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ESE- 2019 (Prelims) - Offline Test Series Test – 11

MECHANICAL ENGINEERING

SUBJECT: Mechanisms and Machines + Design of Machine Elements — SOLUTIONS

01. Ans: (a)

Sol: If the load line coincides with the centroid of the bolts, there will neither be any bending nor tension. In this condition bolts are subjected to primary shear only.

02. Ans: (a)

Sol: A round bar in a hole forms a cylindrical pair having two degree of freedoms.

03. Ans: (c)

Sol: Effective throat thickness = 0.7×5 = 3.5 mm

$$\tau = \frac{P}{2\pi rt}$$

So, $\tau = (10\times10^3)/(2\times\pi\times50\times3.5) \approx 9$ N/mm^2

04. Ans: (b)

Sol: Actual degree of freedom of piston and cylinder is two but retains only linear motion due to assembly. Thus it forms a successfully constrained kinematic pair.

05. Ans: (c)

Sol: Spiral jaw clutch is a positive contact clutch. Centrifugal clutch and Single plate clutch are frictional clutches.

06. Ans: (c)

Sol: Elliptical trammel mechanism is the inversion of double slider crank chain mechanism.

07. Ans: (a)

Sol: Torque transmitting capacity of multi-plate clutch,

$$T = n \times \mu WR$$

Here, n = no. of effective contacting surface

$$= n_1 + n_2 - 1 = 3 + 2 - 1 = 4$$

$$\frac{T'}{T} = \frac{n'}{n} = \frac{n+1}{n} = \frac{5}{4}$$

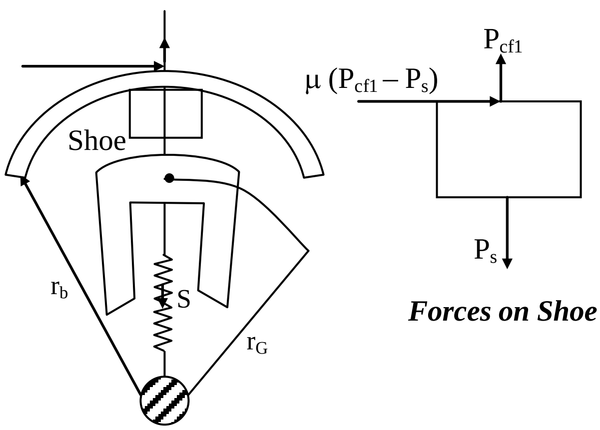
$$\Rightarrow T' = 1.25T$$

08. Ans: (d)

Sol: Hart mechanism is a six link mechanism and Paucellier mechanism is an eight link mechanism. Both are exact straight line mechanisms.

09. Ans: (c)

Sol: Forces on a shoe in centrifugal clutch is shown below.



Forces on Shoe

Here, $(P_{cf})_1$ = centrifugal force = $m\omega_1^2 r_g$

- $(P_{cf})_1$ is balanced by an equal and opposite spring force. Thus, if rpm is doubled then spring force must be increased by factor of four.

10. Ans: (b)

Sol: A four bar mechanism has atleast one revolving link if the sum of the shortest and longest link is less than sum of the lengths of other two links.

11. Ans: (d)

Sol: Torque transmitted by the clutch is given by, $M_t = \mu P R_f$

where R_f is called the friction radius.

For uniform wear theory or worn-out clutches,

$$R_f = \frac{1}{4}(D + d)$$

For uniform pressure theory or new clutches

$$R_f = \frac{1}{3}\frac{(D^3 - d^3)}{(D^2 - d^2)}$$

The results tabulated below are from some numerical values of D and d:

D	d	$\frac{1}{3}\frac{(D^3 - d^3)}{D^2 - d^2}$	$\frac{1}{4}(D + d)$
140	80	56.36	55
200	100	77.78	75

- From the above table, the friction radius for uniform pressure theory is slightly greater than for uniform wear theory clutches.

