) Iron-carbon diagram is an equilibrium diagram but TTT diagram is a non-equilibrium diagram.
 - (d) Iron-carbon diagram is a non-equilibrium diagram but TTT diagram is an equilibrium diagram

67. **Ans: (c)**

Sol: In iron-carbon phase diagram, addition of carbon to iron produces various phases. In mixed phases also (distinct phases) by slow cooling

Whereas in T-T-T curves it doesn't produce a distinct phase based on its rate of cooling the phase formations will change w.r.t time.

68. The correct order of increasing resistivity among the following materials is
- (a) nickel, doped silicon, sodium silicate, pure silica
 - (b) doped silicon, nickel, pure silica, sodium silicate
 - (c) nickel, pure silica, sodium silicate, doped silicon
 - (d) sodium silicate, nickel, pure silica, doped silicon

68. **Ans: (a)**

Sol: Ni → doped silicon → sodium silicate → pure silica

$$10^{-7} \rightarrow 10^{-4} \rightarrow 2 \rightarrow 10^4$$

(resistivity value in increasing)

69. Consider the following statements:
On heating an elastomer under tensile load, its shrinkage

1. maximizes the enthalpy
2. maximizes the entropy
3. minimizes the free energy
4. avoids breaking

Which of the above statements are correct?

- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 1 and 4

69. **Ans: (d)**

Sol: During heating heat will be released to breaking of primary bonds which increases enthalpy. Therefore rubber turns as soft which will avoid breakage.



70. Which of the following properties will be the meaningful indicator/indicators of uniform rate of elongation of a test piece of a structural material before necking happens in the test piece?

1. Ductility
2. Toughness
3. Hardness

Select the correct answer using the code given below.

- (a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

70. **Ans: (a)**

Sol: The elongation before necking will be measured as ductility.

71. Which one of the following alloying elements increases the corrosion resistance of steel?

- (a) Vanadium (b) Chromium
(c) Nickel (d) Copper

71. **Ans: (b)**

Sol: Chromium will improve corrosion resistance in steels.

72. Which of the following mechanisms are examples of forced closed kinematic pairs?

1. Cam and roller mechanism
2. Door-closing mechanism
3. Slider-crank mechanism

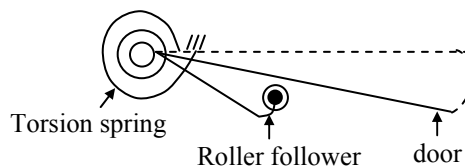
Select the correct answer using the code given below.

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

72. **Ans: (a)**

Sol: Force closed kinematic pair: Contact between the links forming the pair is maintained by an external force/torque but not due to the geometry of surface in contact.

In general, cam and follower will be in contact either due to force of gravity or force of the spring on the follower. Door closing mechanism, has a torsion spring loaded follower in contact with door.



In a slider-crank mechanism, none of the pair is force-closed.



73. A planer mechanism has 10 links and 12 rotary joints. Using Grubler's criterion, the number of degrees of freedom of the mechanism is

- (a) 1 (b) 3 (c) 2 (d) 4

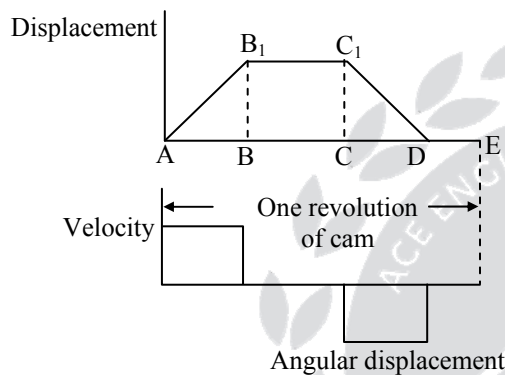
73. **Ans: (b)**

Sol: $m = 3(n-1) - 2j_1 - j_2$

Given $n = 10$; $j_1 = 12$; $j_2 = 0$

$m = 3(10-1) - 2 \times 12 = 3$

74. The displacement and velocity diagrams of a cam and follower mechanism are shown:



Which of the following statements is/are correct?

1. The acceleration of the follower at the beginning and at the end of each stroke will be zero.
2. The follower remains at rest in the dwell period.
3. During period DE, the motion of the follower is retarding.

Select the correct answer using the code given below.

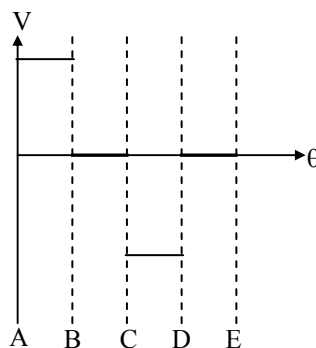
- (a) 1, 2 and 3 (b) 1 only (c) 2 only (d) 3 only

74. **Ans: (c)**

Sol: Given profile is corresponding to uniform velocity motion of follower during rise and return.

AB – rise ; BC – dwell

CD – return; DE – dwell





At start and end of rise and return, velocity suddenly changes, which makes acceleration at these locations tend to ∞ .

During dwell period follower does not move.

75. The number of instantaneous centres of rotation in a slider-crank quick-return mechanism is
 (a) 10 (b) 8 (c) 6 (d) 4

75. **Ans: (c)**

Sol: Number of IC = $n_{c_2} = \frac{n(n-1)}{2} = N$

In a slider-crank Quick-return mechanism $n = 4$, $N = 6$.

76. A simple spring-mass vibrating system has a natural frequency of N . If the spring stiffness is halved and the mass doubled, then the natural frequency will be
 (a) $0.5N$ (b) N (c) $2N$ (d) $4N$

76. **Ans: (a)**

Sol: $\omega_{n1} = \sqrt{\frac{K}{m}} = N$

$$\omega_{n2} = \sqrt{\frac{K}{2m}} = \frac{1}{2} \sqrt{\frac{K}{m}} = \frac{N}{2} = 0.5N$$

77. A car of mass 1450 kg is constructed on a chassis supported by four springs. Each spring has a force constant of 40000 N/m. The combined mass of the two people occupying the car is 150 kg. What is the period of execution of two complete vibrations?

- (a) 0.63 s (b) 1.59 s
 (c) 4.96 s (d) 1.26 s

77. **Ans: (d)**

Sol: $T = 2\pi \sqrt{\frac{m}{K}}$

$$m = 1450 + 150 = 1600 \text{ kg}$$

$$K = 4 \times 40000 \text{ N/m} = 160000 \text{ N/m}$$

$$T = 2\pi \sqrt{\frac{1600}{160000}} = \frac{2\pi}{10} \text{ s} = 0.628 \text{ s}$$

$$\text{Time for two complete oscillation} = 2T = 2 \times 0.628 = 1.26 \text{ sec}$$



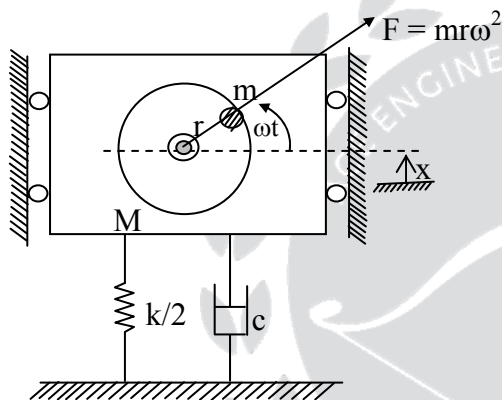
78. Consider the following statements:
Artefacts to prevent harmful effects resulting from vibrations of and unbalanced machine fixed on its foundation include
1. mounting the machine on springs thereby minimizing the transmission of forces
 2. using vibration isolating materials to prevent or reduce the transmission of forces
 3. moving the foundation so as to have only once degree of freedom towards reducing the transmission of forces

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3 only

78. Ans: (d)

Sol:



Spring and damper are used between machine and ground/foundation. Appropriate choice of spring and damper characteristics will enable the displacement transmissibility/amplification factor to be below one.

$$A = \left(\frac{mr}{M} \right) \times \frac{q^2}{(1 - q^2)} \quad \text{If } \xi = 0$$

$$q = \frac{\omega}{\omega_n}$$

As, \$k\$ increases \$\omega_n\$ increases and \$q\$ decreases.

