TEST ID: 410

ACE Engineering Academy

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ESE- 2019 (Prelims) - Offline Test Series Test – 19

MECHANICAL ENGINEERING

Engineering Mechanics & Strength of Materials + Mechanisms And Machines + Design of Machine Elements — SOLUTIONS

01. Ans: (b)

Sol: As the structure is symmetric, the bar will remain horizontal even after elongation of cables.

$$\delta L_1 = \delta L_2 = \delta L_3$$

i.e., $\frac{T_1L_1}{AE} = \frac{T_2L_2}{AE}$ $[\because \delta L = \frac{TL}{AE}]$

$$T_1 = \frac{L_2}{L_1}T_2 = 2T_2$$

$\therefore$ $T_1 = T_3 = 2T_2$ -------(i)

Also,

$$T_1 + T_2 + T_3 = W$$

From (i)

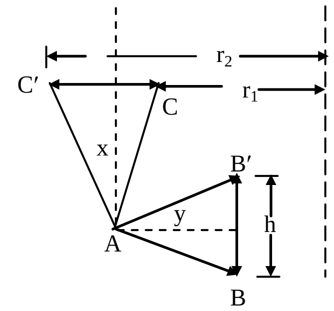
$$2T_2 + T_2 + 2\,T_2 = 100$$

$\therefore$ $T_2 = 20$ N

& $T_1 = T_3 = 40$ N

02. Ans: (b)

Sol: Two extreme position are shown in the figure below.



From the two triangles

$$\frac{\left(\frac{h}{2}\right)}{y} = \frac{\frac{(r_2 - r_1)}{2}}{x}$$

$$\Rightarrow \frac{h}{y} = \frac{r_2 - r_1}{x} \Rightarrow h = (r_2 - r_1)\frac{y}{x}$$

03. Ans: (b)

Sol: Out of all the stress conditions, completely reversed stress is the worst condition because it gives the worst value of parameter like,

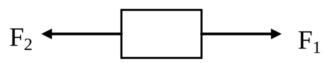
$\sigma_{mean} = 0$, $\sigma_{variable} = \sigma_{max}$

Amplitude ratio = ∞

Stress ratio = –1

04. Ans: (c)

Sol:



If $F_1 = F_2$ and both forces are collinear then $\Sigma F = 0$ and net moment = 0 (about any point). So the body will be in equilibrium.

05. Ans: (a)

Sol: The rubber rod tries to expand along width due to compressive load applied along length but rigid cavity will not allow expansion.

If 'x' represents axial (longitudinal) direction then,

$$\sigma_x = \frac{P}{A} \text{ (compressive)}$$

$\varepsilon_y = \varepsilon_z = 0$

[∵ No displacement along width]

$\sigma_y = \sigma_z$ [due to symmetry]

$$\varepsilon_y = \frac{\sigma_y}{E} - \frac{\mu}{E}(\sigma_x + \sigma_z)$$

But, $\varepsilon_y = 0$

$$\frac{\sigma_y}{E} - \frac{\mu}{E}(\sigma_x + \sigma_z) = 0$$

$$\sigma_y = \mu(\sigma_x + \sigma_y) \quad [\because \sigma_y = \sigma_z]$$

$\therefore \sigma_y (1 - \mu) = \mu\, \sigma_x$

$$\therefore \sigma_y = \frac{\mu}{1-\mu}\frac{P}{A} \text{ (compressive)}$$

06. Ans: (b)

Sol:
$$\tan\phi = \frac{\left(\frac{dy}{d\theta}\right)}{r_b + y}$$

where, ϕ = pressure angle,

y = follower displacement

θ = cam angle

r_b = base circle radius of cam

From the above relation,

Pressure angle varies with

- directly with steepness $\left(\frac{dy}{d\theta}\right)$ of the displacement diagram.
- inversely with base circle radius.
- inversely with follower displacement (y).