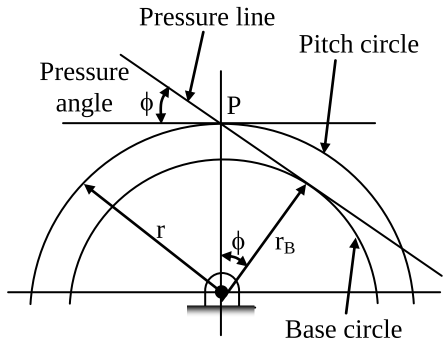
12. Ans: (b)

Sol: Number of instantaneous centres are

$$\frac{n(n-1)}{2} = \frac{8(8-1)}{2} = 28$$

13. Ans: (b)

Sol: Pressure angle (ϕ) is the angle between the common normal to the contacting teeth (line of action) and the common tangent to the pitch circles of meshing gears as shown in the figure below.



14. Ans: (a)

Sol: A spherical pair is a lower pair with three degrees of freedom

15. Ans: (b)

Sol: The dimension of face width of gear is an important aspect in the design of gears. If the face width is too large, there is a possibility of concentration of load at one end of the gear tooth. This is due to number of factors such as misalignment of shafts carrying the meshing gears and the elastic deformation of shafts.

- When the face width is too small, the gear has poor capacity to absorb the shock loads and vibrations. Further, teeth wear at a faster rate. In practice, the optimum range of the face width is in between 8 and 10 modules.

16. Ans: (b)

Sol: $\frac{N_W}{N_P} = \frac{T_P}{T_W}$

$$\frac{150}{900} = \frac{T_P}{90}$$

$$T_P = \frac{150 \times 90}{900} = 15$$

17. Ans: (c)

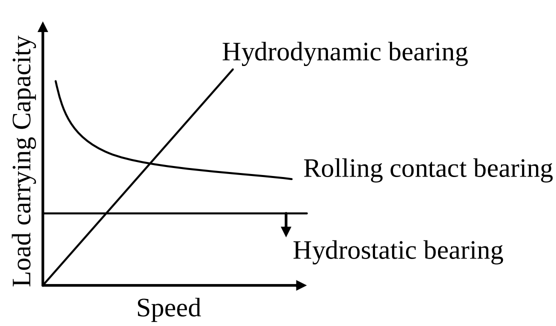
Sol: Spur gears generate normal and tangential component of forces.

18. Ans: (c)

Sol: In involute gears pressure angle remains constant throughout the teeth engagement.

19. Ans: (b)

Sol: For a finite life of rolling-contact bearings, the load carrying capacity should decreases with an increase in the speed of operation. At higher speeds, the centrifugal forces acting on the rolling elements are considerable, lowering the life of the bearings.



20. Ans: (b)

Sol: Davis steering gear has sliding pairs which means more friction and easy wearing. Due to easy wearing it becomes inaccurate after some time. Hence, it is not preferred.

21. Ans: (d)

Sol:

- The noise level for rolling contact bearings are higher compared to sliding-contact bearings due to metal to metal contact.
- The cost of sliding-contact bearings is much higher compared with rolling-contact bearing due to additional accessories. Sliding-contact bearings require more axial space, while rolling-contact bearings require more radial space.
- Power loss is high during starting with hydrodynamic bearings. While running with hydrodynamic bearing, a full lubricant film is developed leading to lower dynamic friction and less power loss compared to rolling-contact bearing.

22. Ans: (d)

Sol: In cycloidal follower programme there are no abrupt changes in velocity and acceleration at any stage of the motion. Thus, it is the most ideal programme for high speed follower motion.

23. Ans: (c)

Sol: $c = 0.05$,

$\varepsilon = 0.2$

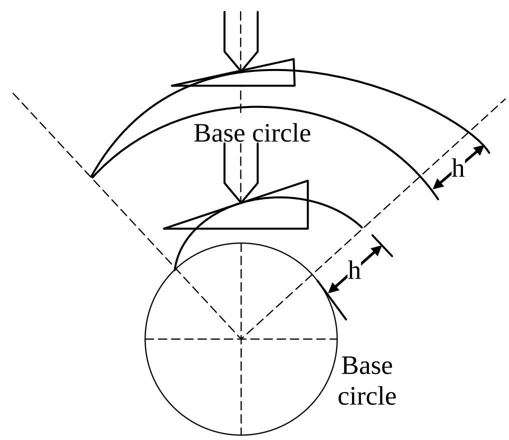
$\Rightarrow h_0 = c \times (1 - \varepsilon)$

$\Rightarrow h_0 = 0.025 \times (0.8) = 0.02$ mm

24. Ans: (a)

Sol:

- Base circle is the smallest circle drawn tangent to the cam profile.
- The smallest circle drawn tangent to the pitch curve is prime circle.
- Pitch point is a point on the pitch curve at which pressure is maximum.