So, Amplitude (\$A\$) value decreases

As rotating unbalance has two components along \$x\$ and \$y\$ directions

By constraining along one direction forces can be reduced.



79. Two heavy rotors are mounted on a single shaft. Considering each of the rotors separately, the transverse natural frequencies are 100 cycles/s and 200 cycles/s, respectively. The lower critical speed will be
- (a) 12000 r.p.m (b) 9360 r.p.m
(c) 8465 r.p.m (d) 5367 r.p.m

79. Ans: (d)

Sol: Given

$$f_1 = 100 \text{ Hz}$$

$$f_2 = 200 \text{ Hz}$$

Lower critical speed can be obtained using Dunkerley's method

$$\frac{1}{f^2} = \frac{1}{f_1^2} + \frac{1}{f_2^2} = \frac{1}{100^2} + \frac{1}{200^2}$$

$$f^2 = \frac{100^2 \times 200^2}{100^2 + 200^2} = \frac{100^2 \times 200^2}{50000}$$

$$f = \sqrt{8000} \text{ Hz}$$

Lower critical speed in rpm = $60 f = 5366.6 \text{ rpm}$

80. Consider the following statements:
In the case of gears of involute profiles, increase in the centre to centre distances between the mounting shafts
1. increase the pressure angle
 2. will not affect the law of gearing
 3. shortens the path of contact
 4. increase the contact ratio
- Which of the above statements are correct?
- (a) 1, 2 and 4 (b) 1, 2 and 3
(c) 1, 3 and 4 (d) 2, 3 and 4

80. Ans: (b)

Sol: As centre distance increases, pressure angle increases.

$$\text{Path of contact} = \sqrt{R_a^2 - R^2 \cos^2 \phi} - R \sin \phi + \sqrt{r_a^2 - r^2 \cos^2 \phi} - r \sin \phi$$

As ϕ increases, $\cos^2 \phi$ decreases, $\sqrt{R_a^2 - R^2 \cos^2 \phi}$ increases, $\sin \phi$ increases.

But increase in square root term is smaller than increase in $\sin \phi$.

So, Overall path of contact decreases.



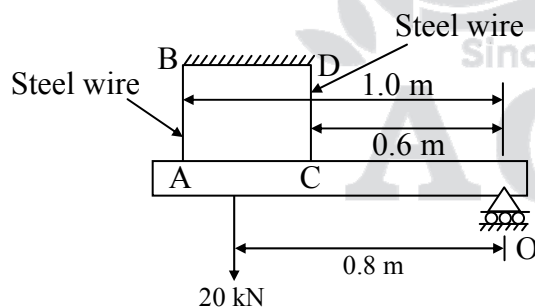
$$\text{Contact ratio} = \frac{\text{Arc of contact}}{\text{circular pitch}}$$

Contact ratio decreases with increase in pressure angle (ϕ).

From the above, increasing center distance will

- increase backlash
- not change base circle size
- teeth profile still remains conjugate and hence satisfies law of gearing.
- not change angular velocity ratio
- increase pressure angle
- increase pitch circle radii.
- pitch point location changes.
- decrease the length of path of contact
- increase the maximum length of path of contact to avoid interference
- reduce the contact ratio
- reduce interference

81. A rigid bar ACO as shown is hinged at O and is held in a horizontal position by two identical vertical steel wires AB and CD. A point load of 20 kN is hung at the position shown. The tensions in wires AB and CD are



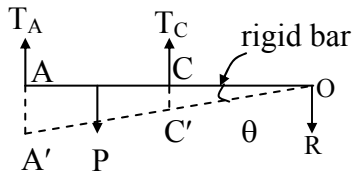
- (a) 15.2 kN and 7.2 kN
- (b) 11.8 kN and 7.1 kN
- (c) 15.2 kN and 5.0 kN
- (d) 11.8 kN and 5.0 kN



81. Ans: (b)

Sol: $\overline{AO} = 1\text{m}$

$\overline{CO} = 0.6\text{m}$



Number of unknowns = 3 (T_A , T_C , R)

Number of equations of equilibrium = 2 ($\Sigma F_y = 0$; $\Sigma M = 0$)

\therefore This is a statically indeterminate system. This can be solved by using displacement compatibility condition.

Let K = axial stiffness of each steel wire

$\overline{AA'} = \delta_A$; $\overline{CC'} = \delta_C$

$\delta_A = \overline{AO} \times \theta$; $\delta_C = \overline{CO} \times \theta$

$T_A = K\delta_A$; $T_C = K\delta_C$

$\therefore \frac{T_A}{T_C} = \frac{\overline{AO}}{\overline{CO}} = \frac{1}{0.6} \Rightarrow 0.6T_A = T_C$

$\Sigma M_O = 0 \Rightarrow T_A \times \overline{AO} + T_C \times \overline{CO} = P \times 0.8$

$\Rightarrow T_A + 0.6T_C = 0.8 P$

$T_A + 0.6 \times 0.6 T_A = 0.8 P$

$T_A = \frac{0.8}{1.36} P = 11.76 \text{ kN}$

$T_C = 0.6T_A = 7.06 \text{ kN}$

82. An epicyclic gear train has 3 shafts A, B and C. A is the input shaft running at 100 r.p.m. clockwise. B is the output shaft running at 250 r.p.m. clockwise. The torque on A is 50 kN m (clockwise), C is a fixed shaft. The torque needed to fix C is

- (a) 20 kN m (anti-clockwise)
- (b) 20 kN m (clockwise)
- (c) 30 kN m (anti-clockwise)
- (d) 30 kN m (clockwise)