07. Ans: (c)

Sol: $\sigma_1 = 300$ MPa

$\sigma_2 = -300$ MPa

$$\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2 = S_{yt}^{\ 2}$$

$$S_{yt} = \sqrt{300^2 + 300^2 - (-300)\times 300}$$

$$= \sqrt{3}\times 300$$

$S_{yt} = 300\sqrt{3}$ MPa

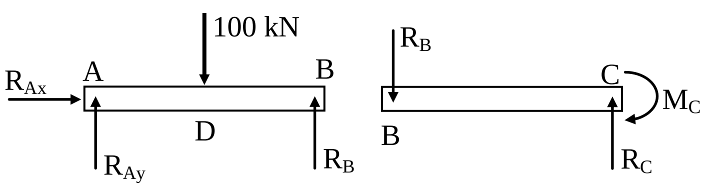
$$S_{ys} = \frac{300\sqrt{3}}{\sqrt{3}} = 300 \text{ MPa}$$

08. Ans: (d)

Sol: In the absense of friction, the acceleration of block A = $\frac{F_o}{m_A} = \frac{120}{10}$ = 12 m/s^2 and the acceleration of block B = $\frac{F}{m_B} = \frac{240}{20}$ = 12 m/s^2. Since, acceleration of block A = acceleration of block B, hence tendency of sliding is not there. Thus, frictional force is zero.

09. Ans: (d)

Sol: The free body diagrams of each half portion of the beam are shown below.



$\Sigma F_x = 0 \Rightarrow R_{Ax} = 0$

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_B = 100$ kN -----(1)

$\Sigma M_A = 0 \Rightarrow R_B \times 2 - 100 \times 1 = 0$

$\Rightarrow R_B = 50$ kN

$\therefore R_{Ay} = 50$ kN

$R_C = R_B = 50$ kN from (i)

The moments can be calculated at each point knowing the loads.

$M_A = R_{Ay} \times 0 = 0$

$M_D = R_{Ay} \times 1 = 50 \times 1 = 50$ kN-m (↻)

$M_B = R_{Ay} \times 2 - 100 \times 1 = 0$

$M_C = R_{Ay} \times 2 = 100$ kN-m (↻)

Between two concentrated loads BMD should be linear. Hence, option (d) is correct answer.

10. Ans: (b)

Sol:

- The smallest circle drawn tangent to the pitch curve from the axis of rotation of the cam is called prime circle of the cam.
- If the line of movement of the roller follower is offset from the centre of rotation of the cam, the follower is known as offset follower. It is provided to decrease the pressure angle during ascent of the follower.

11. Ans: (b)

Sol:

- Washer below the nut will be in compression.
- By tightening the nut, bolt will be pulled, threads which are in contact with nut will be subjected to shear. Bolt will be subjected to tension.

12. Ans: (b)

Sol: Initial angular velocity, $\omega_o = 30$ rad/sec

$$\omega = \omega_o - \alpha t$$

$$0 = 30 - \alpha \times 5$$

$$\alpha = 6 \text{ rad/sec}^2$$

After 1 sec, $\omega = 30 - 6\times1 = 24$ rad/sec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13. Ans: (a)

Sol: As the line of action of load passes through point 'A' moment of all loads acting on left side of section passing through point 'A' is zero.

Alternatively, $R_B = P\ (\uparrow)$

$M_B = P.\ L\ (\circlearrowleft)$

Considering moments of loads on left side of section 'A'.

Bending moment = $M_B - R_B \times L$

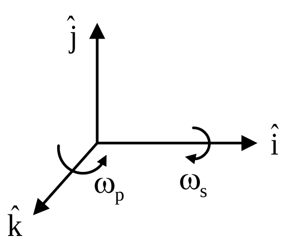
$= PL - PL = 0$

14. Ans: (d)

15. Ans: (c)

16. Ans: (b)

Sol:



Gyroscopic couple

$$= I.\left(\vec{\omega}_s \hat{i} \times \vec{\omega}_p \hat{k}\right) = I\,\omega_s\,\omega_p\left(-\hat{j}\right)$$

If we look from the top then ship will be turn towards right (starboard).

17. Ans: (c)

Sol:

- In rolling contact bearing metal to metal contact generates more noise.
- In hydro dynamic bearing metal to metal contact occurs at the beginning which results in higher starting torque.

18. Ans: (b)

Sol: The mean radius of the ring (R) is given by

$$R = \frac{L}{2\pi}$$

Due to bending the tensile stresses are developed on outer fibres and compressive stresses are developed on inner fibres. The maximum tensile stress being on outer most fiber. The strain (ε) in outermost fibre is given by

$$\varepsilon = \frac{2\pi(R+a) - 2\pi R}{2\pi R}$$

$$= \frac{a}{R} = \frac{2\pi a}{L}$$

$$\therefore\ \sigma = E\varepsilon = \frac{2\pi a E}{L}$$

19. Ans: (b)

Sol:

- A body having a constant velocity can not have varying speed.
- In an inelastic collision, the final kinetic energy is always less than the initial kinetic

energy of the system. This is because in such collisions, there is always a loss of energy in the form of heat, sound, etc.