The size of the base circle controls the pressure angle. As shown in figure, the increase in the base circle diameter increases the length of the arc of the circle upon which the wedge (the raised portion) is to be made. A short wedge for a given rise requires a steep rise or a higher pressure angle.

25. Ans: (c)

Sol: Since coefficient of friction for ball and roller bearing are very low as compared to sliding contact bearing so they are known as antifriction bearing.

26. Ans: (d)

Sol: logarithmic decrement, $\delta = \dfrac{2\pi\zeta}{\sqrt{1-\zeta^2}}$

$$\zeta = \frac{c}{2\sqrt{km}}$$

if $k' = \frac{1}{2}k \quad m' = 2m$

$$\therefore \quad \zeta' = \frac{c}{2\sqrt{\frac{k}{2}.2m}} = \frac{c}{2\sqrt{km}} = \zeta$$

$\therefore$ logarithmic detrimental remain same.

27. Ans: (a)

Sol: For the design of brittle material maximum normal stress theory or Rankine's theory is used.

28. Ans: (a)

Sol:

- Flywheel serves as a reservoir of energy. It stores energy during the period when the supply of energy is more than the requirement and releases when the supply of energy is less than the requirement.
- A flywheel influences cyclic variation of turning moment.
- A governor takes care of load fluctuation in the engine and controls speed variation.

29. Ans: (b)

Sol: N = 1200 rpm, d = 100 mm,

L = 100 mm, W = 5 kN,

$\mu = 3\times10^{-3}$

Power loss = $\dfrac{2\pi NT}{60} = \dfrac{2\pi N \times \mu W r}{60}$

$$= \frac{2\times\pi\times1200}{60}\times3\times10^{-3}\times5\times10^{3}\times\frac{100}{2}\times10^{-3}$$

$= 30\pi$ W

30. Ans: (c)

Sol:

- The axis of spin, the axes of precession and the axis of gyroscopic torque are in three perpendicular planes.
- There is no gyroscopic effect due to rolling of a ship

31. Ans: (c)

Sol: Needle roller bearings are suited for application involving oscillatory motion such that piston pin bearings, rocker arms and universal joint.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32. Ans: (c)

Sol: Taking anticlockwise as positive

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

$$\Rightarrow \frac{-200-50}{N_B - 50} = -\frac{45}{36} - 1.25$$

$\therefore$ N_B = 250 rpm anticlockwise

33. Ans: (a)

Sol: The dynamic load on a gear is due to inaccuracies of tooth spacing, irregularities in tooth profile and deflection of the teeth under load.

34. Ans: (c)

Sol: The system of masses in different parallel plane is in dynamic balance if the resultant force and resultant couple are both equal to zero

35. Ans: (d)

Sol: The causes of stress concentration are as follows:

1. Variation in properties of materials.
   - Internal cracks and flaws like blow holes.
   - Cavities in welds
   - Air holes in steel components
   - Non-metallic or foreign inclusions.
2. Load application
3. Abrupt changes in section
4. Discontinuities in the component
5. Machining scratches

36. Ans: (c)

Sol:

- Pressure angle varies from maximum at the beginning of the engagement reducers to zero at the pitch point and again increases to maximum at the end of engagement.
- The teeth have spreading flanks and are stronger than involute teeth.
- Cycloidal teeth involves double curve for the teeth, epicycloid and hypocycloid.
- Exact centre distance is required to transmit a constant velocity ratio.