82. Ans: (c)

Sol: Net torque on the system is zero as shafts are rotating at constant speed. (assuming clockwise as negative and counter clockwise as positive)

$$T_A + T_B + T_C = 0$$

Assuming no loss in total power transmitted, net power transmitted = 0

$$T_A N_A + T_B N_B + T_C N_C = 0$$

Given $N_C = 0$ (C is fixed shaft)

$$N_A = -100 \text{ rpm (clockwise)}$$

$$N_B = -250 \text{ rpm (clockwise)}$$

$$T_A = -50 \text{ kNm (clockwise)}$$

$$T_A N_A + T_B N_B = 0 \Rightarrow T_B = -\frac{T_A N_A}{N_B}$$

$$T_C = -(T_A + T_B)$$

$$T_B = -\frac{(-50) \times (-100)}{(-250)} = 20 \text{ kNm (ccw)}$$

$$T_C = -(-50 + 20) = 30 \text{ kNm (ccw)}$$

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WEEKEND & MORNING BATCH

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From

27

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WEEKEND BATCH

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Batches Starting
From

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WEEKEND BATCH

CHENNAI

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From

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JAN 2017

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EVENING BATCH

PUNE

Batches Starting
From

06

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83. A fixed gear having 200 teeth is meshed with a smaller gear having 50 teeth. The two gears are connected by an arm. The number of turns made by the smaller gear for one revolution of the arm about the centre of the bigger gear is

- (a) 1 (b) 2 (c) 3 (d) 5

83. Ans: (d)

Sol: $T_S = 200$; $T_P = 50$; $N_S = 0$; $N_a = 1$; $N_P = ?$

$$\frac{N_P - N_a}{N_S - N_a} = -\frac{T_S}{T_P} \Rightarrow \frac{N_P - 1}{0 - 1} = -\frac{200}{50}$$

$$N_P = 5$$

84. Consider the following statements:

1. Balancing of several masses rotating in the same plane can be effected by a single mass.
2. Balancing of several masses in different planes can be done by 2 masses in 2 planes on either side of the reference plane or on the same side.
3. Reciprocating masses cannot be completely balanced by rotating masses.
4. Secondary unbalanced forces will be negligible compared to primary imbalance forces.

Which of the above statements are correct?

- (a) 1, 2, 3 and 4 (b) 1, 2 and 3 only
(c) 3 and 4 only (d) 1, 2 and 4 only

84. Ans: (a)

85. A body of mass 10 kg with its CG 200 mm from the axis of rotation is to be completely balanced by another mass B of 5 kg placed in the same plane. The radius at which the CG of mass B should be is

- (a) 500 mm (b) 400 mm (c) 300 mm (d) 200 mm

85. Ans: (b)

Sol: $m_1 = 10$ kg, $m_2 = 5$, $r_1 = 200$ mm, $r_2 = ?$

For same plane, $m_1 r_1 = m_2 r_2$

$$\Rightarrow 10 \times 200 = 5 \times r_2$$

$$\Rightarrow r_2 = 400 \text{ mm}$$



86. Consider the following statements:

1. In stationary constant speed engines, the spring-loaded governor mechanism is fitted on the cam-shaft of the engine.
2. Hunting occurs when the governor is not sensitive.
3. Isochronous governors have the same speed over a wide range of governor action.
4. A governor is said to be unstable if the radius of rotation falls as the speed increase.

Which of the above statements are correct?

- (a) 1, 2, 3 and 4 (b) 1, 2 and 4 only
(c) 1, 3 and 4 only (d) 2 and 3 only

86. Ans: (c)

Sol: Statement (II) is incorrect as hunting occurs when governor becomes infinitely sensitive.

87. An aircraft cruising at 360 kmph takes a right turn on an arc of 100 m radius. The turbines and propellers have a total mass of 500 kg with radius of gyration of 25 cm. The engine rotates at 2000 r.p.m. The magnitude of the gyroscopic couple generated is

- (a) 6.55 kN m (b) 7.65 kN m (c) 9.81 kN m (d) 13.1 kN m

87. Ans: (a)

Sol: Gyroscopic couple = $I\omega\omega_p$

Given $V = 360 \text{ kmph} = 100 \text{ m/s}$

$R = 100 \text{ m}$

$\omega_p = \frac{V}{R} = 1 \text{ rad/s}$

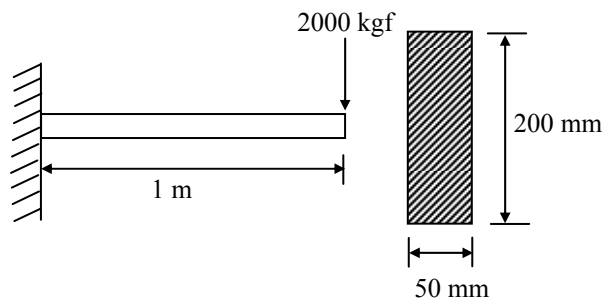
$I = mk^2 = 500 \times 0.25^2 = 31.25 \text{ kgm}^2$

$N = 2000 \text{ rpm}, \omega = \frac{2 \times \pi \times 2000}{60} = 209.44 \text{ rad/s}$

$C_G = 31.25 \times 209.44 \times 1 = 6545 \text{ N-m} = 6.545 \text{ kN-m}$

88. The maximum shearing stress induced in the beam section at any layer at any position along the beam length (shown in the figure) is equal to

- (a) 30 kgf/cm^2
(b) 40 kgf/cm^2
(c) 50 kgf/cm^2
(d) 60 kgf/cm^2



Cross-section of beam



88. Ans: (a)

Sol: For rectangular cross section,

$$\tau_{\max} = \frac{3}{2} \tau_{\text{avg}}$$

$$\tau_{\max} = \frac{3}{2} \times \frac{2000}{20 \times 5}$$

$$\tau_{\max} = 30 \text{ kg f/cm}^2$$

89. Consider the following statements:

For a component made of ductile material, the failure criterion will be

1. endurance limit, if the external force is fluctuating
2. fatigue, if the external force is fluctuating
3. yield stress, if the external force is static

Which of the above statements are correct?

- | | |
|------------------|------------------|
| (a) 1 and 2 only | (b) 1 and 3 only |
| (c) 2 and 3 only | (d) 1, 2 and 3 |

89. Ans: (d)

Sol: 2. Failure of ductile material under fluctuating load is called fatigue.

3. Failure of ductile material under static load occurs at yield stress.

1. Endurance limit is the maximum stress amplitude of a component can withstand. It is the strength of material.

90. A machine component is subjected to a flexural stress, which fluctuates between 300 MN/m^2 and -150 MN/m^2 . Taking the yield strength = 0.55 of the ultimate strength, endurance strength = 0.50 of the ultimate strength and factor of safety to be 2, the value of the minimum ultimate strength according to modified Goodman relation will be

- | | |
|---------------------------|---------------------------|
| (a) 1100 MN/m^2 | (b) 1075 MN/m^2 |
| (c) 1050 MN/m^2 | (d) 1025 MN/m^2 |

90. Ans: (c)

Sol: $\sigma_{\text{mean}} = \frac{300 - 150}{2} = 75 \text{ MPa}$

$$\sigma_a = \frac{300 + 150}{2} = 225 \text{ MPa}$$

By Goodman's relation,



$$\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}} = \frac{1}{FS}$$

$$\frac{0.25}{0.5S_{ut}} + \frac{75}{S_{ut}} = \frac{1}{2}$$

$$\Rightarrow \frac{1}{S_{ut}}(450 + 75) = \frac{1}{2}$$

$$S_{ut} = 525 \times 2 = 1050 \text{ MPa}$$

91. In a Hartnell governor, the mass of each ball is 4 kg. The maximum and minimum centrifugal forces on the basis are 1800 N and 100 N at radii 25 cm and 20 cm, respectively. The lengths of vertical and horizontal arms of the bell-crank levers are the same. What is the spring stiffness?