- A body at rest may have potential energy yet no momentum.

20. Ans: (c)

Sol: For double parallel fillet weld,

Shear force P = 2×0.707×B×L×τ

$$= 2\times\frac{1}{\sqrt{2}}\times B\times L\times\tau$$

$$\Rightarrow \tau = \frac{P}{\sqrt{2}\times B\times L}$$

21. Ans: (c)

Sol: If link adjacent to shortest link is fixed input link becomes crank but output link becomes rocker thus results in *rocker mechanism* (C-R). In a four-bar linkage, if coupler is the shortest link, a double –rocker mechanism will result.

22. Ans: (c)

Sol: $$\sigma = \frac{My}{I} = \frac{M\times\frac{d}{2}}{\frac{bd^3}{12}} = \frac{6M}{bd^2}$$

Thus, $\frac{\sigma_2}{\sigma_1} = \frac{M_2}{M_1}\times\left(\frac{d_1}{d_2}\right)^2$ [∵ b = constant]

$$= \frac{(P\times L)}{\left(P\times\frac{L}{2}\right)}\times\left(\frac{75}{100}\right)^2$$

$$= \frac{9}{8}$$

23. Ans: (b)

Sol: $a = \frac{dv}{dt} = -2v^{-1}$

$$\int_{10}^{v}\frac{dv}{v^{-1}} = -2\int_0^9 dt$$

Integrating we get

$$\left[\frac{v^2}{2}\right]_{10}^{v} = -2\left[t\right]_0^9$$

$$\frac{1}{2}\left[v^2-100\right] = -2\times 9$$

$\Rightarrow$ $v^2 = 64 \Rightarrow$ v = 8 m/s

24. Ans: (d)

Sol: According to maximum shear stress theory (Guest's theory)

$$\frac{\tau_{max}}{FS} = \text{Max.}\left|\left(\frac{\sigma_1-\sigma_2}{2}\right)\right|;\left|\left(\frac{\sigma_2-\sigma_3}{2}\right)\right|;\left|\left(\frac{\sigma_3-\sigma_1}{2}\right)\right|$$

25. Ans: (b)

Sol: $$TR = \frac{\left[1+\left[2\xi\frac{\omega}{\omega_n}\right]^2\right]^{\frac{1}{2}}}{\left[\left[1-\left[\frac{\omega}{\omega_n}\right]^2\right]^2+\left[2\xi\frac{\omega}{\omega_n}\right]^2\right]^{\frac{1}{2}}}$$

At $0 < \frac{\omega}{\omega_n} < \sqrt{2}$,

TR > 1 and TR decreases when ξ increases

26. Ans: (c)

Sol:

- Acceleration, $a = \frac{VdV}{dx} = -\alpha V$

$\therefore \int_{V_0}^{0} dV = -\alpha \int_0^x dx \Rightarrow [V]_{V_0}^{0} = -\alpha x$

$\Rightarrow x = \frac{V_0}{\alpha}$

Thus, particle covers a distance of $x = \frac{V_0}{\alpha}$

- Acceleration, $a = \frac{dV}{dt} = -\alpha V$

$\therefore \int_{V_0}^{V} \frac{dV}{V} = -\alpha \int_0^t dt$

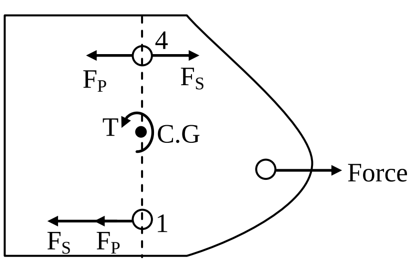
$\Rightarrow V = V_0 e^{-\alpha t}$

$\therefore$ V = 0 for $t \to \infty$

$\therefore$ Particle moves for a very long time.