37. Ans: (c)

Sol: Theoretical stress concentration factor,

$k_t = 2$

Notch sensitivity (q) = 0.5

$$q = \frac{k_f - 1}{k_t - 1}$$

k_f = fatigue stress concentration factor

$\Rightarrow k_f = 1 + q(k_t - 1)$

$= 1 + 0.5\,(2 - 1) = 1 + 0.5 = 1.5$

We know that, $\sigma'_e = k_a \times k_b \times k_c \times k_d \times \sigma_e$

Here, $k_d = \dfrac{1}{k_f}$

$$\Rightarrow \sigma'_e \propto k_d \Rightarrow \sigma'_e \propto \frac{1}{k_f}$$

$$\Rightarrow \sigma'_e = \frac{1}{1.5} \times \sigma_e = 0.667\,\sigma_e$$

Endurance strength is reduced by 33.33 %.

38. Ans: (c)

Sol: Spring constant, $S = 2\left(\frac{a}{b}\right)^2\left(\frac{F_2 - F_1}{r_2 - r_1}\right)$

$$= 2\left(\frac{100-50}{50-30}\right) = 5 \text{ N/m}$$

39. Ans: (b)

Sol: Total length of weld = 2*l* + 100

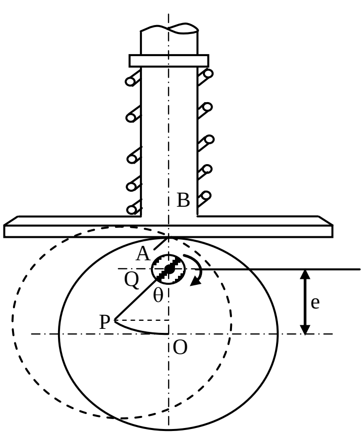
$\therefore\ 200(2l + 100) = 100 \times 10^3$

$2l + 100 = 500$

$\Rightarrow \quad l = 200$ mm

40. Ans: (c)

Sol:



The displacement of follower is given by

$$x = e - e\cos\theta$$

Velocity, $\dot{x} = e\omega\sin\theta$

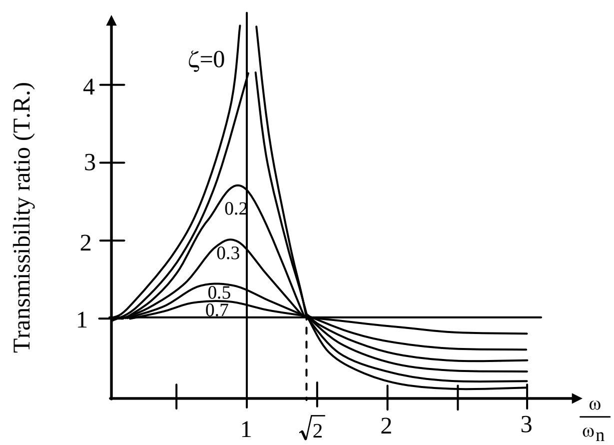
Acceleration, $\ddot{x} = e\omega^2\cos\theta$

41. Ans: (c)

Sol: Resistance to fatigue of a material is measured by its endurance strength. Thus statement 2 is incorrect.

42. Ans: (b)

Sol: When $\frac{\omega}{\omega_n} > \sqrt{2}$, the transmitted force is always less than exciting force.



Transmissibility versus frequency ratio for different values of ζ

Important conclusions from transmissibility curves :

(i) TR→1 as $\frac{\omega}{\omega_n} = 0$ for all values of ξ

(ii) When $\frac{\omega}{\omega_n} \to \infty$, TR $\to 0$

(iii) When $\frac{\omega}{\omega_n} = \sqrt{2}$, TR = 1 for all values of ξ

(iv) $0 < \frac{\omega}{\omega_n} < 1$, TR > 1;

- ➢ TR increases when $\frac{\omega}{\omega_n}$ increases.
- ➢ TR decreases when ξ increases.

(v) at $1 < \frac{\omega}{\omega_n} < \sqrt{2}$, TR > 1, i.e., the transmitted force is always more than the exciting force.