(a) 780 N/cm

(b) 740 N/cm

(c) 720 N/cm

(d) 680 N/cm

91. **Ans: (d)**

Sol: Given $m = 4 \text{ kg}$; $a = b$

at $r_2 = 25 \text{ cm}$; $F_2 = 1800 \text{ N}$

$r_1 = 20 \text{ cm}$; $F_1 = 100 \text{ N}$

$$K = 2 \left(\frac{b}{a} \right)^2 \left(\frac{F_2 - F_1}{r_2 - r_1} \right)$$

$$F = \frac{Ka^2}{2b^2} r - \frac{Ka}{2b} \left(\frac{a}{b} r_1 - x_0 \right) = Ar - B$$

$r_1 =$ least radius of rotation

$x_0 =$ initial compression of spring

$F_1 = Ar_1 - B$; $F_2 = Ar_2 - B$

$$F_2 - F_1 = A(r_2 - r_1) = \frac{Ka^2}{2b^2} (r_2 - r_1)$$

$$K = 2 \left(\frac{b}{a} \right)^2 \left(\frac{F_2 - F_1}{r_2 - r_1} \right)$$

$$= 2 \times \frac{1700}{5} = 680 \text{ N/cm}$$



92. Consider the following statements regarding the ends of the pressure vessels flanged by pre-tensioned bolts:
1. Pre-tensioning helps to seal the pressure vessel.
 2. Pre-tensioning reduces the maximum tensile stress in the bolts.
 3. Pre-tensioning countermands the fatigue life of the bolts.
 4. Pre-tensioning helps to reduce the deleterious effect of pressure pulsations in the pressure vessel.

Which of the above statements are correct?

- (a) 1, 2 and 3 only (b) 1, 3 and 4 only (c) 2 and 4 only (d) 1, 2, 3 and 4

92. **Ans: (b)**

Sol: Effect of Pretension

1. Pre-tensioning helps to seal/prevents the leakage from the pressure vessel.
2. Pre-tensioning increases fatigue life of bolts
3. Pre-tensioning reduces the stress amplitude i.e., decreases the deleterious effect of pressure pulsations.
4. Pre-tensioning increases the tensile stress in the bolt.

$$F_b = F_i + \left(\frac{k_b}{k_b + k_m} \right) P \Rightarrow F_b = F_i + CP$$

93. Two shafts, one solid and the other hollow, made of the same material, will have the same strength and stiffness, if both are of the same
- (a) length as well as weight
 - (b) length as well as polar modulus
 - (c) weight as well as polar modulus
 - (d) length, weight as well as polar modulus

93. **Ans: (b)**

Sol: Solid shaft and hollow shaft are same material, so G is same

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

$$k_t = \frac{T}{\theta} = \frac{GJ}{L}$$

$$\tau_{\max} = \frac{T}{J} \times r_{\max}$$

∴ For strength and stiffness to be same, both must have same polar moment of inertia (J) and same length (L) .



94. A solid shaft is to transmit 20 kW at 200 r.p.m. The ultimate shear stress for the shaft material is 360 MPa and the factor of safety is 8. The diameter of the solid shaft shall be

- (a) 42 mm (b) 45 mm
(c) 48 mm (d) 51 mm

94. **Ans: (c)**

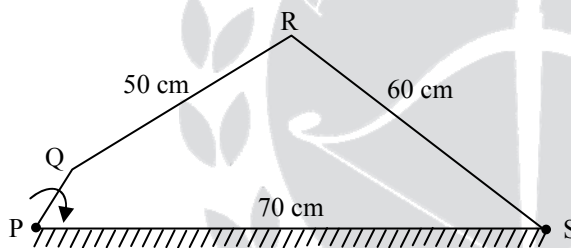
Sol: $T = \frac{60P}{2\pi N} = \frac{60 \times 20}{2\pi \times 200} = \frac{3}{\pi} \text{ kN-m}$

$$\tau = \frac{16T}{\pi d^3} = \frac{S_{su}}{FS}$$

$$\Rightarrow \frac{16 \times 3 \times 10^6}{\pi^2 \times d^3} = \frac{360}{8}$$

$$\Rightarrow d = 47.6 \text{ mm}$$

95. In the 4-bar mechanism as shown, the link PQ measures 30 cm and rotates uniformly at 100 rev/min. The velocity of point Q on link PQ is nearly



- (a) 2.54 m/s (b) 3.14 m/s (c) 4.60 m/s (d) 5.80 m/s

95. **Ans: (b)**

Sol: $V_Q = \omega \times r_{Q/P} = \frac{2\pi}{60} \times 100 \times 0.3 = 3.14 \text{ m/s}$

96. The rim of a flywheel is subjected to

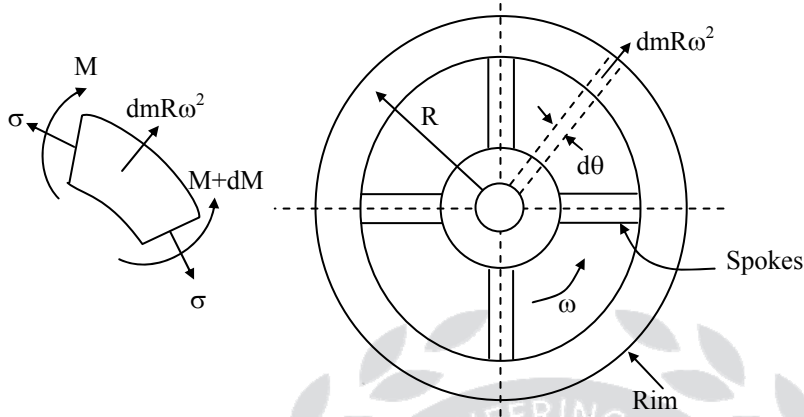
- (a) direct tensile stress and bending stress
(b) torsional shear stress and bending stress
(c) direct shear stress and bending stress
(d) compressive stress and bending stress

96. **Ans: (a)**

Sol: Due to rotation, rim is subjected to radially outwards centrifugal force. Due to centrifugal force, tensile stress develops. Considering an element subtending angle $d\theta$ at center, internal resistance in hoop/circumferential direction produces direct tensile stress and due to distance between



distributed centrifugal force and supports (spokes) there will be bending stresses. Portion of beam between two arms will act as fixed beam and uniformly loaded and hence, bending stress develops.