27. Ans: (a)

Sol:



F_p = primary shear force,

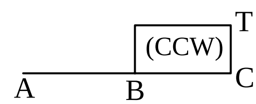
F_s = secondary shear force,

Resultant load in Bolt 1 = $F_P + F_s$

Resultant Load at Bolt 4 = $F_P - F_s$

28. Ans: (c)

Sol: The torque distribution diagram along the length of the shaft is,



$\theta_{CA} = \theta_{AB} + \theta_{CB}$

$= 0 + \frac{TL}{GJ}$ (CCW)

$= \frac{TL}{GJ}$ (CCW)

29. Ans: (c)

Sol: Strain tensor $= \begin{bmatrix} \varepsilon_{xx} & \frac{\phi_{xy}}{2} & \frac{\phi_{xz}}{2} \\ \frac{\phi_{yx}}{2} & \varepsilon_{yy} & \frac{\phi_{yz}}{2} \\ \frac{\phi_{zx}}{2} & \frac{\phi_{zy}}{2} & \varepsilon_{zz} \end{bmatrix}$

$\therefore \frac{\phi_{xy}}{2} = 0.004$

$\phi_{xy} = 0.004 \times 2 = 0.008$

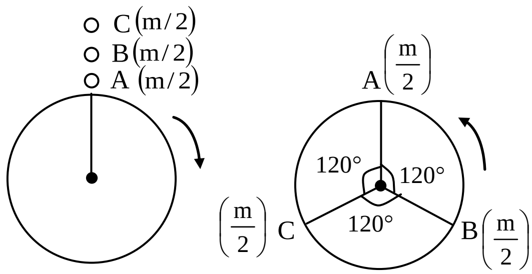
$\therefore \tau_{xy} = (\phi_{xy})\, G$

$= 0.008 \times 100 \times 10^3$

$= 800$ MPa

30. Ans: (c)

Sol:



2r = 100 mm

N = 3000 rpm

m = 1.5

Net primary force = $3\times\frac{m}{2}r\omega^2$ = 11.1 kN

31. Ans: (c)

Sol:

- Since the collision is completely elastic so there is an exchange of linear velocities.
- There is no torque on sphere after the collision as the contact force passes through centre of mass and their surfaces are frictionless, so there is no frictional torque. Thus, the angular velocities of the sphere will not change.

32. Ans: (b)

Sol: Shear stress distribution, due to transverse loads is given by

$$\tau = \frac{Va\bar{y}}{Ib}$$

For points P and Q which are very close

$a\bar{y}$ = constant

$$\therefore\ \tau \propto \frac{1}{b}$$

$$\therefore\ \frac{\tau_P}{\tau_Q} = \frac{b_Q}{b_P} = \frac{10}{100} = 1:10$$

33. Ans: (a)

Sol:

- Maximum shear stress,

$$(\tau_{max}) = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

- Maximum normal stress,

$$(\sigma_1) = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

- The shear stresses on principal planes are zero but normal stress on maximum shear stress plane is not zero. It is equal to average stress $\left(\frac{\sigma_x + \sigma_y}{2}\right)$.

34. Ans: (a)

Sol: The spring will exert maximum force when the compression is maximum i.e when the block stops. Using conservation of mechanical energy,

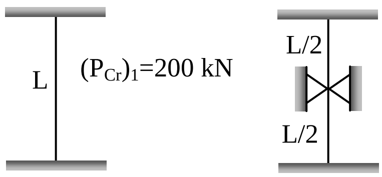
$$\frac{1}{2}mV^2 = \frac{1}{2}kx^2$$

$$\Rightarrow\quad x = \sqrt{\frac{mV^2}{k}}$$

Spring force = kx = $V\sqrt{mk}$

35. Ans: (d)

Sol:



$$(P_{cr})_2 = \frac{\pi^2 EI}{\left(\frac{L}{2}\right)^2}$$

$$(P_{cr})_2 = 4(P_{cr}) = 800 \text{ kN}$$

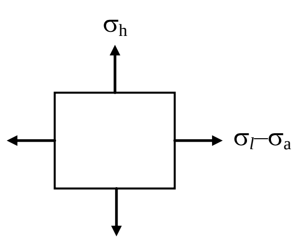
36. Ans: (c)

Sol:

- Governor is used to control speed of crankshaft if load on engine varies.
- In case of centrifugal governors, balls are operated by actual change of speed whereas, in inertia governors, it is the rate of change of speed.