- ➢ TR decreases when $\frac{\omega}{\omega_n}$ increases
- ➢ TR decreases when ξ increases

(vi) at $0 < \frac{\omega}{\omega_n} < \sqrt{2}$, TR > 1 and TR decreases when ξ increases

(vii) when $\frac{\omega}{\omega_n} > \sqrt{2}$, TR < 1, i.e., the transmitted is always less than the exciting force.

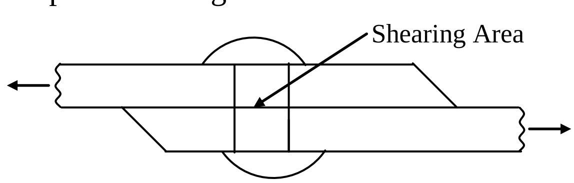
- ➢ TR decreases when $\frac{\omega}{\omega_n}$ increases
- ➢ TR increases when ξ increases

(viii) When $\frac{\omega}{\omega_n} = 1$, the transmitted force is infinite; if damping is used, the magnitude of the transmitted force can be reduced.

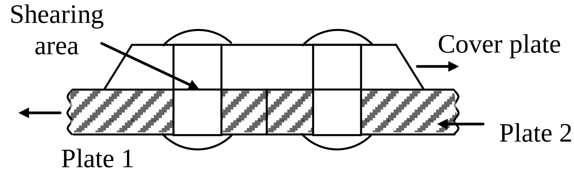
43. Ans: (b)

Sol:

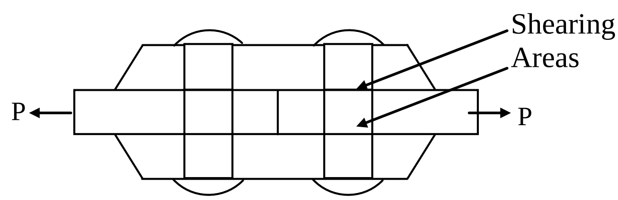
- Lap Joint – Single Shear



- Single Cover Butt Joint – Single Shear



- Double Cover Butt Joint – Double Shear



- Riveted lap joint is recommended for circumferential joint in a boiler.

44. Ans: (b)

Sol: Damping has no effect on phase angle at resonance frequency. Phase angle at this condition is always $\pi/2$.

45. Ans: (c)

Sol: Tearing resistance = $(p - d)\, t\, \sigma_t$

Strength of solid unriveted plate = $p\, t\, \sigma_t$

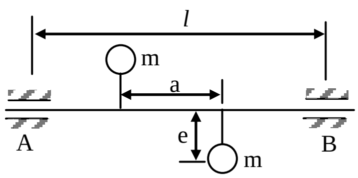
Tearing efficiency = $\frac{(p-d)t\,\sigma_t}{pt\,\sigma_t} = \frac{p-d}{p}$

$\therefore \quad \frac{p-d}{p} = 0.6$

(or) $\frac{p}{d} = 2.5$

46. Ans: (c)

Sol: If a shaft carries a number of unbalanced masses such that the centre of mass of the system lies on the axis of rotation, the system is said to be statically balanced. Such a system may, nevertheless, exert dynamic forces at the supports when it is rotated.



$R_B = -R_A = m(\omega^2 ea / l)$.

The reactions on the left and right bearing are of same magnitude and are out of phase by 180°.

47. Ans: (d)

Sol: Resultant load on the bolt is given by,

$$P_b = P_i + P\left(\frac{k_b}{k_b + k_c}\right)$$

Here, k_b = stiffness of the bolt,

k_c = combined stiffness,

P_i = initial tension,

P = external load.

48. Ans: (b)

Sol:

$$MF = \frac{X}{\left(\frac{F_0}{k}\right)} = \frac{1}{\sqrt{\left(1-\left(\frac{\omega}{\omega_n}\right)^2\right)^2 + \left(2\xi\frac{\omega}{\omega_n}\right)^2}}$$

At maximum amplitude $\frac{d(MF)}{d\left(\frac{\omega}{\omega_n}\right)} = 0$

and it gives $\omega_p = \sqrt{1-2\xi^2}\,\omega_n$

$\therefore\ \omega_p < \omega_n$

49. Ans: (a)

Sol: To ensure self-locking in a screw

$\phi > \alpha$; $\tan\phi > \tan\alpha$

Here, α = Helix angle,

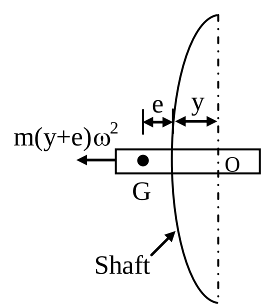
ϕ = friction angle.