97. A stockist has to supply 400 units of a product every Monday to his customers. He gets the product at Rs. 50 per unit from the manufacturer. The cost of ordering and transportation from the manufacturer to the stockist's premises is Rs.75 per order. The cost of carrying inventory is 7.5% per year of the cost of the product. What are the economic lot size and the total optimal cost (including capital cost) for the stockist ?
- (a) 989 units/order and Rs. 20,065.80/week
 (b) 912 units/order and Rs.20,065.80/week
 (c) 989 units/order and Rs. 18574.50/week
 (b) 912 units/order and Rs. 18574.50/week

97. **Ans: (b)**

Sol: Weekly demand (d) = 400 units
 Annual demand (D) = 52×400 = 20800
 Unit cost (C_u) = 50
 Ordering cost (C_o) = 75/ orders
 Carrying cost (C_c) = 7.5% of C_u
 = 7.5% of 50
 = 3.75/ unit /year

$$EOQ = \sqrt{\frac{2DC_o}{C_c}}$$

$$= \sqrt{\frac{2 \times 20800 \times 75}{3.75}} = 912 \text{ units}$$



Total optimal cost/year

$$\begin{aligned} &= \sqrt{2DC_oC_c} + D \times C_u \\ &= 3420.52 + 10,40,000 \\ &= 10,43,420.52 \end{aligned}$$

Total optimal cost/week = 20,065/-

98. Consider just only the following parameters:

1. Grinding wheel diameter
2. Regulating wheel diameter
3. Speed of grinding wheel
4. Speed of regulating wheel

Which of the above parameters will influence the axial feed rate in centre-less grinding?

- (a) 2 and 4 (b) 2 and 3
(c) 1 and 3 (d) 1 and 4

98. **Ans: (a)**

Sol: Axial feed in centerless grinding = $V \cdot \sin(\alpha) = \alpha \cdot D \cdot N \sin(\alpha)$

Where V = surface velocity of regulating wheel.

D = Diameter of the regulating wheel , N = speed of the regulating wheel.

99. A metric thread of pitch 2 mm and thread angle 60° is inspected for its pitch diameter using the 3-wire method. The indicated diameter of the wire will be nearly

- (a) 0.85 mm (b) 1.05 mm
(c) 1.15 mm (d) 2.05 mm

99. **Ans: (c)**

Sol: Best wire diameter = $\frac{p}{2} \sec\left(\frac{\theta}{2}\right) = 1 \cos 30 = 1.15 \text{ mm}$

100. Consider the following statements with reference to NC machines:

1. Both closed-loop and open-loop systems are used.
2. Papers, tapes, floppy tapes and cassettes are used for data storage.
3. Digitizers may be used as interactive input devices.
4. Post-processor is an item of hardware.



102. A firm's inventory turnover of Rs.8,00,000 is 5 times the cost of goods sold. If the inventory turnover is improved to 8 with the cost of goods sold remaining the same, a substantial amount of fund is either released from, or gets additionally invested in, inventory. Which one of the following statements is correct?

- (a) Rs. 1,60,000 is released. (b) Rs. 1,60,000 is additionally invested.
(c) Rs. 60,000 is released (d) Rs. 60,000 is additionally invested.

102. Ans: (c)

Sol: Inventory Turnover = $\frac{\text{cost of goods sold}}{\text{Avg inventory cost}}$

$$\text{Avg.inventory cost} = \frac{8,00,000}{5} = 1,60,000/-$$

New inventory turnover = 8

$$\text{New Average inventory cost} = \frac{8,00,000}{8} = 1,00,000/-$$

Fund to be released = 60,000/-

103. An 8-hour measurement study in a plant reveals that 320 number of units were produced. If idle time = 15% and performance rating = 120%, with allowance = 12% of normal time, the standard time per unit produced will be

- (a) 1.823 minutes (b) 1.714 minutes
(c) 1.645 minutes (d) 1.286 minutes

103. Ans: (b)

Sol: Total available time = 8hrs

Idle time = 15%

Actual available time = $8 \times 0.85 = 6.8\text{hrs}$

Observed time (OT)

$$= \frac{\text{Actual available time}}{\text{No.of units to be produced}}$$

$$= \frac{6.8 \times 60}{320} = 1.275 \text{ min}$$

Normal Time (NT) = OT × Performance rating factor

$$= 1.275 \times \frac{120}{100} = 1.53 \text{ min}$$

Standard Time (ST) = NT × 1.12 = $1.53 \times 1.12 = 1.7289\text{min}$



104. An organization's sales during a financial year is Rs.6,00,000 with 90% of it on credit. At the end of the year, the receivables turnover was found to be 5. Considering 365 days to a year, the average collection period and receivables are, respectively

- (a) 81 days and Rs. 1,08,000 (b) 73 days and Rs. 1,08,000
(c) 81 days and Rs. 1,20,000 (d) 73 days and Rs. 1,20,000

104. Ans: (b)

Sol: Organization sales = 6,00,000

Turnover = 5

$$\text{Turnover} = \frac{\text{sales}}{\text{Inventory cost}}$$

$$\text{Inventory cost} = \frac{6,00,000}{5} = 1,20,000/-$$

$$\text{Received inventory cost} = 1,20,000 \times 0.9 = 1,08,000/-$$

$$\text{Days inventory} = \frac{1}{5} \times 365 = 73 \text{ days}$$

105. A particular item has a demand of 9000 units/year. The cost of one procurement is Rs.108 and the holding cost per unit is Rs.2.40/year. The replacement is instantaneous and no shortages are allowed. What is the optimum number of orders/year?

- (a) 7 orders/year (b) 8 orders/year
(c) 9 orders/year (d) 10 orders/year

105. Ans: (d)

Sol: Annual demand (D) = 9000 units/year

Cost of procurement (C_0) = Rs. 108

Holding cost (C_c) = 2.4 / unit / year

No. of orders (N) = ?

$$N = \frac{D}{\text{EOQ}}$$

$$\text{EOQ} = \sqrt{\frac{2DC_0}{C_c}}$$

$$= \sqrt{\frac{2 \times 9000 \times 108}{2.4}} = 900 \text{ units}$$

$$N = \frac{D}{\text{EOQ}} = \frac{9000}{900} = 10 \text{ orders / year}$$



106. Which one of the following is correct with respect to microcontrollers?
- (a) Integration of a microprocessor with I/O interfaces and memory and other peripherals in a single IC chip
 - (b) A single very large scale integrated (VLSI) chip that contains programmable electronic components that perform control functions
 - (c) Digital circuit for data handling and computation
 - (d) The primary computation and system control operations

106. Ans: (a)

Sol: Microcontroller is integration of all microprocessor and input and memory other peripherals in a single chip.

107. Which one of the following statements is correct?
Seismic transducer working in the displacement mode should have
- (a) weak springs and heavy mass
 - (b) stiff springs and light mass
 - (c) weak springs and light mass
 - (d) stiff springs and heavy mass

107. Ans: (a)

Sol: In displacement mode

$$\text{Ratio, } r = \frac{\omega}{\omega_n} > 2 \Rightarrow \omega > \omega_n$$

$$\text{Natural frequency is low} = \sqrt{\frac{k}{m}}$$

So, 'k' is low \Rightarrow weak spring and 'm' is high \Rightarrow heavy mass

108. What will be the velocity of piston movement for a single-acting hydraulic actuator, when the fluid pressure is 100 bar, the diameter of the piston is 50 mm and the flow rate is 0.3 m³/ min?
- (a) 2.41 m/s
 - (b) 2.55 m/s
 - (c) 2.67 m/s
 - (d) 2.84 m/s

108. Ans: (b)

Sol: $Q = \pi r^2 l$ (or) $\frac{dQ}{dt} = \pi r^2 v$

Where, Q = volume

$$0.3 \text{ m}^3 / \text{min} = \pi(0.025)^2 \cdot v$$

$$v = 2.5477 \text{ m/s} = 2.55 \text{ m/s}$$



109. A stepper motor is to be used to drive the linear axis of a certain Mechatronics system. The motor output shaft is connected to a screw thread with a 30 mm pitch. Linear resolution of 0.5 mm is stipulated. What is the needed step angle?