37. Ans: (b)

Sol: State of stress at any point on the pressure vessel



Where σ_h – hoop stress = $\frac{pd}{2t}$

σ_l = longitudinal stress = $\frac{pd}{4t}$

σ_a = axial stress = $\frac{P}{\pi dt}$

$\sigma_h > \sigma_l - \sigma_a$

$\therefore\ \sigma_h = \sigma_1$

$\sigma_l - \sigma_a = \sigma_2$

For the case of pure shear $\Rightarrow \sigma_1 = -\sigma_2$

$\Rightarrow \sigma_h = -\sigma_l + \sigma_a$

$\sigma_h + \sigma_l = \sigma_a$

$$\frac{pd}{2t} + \frac{pd}{4t} = \frac{P}{\pi dt}$$

$$\frac{3pd}{4t} = \frac{P}{\pi dt} \Rightarrow P = \frac{3}{4}\pi p d^2$$

38. Ans: (c)

Sol: We know that, Angular impulse = Change in angular momentum

$$J \times \ell = \frac{m\ell^2}{3} \times \omega$$

$$\Rightarrow \omega = \frac{3J}{m\ell}$$

$$\therefore V_{c.m} = \omega \times \frac{L}{2} = \frac{3J}{m\ell} \times \frac{\ell}{2} = \frac{3J}{2m}$$

39. Ans: (c)

Sol: $\varepsilon_{xx} = \frac{\partial u}{\partial x} = 11 \times 10^{-6}$

$$\varepsilon_{yy} = \frac{\partial v}{\partial y} = 3 \times 10^{-6}$$

$$\gamma_{xy} = \left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)$$

$$= 4\times10^{-6} + 2\times10^{-6} = 6\times10^{-6}$$

$$\varepsilon_1 = \frac{\varepsilon_{xx} + \varepsilon_{yy}}{2} + \sqrt{\left(\frac{\varepsilon_{xx} - \varepsilon_{yy}}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

$$= \frac{(11+3)\times 10^{-6}}{2} + \sqrt{\left[\left(\frac{11-3}{2}\right)\times 10^{-6}\right]^2 + \left(3\times 10^{-6}\right)^2}$$

$$= 7\times 10^{-6} + \sqrt{4^2+3^2}\times 10^{-6}$$

$$= (7 + 5) \times 10^{-6}$$

$$= 12\times 10^{-6}$$

40. Ans: (d)

41. Ans: (c)

Sol: $\delta = \delta_{concentrated} + \delta_{iddle}$

$$= \frac{W(2L)^3}{48\,EI} + \frac{5}{384}\frac{W(2L)^3}{EI}$$

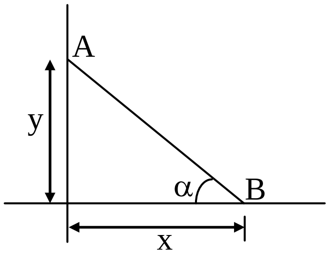
$$= \left(\frac{1}{48} + \frac{5}{384}\right)\frac{W\,8L^3}{EI}$$

$$= \frac{13\times 8\,WL^3}{384\,EI}$$

$$= \frac{13\,WL^3}{48\,EI}$$

42. Ans: (b)

Sol:



$$x^2 + y^2 = AB^2$$

$$2x\dot{x} + 2y\dot{y} = 0$$

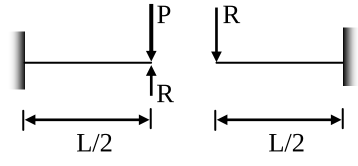
$$\dot{x} = -\dot{y}\times\frac{y}{x} = V\times\frac{y}{x} = V\tan\alpha \quad [\because \dot{y} = -V]$$

$$\Rightarrow V_B = \dot{x} = V\tan\alpha$$

43. Ans: (b)

44. Ans: (a)

Sol: The free body diagram for each half part is



The deflection at free end for each part is same.

$$\frac{(P-R)(L/2)^3}{3EI} = \frac{R(L/2)^3}{3EI} \Rightarrow P - R = R$$

or $R = \frac{P}{2}$

$$\delta = \frac{R(L/2)^3}{3EI} = \frac{\left(\frac{P}{2}\right)\left(\frac{L}{2}\right)^3}{3EI} = \frac{P\,L^3}{48\,EI}$$

45. Ans: (c)

Sol: $\delta \propto N$

$$\frac{\delta_A}{\delta_B} = \frac{(N/2)}{N} = \frac{1}{2}$$

46. Ans: (c)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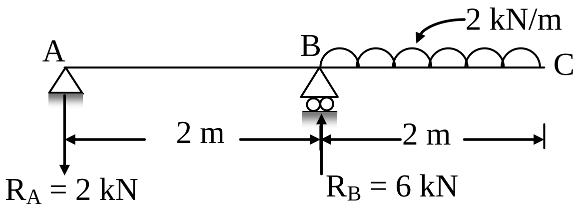
47. Ans: (c)

Sol:

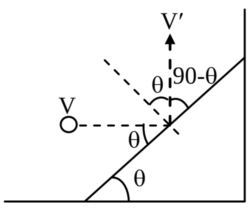


No support on load at C

∴ Statement 1, 2 and 3 are wrong

48. Ans: (b)

Sol: Let the particle is moving with speed V and after collision the particle moves with velocity V′ vertically.



Along the incline there is no change of velocity.

$\Rightarrow$ V cosθ = V′ cos (90 - θ) = V′ sinθ

$$V' = \frac{V}{\tan\theta} \quad \text{------(i)}$$

$$e = \frac{V'\cos\theta}{V\sin\theta} = \frac{1}{3} \quad \text{[from (i)]}$$

49. Ans: (a)

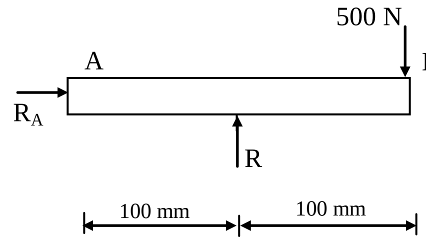
Sol: Safe rim velocity, $v = \sqrt{\dfrac{\sigma}{\rho}}$

where, σ = centrifugal stress and

ρ = density of material

50. Ans: (d)

Sol:



From the Free body diagram of the beam,

$\sum M_A = 0$

R(100) = 500(200)

R = 1000 N

$$K = \frac{R}{\delta}$$

$$\delta = \frac{R}{K} = \frac{1000}{200} = 5\,\text{mm}$$

From similar triangles

$$\frac{5}{100} = \frac{\delta_B}{200}$$

δ_B = 10 mm

51. Ans: (a)

Sol:

- Herringbone gear is a double helical gear. Their advantage over helical gear is that the side thrust of one half is balanced by that of the other half.
- The relative velocity of sliding in the teeth of gears in mesh is zero at the pitch point.

52. Ans: (a)

53. Ans: (c)

Sol: $\gamma = \dfrac{t^2}{6hm}$

Here, t = thickness of the tooth

h = height of the tooth

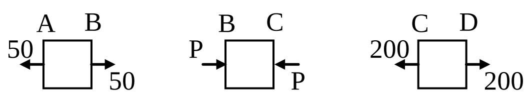
54. Ans: (a)

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

$$= 3 \times \left(\frac{50}{1000}\right)^2 \times 30 \times 4 = 0.9 \text{ N-m}$$

55. Ans: (c)

Sol:



450 = P + 200

P = 450 – 200

P = 250 N

Stress = $\dfrac{250}{100}$ = 2.5 MPa (compressive)

56. Ans: (a)

Sol: For high speed cams, cycloidal motion of follower should be preferred.

57. Ans: (a)

Sol: For a given state of stress,

$$\sigma_1 = \sigma_2 = \sigma_3 = \sigma$$

Distortion energy = 0

Shear stress = 0

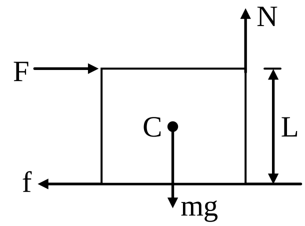
Hence, maximum principal stress theory is only suitable for given state of stress.

58. Ans: (a)

Sol: $h = \dfrac{895}{N^2} = \dfrac{895}{60 \times 60} = 0.248\,\text{m}$

59. Ans: (c)

Sol: F.B.D of cubical block is shown below:



At the verge of toppling normal reaction shifts to extreme right.

F = f [∵ There is no sliding]

and N = mg

Taking moment about centre ‘C’

$$F \times \frac{L}{2} + f \times \frac{L}{2} = N \times \frac{L}{2}$$

$$\Rightarrow 2F = mg \quad \text{or} \quad F = \frac{mg}{2}$$

60. Ans: (a)

Sol: Power, $P = F_t V \Rightarrow F_t = \dfrac{P}{V}$

$$V = \frac{\pi d_a N}{60} = \frac{\pi T_a m_a N}{60} \qquad [\because d = mT]$$

$$= \frac{\pi \times 40 \times 5 \times 3600 \times 10^{-3}}{\pi \times 60} = 12 \text{ m/s}$$

$$F_t = \frac{12 \times 10^3}{12} = 1000 \text{ N}$$

$F_r = F_t \tan\phi = 1000 \tan 20°$

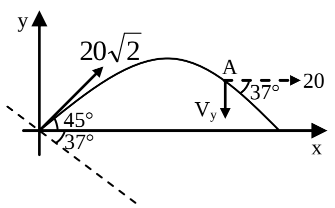
61. Ans: (c)

Sol: Shear force on a beam at a section x-x is the algebraic sum of transverse loads either on RHS or LHS of the section, including transverse loads acting on the section.