- (a) 9° (b) 8° (c) 7° (d) 6°

109. Ans: (d)

Sol: Linear resolution = BLU = 0.5 mm = pitch / no.of pulses required for one revolution
= 30 / pulses
no.of pulses required for one revolution = 30/0.5 = 60 pulses
step angle = 360 /60 = 6

110. Consider the following statements regarding a stepper motor:

1. The rotation angle of the motor is proportional to the input pulse.
2. The motor has full torque at standstill.
3. Speed and electric control signal of the motor vary mutually linearly.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

110. Ans: (d)

Sol:

Advantages of stepper motor are

- The rotation angle of the motor is proportional to the input pulse.
- The motor has full torque at standstill.
- Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 – 5% of a step and this error is non cumulative from one step to the next.
- Excellent response to starting, stopping and reversing.
- Very reliable since there are no contact brushes in the motor. Therefore the life of the motor is simply dependant on the life of the bearing.
- The motors response to digital input pulses provides open-loop control, making the motor simpler and less costly to control.
- It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.
- A wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses



111. The following table lists the tasks in a project and the time duration for each task:

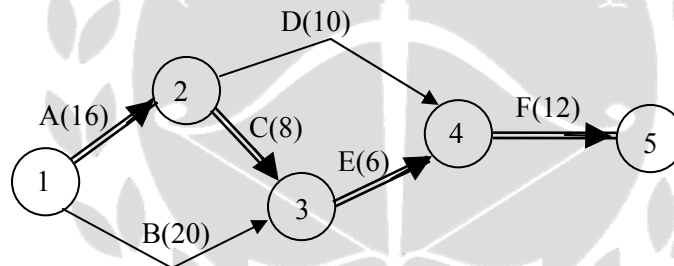
| Task | Preceding task | Normal duration (in weeks) |
|------|----------------|----------------------------|
| A | – | 16 |
| B | – | 20 |
| C | A | 8 |
| D | A | 10 |
| E | B, C | 6 |
| F | D, E | 12 |

The critical path, the project duration and the free float for activity A are, respectively

- (a) A-C-E-F; 42 weeks and 0 week (b) B-E-F; 42 weeks and 1 week
 (c) B-C-D-F; 50 weeks and 2 weeks (d) A-C-E-F; 50 weeks and 0 week

111. Ans: (a)

Sol:



| Path | Duration |
|---------|----------------|
| A-D-F | 16+10+12 = 38 |
| A-C-E-F | 16+8+6+12 = 42 |
| B-E-F | 20+6+12 = 38 |

‘A’ is the critical activity, hence free float of ‘A’ is zero.

112. Consider the following statements with reference to SCARA Robot;

1. It has four degrees of freedom.
2. It has only one forward kinematic solution.
3. It has two inverse kinematic solutions.



Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

112. Ans: (d)

Sol: 1, 2, 3 correct

1: SCARA robot has 4 degrees of freedom [VRO : T]

2: Forward solution is only one

3: Inverse Kinematic solutions are two (+ or –)

113. Consider the following statements regarding the laws of Robotics:

1. A Robot shall not injure a human being or, through inaction, allow a human being harmed.
2. A Robot must obey orders given by humans except when such orders conflict with first law.
3. A Robot must always protect its own existence.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

113. Ans: (a)

Sol: (3rd sentence is wrong as robot protect it own existence as long as not conflict 1st, 2nd laws)

114. The number of degrees of freedom in a 3D Robot of TRL : R type configuration is

- (a) 4 (b) 3 (c) 2 (d) 1

114. Ans: (a)

Sol: TRL : R \Rightarrow 4 DOF

115. Which of the following are the basic difference between vibration signature and noise signature?

1. Vibration signature is essentially in the frequency range zero to 100 cps whereas noise signature is in the range 20 cps to 3000 cps.
2. Vibration signature has well-defined peaks whereas the noise signal smeared.
3. The intensities of noise signatures are much less than that of vibration signatures.
4. Detection of vibration signature calls for a microphone whereas that of noise can do with a pickup.

Select the correct answer using the code given below.

- (a) 1 and 4 (b) 2 and 3
(c) 1 and 2 (d) 3 and 4

115. Ans: (b)



116. Consider the following features relating to Robot kinematics with reference to SCARA Robot:

1. Shoulder and elbow rotational axes are vertical.
2. The Robot could perform insertion tasks along the vertical direction.
3. Its general configuration is analogous to that of a human arm.

Which of the above features are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

116. Ans: (d)

117. A flywheel fitted to a steam engine has a mass of 500 kg and radius of gyration 300 mm. The starting torque is 900 N m. What is the kinetic energy after 10 s?

- (a) 225 kJ (b) 450 kJ
(c) 900 kJ (d) 1800 kJ

117. Ans: (c)

Sol: $I = mk^2 = 500 \times 0.3^2 = 45 \text{ kg-m}^2$

$$T = 900 \text{ Nm} = I\alpha \Rightarrow \alpha = \frac{T}{I}$$

$$\alpha = 20 \text{ rad/s}^2 ; \omega_i = 0 ; t = 10 \text{ s}$$

$$\omega_f = \omega_i + \alpha t = 200 \text{ rad/s}$$

$$\begin{aligned} \text{KE} &= \frac{1}{2} I \omega_f^2 = \frac{1}{2} \times 45 \times 200^2 \\ &= 900 \text{ kJ} \end{aligned}$$

118. In a counterflow heat exchanger, hot gases enter at 250°C and leave at 100°C. Atmospheric air enters at 50°C and leaves at 80°C. The effectiveness of the heat exchanger will be

- (a) 0.20 (b) 0.25 (c) 0.30 (d) 0.35

118. Ans: (*)

Sol: $T_{h1} = 250^\circ\text{C}, T_{h2} = 100^\circ\text{C}$

$$T_{c1} = 50^\circ\text{C}, T_{c2} = 80^\circ\text{C}$$

Hot fluid undergoes large temperature difference. Therefore hot fluid have lower heat capacity rate $\dot{m}_h C_h = C_{\min}$

$$\epsilon = \frac{\dot{m}_h C_h (T_{h1} - T_{h2})}{C_{\min} (T_{h1} - T_{c1})}$$



$$\epsilon = \frac{T_{h1} - T_{h2}}{T_{h1} - T_{c1}}$$

$$\epsilon = \frac{250 - 100}{250 - 50}$$

$$\epsilon = 0.75 \text{ (Not in options)}$$

119. Two air streams with mass flow rates of 36 kg/min and 14 kg/min with respective enthalpies of 36 kJ/kg da and 50 kJ/kg da are mixed. The enthalpy of the mixture is nearly

(a) 64 kJ/kg da (b) 55 kJ/kg da

(c) 46 kJ/kg da (d) 40 kJ/kg da

119. Ans: (d)

Sol:

m_1 = mass of water at state 1

m_2 = mass of water at state 2

h_1 = enthalpy of water at state 1

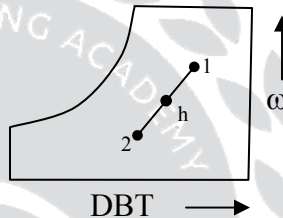
h_2 = enthalpy of water at state 2

h = enthalpy after mixing

Energy balance, $(m_1 + m_2)(h) = m_1 h_1 + m_2 h_2$

$$h = \frac{m_1 h_1 + m_2 h_2}{(m_1 + m_2)}$$

$$= \frac{36 \times 36 + 14 \times 50}{36 + 14}$$
$$= 40 \text{ kJ/kg da}$$



120. Consider the following statements in respect of maximum efficiency of a two-stage reciprocating compressor:

1. The pressure ratios are same for each stage.

2. The work done is same in each stage.

3. The intercooling is perfect.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

120. Ans: (d)

Sol: For ideal two stages reciprocating air compressor the pressure ratio is same in all stages. The workdone is same in all stages and for ideal situation inter cooling is perfect.