$\therefore$ $(SF)_{x-x} = 100 \sin 30° + 50 = 100$ kN

62. Ans: (c)

Sol:



When the particle is at A the velocity makes an angle 82° with initial velocity vector.

$$\tan 37° = \frac{3}{4} = \frac{V_y}{20}$$

$\Rightarrow V_y = 15$ m/s $\downarrow$

$V_y = U_y + a_y t$

$-15 = 20 - 10t$

$\Rightarrow$ t = 3.5 sec

63. Ans: (b)

Sol: Primary unbalanced force, $F_p = mr\omega^2 \cos\theta$

Secondary unbalanced force,

$$F_s = \frac{mr\omega^2 \cos 2\theta}{n}$$

as $n = \frac{\ell}{r}$, if n increases, secondary unbalanced forces decrease.

64. Ans: (b)

Sol: Power, $P = \frac{\pi}{16} d^3 \times \tau \times \frac{2\pi N}{60}$

$$P \propto d^3 N$$

$$\frac{P_1}{P_2} = \frac{d_1^3 N_1}{d_2^3 N_2}$$

$$\frac{400}{P_2} = \left(\frac{d_1}{\frac{d_1}{2}}\right)^3 \times \left(\frac{N_1}{2N_1}\right) \Rightarrow P_2 = 100 \text{ kW}$$

65. Ans: (a)

Sol: A governor is said to be stable when for each speed within working range there is only one radius of rotation for the governor ball.

66. Ans: (c)

67. Ans: (b)

Sol: Strain is independent quantity while stress is dependent on strain.

68. Ans: (d)

Sol: Involute pinion should have a minimum number of teeth to avoid interference.

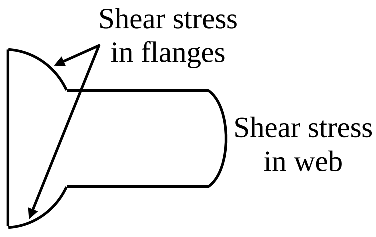
69. Ans: (c)

Sol: As ductile materials can elongate more and they can absorb more energy before failure. Further, area under stress-strain curve of ductile material is more as compared to that for brittle material. Ductile material can have lower UTS than brittle material. For example, UTS of aluminium is less than that of cast iron.

70. Ans: (b)

71. Ans: (d)

Sol: In 'I' section maximum transverse shear force is carried by web not flanges. The flanges carry maximum bending load.



72. Ans: (d)

Sol: $\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau_{max}}{R}$

$T = \frac{\tau_{max} J}{R}$

$J_h = \frac{\pi}{32}\left(D_0^4 - D_i^4\right)$

$J_s = \frac{\pi}{32} D_o^4$

$J_s > J_h$. Hence, solid shaft transmits more torque than hollow shaft for same τ_{max} and D_o .

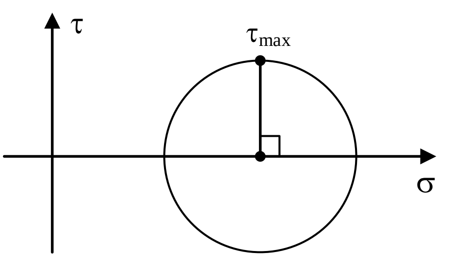
Note: However, hollow shaft will have more torque capacity than solid shaft for same weight. In this case outer diameter of hollow shaft will be more than diameter of solid shaft.

In solid shaft, the particles near to centerline are subjected to very low stress. Hence, the particles near to centerline are not utilized upto their maximum stress carrying capacity.

73. Ans: (a)

74. Ans: (d)

Sol:



Angle between two actual planes get doubled when same planes are represented on Mohr's circle. Hence, angle between principal plane and maximum shear stress plane is 45°.

75. Ans: (d)

Sol: The Endurance limit, in true sense, is not a property of material because size of component, temperature, surface finish, shape etc.

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