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Directions:

Each of the following thirty (30) items consists of two statements, one labeled as ‘Statement (I)’ and the other as ‘Statement (II)’. Examine these two statements carefully and select the answer to these items using the code given below:

Code:

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true and Statement (II) is not the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

121. **Statement (I):** Depth of centre of pressure of any immersed surface is independent of the density of the liquid.

Statement (II): Centre of area of the immersed body lies below the centre of pressure.

121. **Ans: (c)**

122. **Statement (I):** In flow through a pipeline, the nature of the fluid flow depends on the velocity of the fluid.

Statement (II): Reynolds number of the flow depends on the velocity, the diameter of the pipe and the kinematic viscosity of the fluid.

122. **Ans: (a)**

123. **Statement (I):** The specific heat at constant pressure for an ideal gas is always greater than the specific heat at constant volume.

Statement (II): Heat added at constant volume is not utilized for doing any external work.

123. **Ans: (a)**

Sol:

$$c_p = \left(\frac{dh}{dT} \right)_{p=c}$$

$$c_v = \left(\frac{du}{dT} \right)_{v=c},$$

$h > u$. Therefore, $c_p > c_v$



124. **Statement (I):** A homogeneous mixture of gases that do not react within themselves can be treated as a pure substance.

Statement (II): Flue gases can be treated as a homogeneous mixture of gases.

124. **Ans: (a)**

125. **Statement (I):** Air-blast injection in diesel engines could reduce engine efficiency.

Statement (II): Air-blast injection in diesel engines is not instantaneous but happens when the piston moves outward with the injection valve remaining open for whatever reason.

125. **Ans: (c)**

126. **Statement (I):** Use of non-azeotropic mixtures used as the refrigerant in a vapour compression system improves the coefficient of performance.

Statement (II): The increase in this coefficient is attributable to reduction in volume.

126. **Ans: (c)**

Sol: The evaporation takes place over a temperature range increasing direction. Hence mean temperature of evaporation increases and condensation takes place over a temperature range in decreasing direction hence mean temperature of heat rejection decreases. Hence COP increases.

127. **Statement (I):** Sub-cooling of a refrigerant liquid increases the coefficient of performance of a refrigeration cycle.

Statement (II): Sub-cooling reduces the work requirement of the refrigeration cycle.

127. **Ans: (c)**

Sol: Subcooling has no effect on work of compression in vapour compression refrigerating system.

128. **Statement (I):** In vapour-absorption system, larger the value of specific solution circulation, more the pump work.

Statement (II): Higher solution circulation rates of poor as well as rich solutions need larger pressure drops in the system.

128. **Ans: (a)**

Sol: Because of higher value of specific solution circulation the work of compression increases and pressure drop also increases.

129. **Statement (I):** Outward radial flow turbines do race inherently.

Statement (II): In outward radial turbines, the centrifugal head impressed upon the exiting water leads to flow increase.

129. **Ans: (a)**



130. **Statement (I):** Regarding the power transmitted by a clutch, greater the speed, lower the torque to be transmitted for fixed power rating.

Statement (II): The clutch is placed on the low-speed side to transmit larger torque.

130. Ans: (c)

Sol: Clutch is placed on high speed side

131. **Statement (I):** The volume of air taken into the cylinder of a reciprocating air compressor is less than the stroke volume of the cylinder.

Statement (II): Air that has been compressed to clearance volume expands to larger volumes during the suction stroke.

131. Ans: (a)

132. **Statement (I):** Providing reheat in a Rankine cycle would increase the efficiency of the cycle.

Statement (II): Reheat in Rankine cycle reduces specific steam consumption.

132. Ans: (a)

133. **Statement (I):** Heat carried away by hot gases in chimney draught is much greater than the work required for lifting the same gases through the height of the chimney. Yet artificial draught is not preferred.

Statement (II): Artificial draught involves large initial cost as well as large maintenance cost.

133. Ans: (d)

Sol: In most power plants artificial draught is preferred.

134. **Statement (I):** The overall combustion efficiency of a fuel oil based plant is less as compared to that of a coal burning plant.

Statement (II): Fuel oils contain comparatively larger percentage of hydrogen, which produce more moisture per kg of fuel burnt.

134. Ans: (d)

Sol: Combustion efficiency of fuel oil is around 98%. Because of high ash content in coals same efficiency cannot be obtained.

135. **Statement (I):** Proximate analysis of coal is done to determine its calorific value.

Statement (II): In proximate analysis of coal, the percentage of moisture, volatile matter, fixed carbon and ash are determined.



135. **Ans: (d)**

Sol: Ultimate analysis gives the composition of the fuel and this is useful in calculating empirically the high calorific value using Dulong and Petit formula.

136. **Statement (I):** Water entering into a condenser from the cooling tower has much dissolved impurities.

Statement (II): In a closed cooling system, the water is continuously aerated, therefore, there is abundant dissolved oxygen in this water.

136. **Ans: (a)**

Sol: In the cooling tower water pickup air and it is dissolved condition. Hence oxygen concentration increases. Which is a impurity in a closed circuit the water from cooling tower is circulated in the condenser.

137. **Statement (I):** Pyranometer is used to measure diffuse solar radiation by blocking the direct radiation with a shadow band.

Statement (II): Pyrhelimeter is used to measure diffuse radiation.

137. **Ans: (c)**

138. **Statement (I):** Directionally solidified materials have good creep resistance.

Statement (II): Directionally solidified materials may be so loaded that there is no shearing stress along or tensile stress across, the grain boundaries.

138. **Ans: (a)**

Sol: Directional solidification of material produced aligned grains in a particular direction. Hence creep resistance increases.

139. **Statement (I):** The ideal material for shafts transmitting power is CI.

Statement (II): CI resists compression well.

139. **Ans: (d)**

140. **Statement (I):** Hardenability curves are developed based on the fact that any given steel item always develops the same microstructure under a standardized cooling rate.

Statement (II): Industry employs Jominy hardenability test to measure hardenability.

140. **Ans: (b)**



141. **Statement (I):** Cams used in high-speed application should have displacement, velocity and acceleration curves of the follower in continuity.

Statement (II): Abrupt changes in these curves will cause high contact stresses at the bearings and make the operation noisy.

141. Ans: (a)

Sol: Acceleration curve with abrupt changes (such as parabolic/simple harmonic motion of follower) will exert abruptly changing contact stresses at the bearings and on the cam surface and lead to noise, surface wear and eventual failure.

Statement (I) is correct of statement (II) is correct explanation.

142. **Statement (I):** Resonance is a special case of forced vibration in which the natural frequency of the body is the same as the impressed frequency of the external periodic force whereby the amplitude of the forced vibration peaks sharply.

Statement (II): The amplitude of forced vibration of a body increases with increase in the frequency of the externally impressed periodic force.

142. Ans: (c)

Sol: Magnification factor, $MF = \frac{X}{\delta_{static}}$

X = amplitude of forced vibration

r = frequency ratio = $\frac{\omega}{\omega_n} = \frac{\text{excitation frequency}}{\text{natural frequency}}$

$r = 1 \Rightarrow \omega = \omega_n$ (resonance), $MF \rightarrow \infty$

Statement (I) is correct.

$0 < r < 1$ as $\omega \uparrow MF \uparrow X \uparrow$

$r > 1$ as $\omega \uparrow MF \downarrow$

$r > \sqrt{2}$ as $\omega \uparrow MF < 1$

Statement (II) is incorrect.

143. **Statement (I):** All worm drives (worm and worm wheel) are reversible.

Statement (II): The worm and worm wheel are made of different materials.

143. Ans: (d)

Sol: All worm drives are not reversible.

Worm drives are reversible (meaning, worm can drive worm gear and vice-versa) only when coefficient of friction $\mu < \cos\phi \tan \lambda$



Where, ϕ = pressure angle

λ = lead angle

Statement (I) is incorrect.

144. **Statement (I):** There is no balancing methodology in the case of reciprocating engines.

Statement (II): Balancing of dynamic forces is achieved mostly by resorting to multi-cylinder engine concept.

144. **Ans: (d)**

Sol: Partial balancing & complete balancing of primary unbalance is done in the case of reciprocating engines.

Statement (I) is incorrect.

145. **Statement (I):** Two circular discs of equal masses and thickness made of different materials will have same moment of inertia about their central axes of rotation.

Statement (II): Moment of inertia depends upon the distribution of mass with in the body.

145. **Ans: (d)**

Sol: Mass moment of inertia $I = \frac{mR^2}{2}$ for a uniform disc about its axis of rotation.

$$I = \frac{\rho A t R^2}{2}$$

But since mass is same & thickness is same,

$\rho_1 A_1 t = \rho_2 A_2 t$ (ρ = density, A = cross-sectional area, t = thickness)

$$I_1 = \frac{\rho_1 A_1 t R_1^2}{2} = \frac{\pi}{8} \rho_1 R_1^4 t$$

$$I_2 = \frac{\rho_2 A_2 t R_2^2}{2} = \frac{\pi}{8} \rho_2 R_2^4 t$$

If $\rho_1 > \rho_2$; $R_1 < R_2$; $I_1 < I_2$

Hence statement (I) is incorrect.

146. **Statement (I):** The speed of a governed water turbine will remain constant irrespective of load.

Statement (II): In governing, the water supply is regulated to maintain the speed constant.

146. **Ans: (a)**



147. **Statement (I):** In sugarcane crushing rollers, the fit between the cast roll and the forged steel shaft is of interference type.

Statement (II): This helps in removing the roll from the shaft whenever not needed.

147. **Ans: (a)**

Sol: For power transmission from shaft to the rollers, the fit between the crushing rollers and shaft is interference fit. Also whenever there is a requirement it can be separated easily. Both are correct and statement 2 is also correct explanation to the statement 1

148. **Statement (I):** Thicker sections of casting take longer to solidify than thinner sections.

Statement (II): Thicker sections of casting carry residual stresses.

148. **Ans: (b)**

Sol: Thicker sections take longer time for solidification because they have higher $\frac{V}{A} \left[t = k \left(\frac{V}{A} \right)^2 \right]$.

Thicker sections have more residual stresses due to higher differential cooling rate. Thicker sections of casting will take longer duration because, amount of molten metal in cavity is high, heat to be removed from the molten metal is high and hence time taken is longer. As the solidified metal is shrinking, it induces residual stresses in the thicker sections. Hence both the statements are correct but statement 2 is not the correct explanation to statement 1

149. **Statement (I):** Sand with grains of uniform round shape is preferred for preparing moulds.

Statement (II): If grains are large and regular in shape, the air-venting property of the mould prepared with them would be better.

149. **Ans: (d)**

Sol: Uniform round shape grains do not provide good strength. Generally good sand is one in which most of the sand is refined in 3 consecutive sieves. Round grains have more void space. So air venting capability is more.

Sand with uniform round shape of grains is not preferable because it gives lower strength due to lower mechanical interlocking. As grain size is large, the inter space will be high hence porosity property is high. (statement – 1 is false and statement -2 is correct)

GRAIN SIZE

- Many properties of molding sand like permeability, adhesiveness, surface fineness, strength. etc, depend upon the grain size and distribution of sand particles.
- The finer the grain size, the finer is the sand as a whole.
- Finely grained sand gives a good surface finish but possesses low permeability.



- Coarse grained sand gives lesser surface finish but imparts good flow ability, good refractoriness and good permeability.
- The green strength of fine sand is higher than coarse sand for the same quantity of ingredients added to it.

Foundry Sand Grain Shape :

The grain shape of foundry sand has a marked influence on its properties like flow ability, cohesiveness and strength. Generally, four types of grains are present in foundry sand given as follows.

- (I) Rounded Sand Grains:** Rounded sand grains give poor bonding strength as compared to angular sand grains. Too many smooth and rounded sand grains result in sand wash, sand crack and sand scales. These sands also possess greater flow ability.
- (II) Angular Grains:** These grains are produced by breaking of rocks without movement of particles. These are also formed by frost and glacial action. Angular grains have greater bonding strength, lesser flow ability and low permeability than round grain sands. Angular grains have sharp corners and greater contact surface.
- (III) Sub-angular Grains:** As compared to rounded grains, sub-angular grains possess better strength and lower permeability. In comparison to angular grains, they possess lower strength and better permeability.
- (IV) Compound Grains:** Compound grained sand is formed when two or more sand grains stick together and don't separate either on sawing or washing. These sands are not preferred and used in foundries

150. **Statement (I):** Bar chart plots in the time dimension the planned performance of various activities of a project.

Statement (II): One advantage of a bar chart is that the inter se sequence and linkage of all activities is indicated therein.

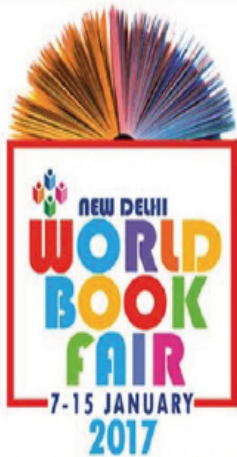
150. **Ans: (c)**

Sol: The main / major limitation of bar chart is “Lack of degree of details w.r.t inter relationship among the activities” i.e., precedence relationship can not be shown exactly.

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