Since $\tan\phi = \mu$ and $\tan\alpha = \frac{\ell}{\pi d}$

Or, $\mu > \frac{\ell}{\pi d}$ (or) $d > \frac{\ell}{\pi\mu}$

50. Ans: (c)

Sol:



$m(y + e)\omega^2 = ky$

$$y = \frac{me\omega^2}{m\omega^2 - k} = \frac{e}{1-\left(\frac{\omega}{\omega_n}\right)^2}$$

At higher speeds ($\omega > \omega_n$) y is negative when y = –e, there is no unbalance because O & G coincide.

51. Ans: (a)

Sol: Safe stress in flywheel rim is

$\sigma_{cf} = \rho V^2$

$\therefore\ V < \sqrt{\frac{\sigma_{cf}}{\rho}}$

$\text{But},\ V = \frac{\pi DN}{60} = \sqrt{\frac{\sigma_{cf}}{\rho}}$

$\therefore D_{max} = \frac{60}{\pi \times 1000}.\sqrt{\frac{70 \times 10^6}{7000}}$

$D_{max} = \frac{6}{\pi} m$

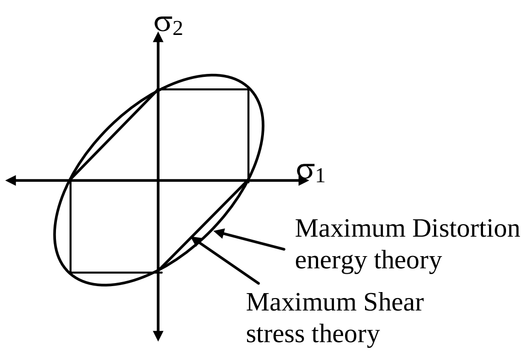
52. Ans: (a)

Sol: $T_m \times 4\pi = \frac{1}{2} \times \pi \times T_P$

$\Rightarrow\ T_P = 8T_m = 80$ N-m

53. Ans: (d)

Sol: The hexagonal diagram of Tresca (maximum shear stress) theory is inside the ellipse of von-Mises' (distortion energy) theory as shown below.



- Tresca theory is used for ductile materials, if dimensions need not be held too close and a generous factor of safety is used.
- von-Mises' theory is used when the factor of safety is to be held in close limits. This theory predicts the failure most accurately.

54. Ans: (c)

Sol: Herringbone gears do not produce any axial thrust because there are two pairs of gears and the thrust generated by one pair is cancelled by another.

Worm gears are used for extreme speed reduction. Helical gears give quiet motion because of gradual engagement of teeth.

Hypoid gears are non-interchangeable.

55. Ans: (b)

Sol: $\frac{T_1}{T_2} = 2$,

$P_{max} = 0.5$ MPa,

P = 10 kW

v = 10 m/s,

D = 500 mm

$(T_1 – T_2)v = 10000$

$T_1 – T_2 = 1000$ .... (I)

Also, $\frac{T_1}{T_2} = 2$. From equation (I)

$T_2 = 1000$ N,

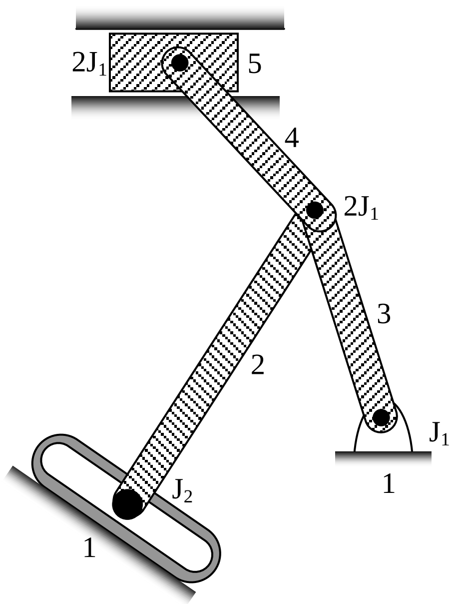
$T_1 = 2000$ N

$$P_{max} = \frac{T_{max}}{R \times b} = \frac{T_1}{R \times b}$$

$$b = \frac{2000}{\left(\frac{500}{2}\right) \times 0.5} = 16 \text{ mm}$$

56. Ans: (b)

Sol:



No. of links, N = 5,

No. of joints having one DOF, $J_1 = 5$,

No. of joint having two DOF, $J_2 = 1$

By Kutzbach criterion,

$DOF = 3(N - 1) - 2J_1 - J_2$

$= 3(5 - 1) - 2 \times 5 - 1$

$= 1$

57. Ans: (c)

Sol: Equivalent torque as per maximum shear stress theory is given by,

$$T_e = \sqrt{M^2 + T^2} = \sqrt{3^2 + 4^2} = 5 \text{ kN.m}$$

58. Ans: (a)

Sol: Primary reverse crank is mirror image of primary direct crank about the line of stroke.

59. Ans: (d)

Sol: Given data:

$S_{yt} = 500$ MPa,

$T = 250\pi$ N.m,

FOS = 4,

We know that,

$$\frac{T}{J} = \frac{\tau_{max}}{D/2}$$

$$\Rightarrow \tau_{max} = \frac{16T}{\pi D^3}$$

According to maximum shear stress theory,

$$\tau_{max} \le \tau_{allow}$$

$$\therefore \frac{16T}{\pi D^3} \le \frac{S_{yt}}{2 \times FOS}$$

$$\therefore \frac{16 \times 250\pi \times 10^3}{\pi D^3} \le \frac{500}{2 \times 4}$$

$$\therefore D \ge 40 \text{ mm}$$

60. Ans: (b)

Sol: $h = \frac{g}{m\omega^2}\left[m + \frac{(M)(1+k)}{2}\right]$

k = 1 (arms are equal length)

$$\frac{0.50}{\sqrt{2}} = \frac{g}{\omega^2}(21)$$

$$\Rightarrow \omega = 24 \text{ rad/s}$$


INDIA

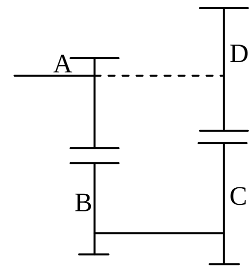
61. Ans: (a)

Sol:

- Bevel gear is used for connecting two non-parallel or, intersecting but coplanar shafts.
- Mitre gear is used for connecting two shafts whose axes are mutually perpendicular to each other.
- Spur gear is used for connecting two parallel and coplanar shafts with teeth parallel to the axis of the gear wheel.
- Helical gear is used for connecting two parallel and coplanar shafts with teeth inclined to the axis of the gear wheel.

62. Ans: (d)

Sol:



N_A = 600 rpm (CCW)

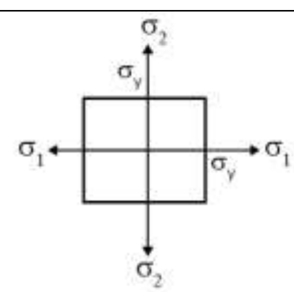
$$\frac{m}{2}(T_A + T_B) = \frac{m}{2}(T_C + T_D)$$

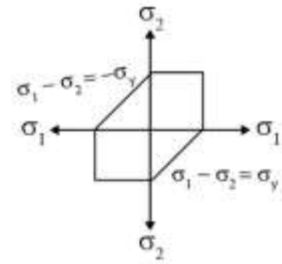
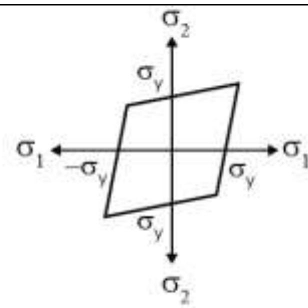
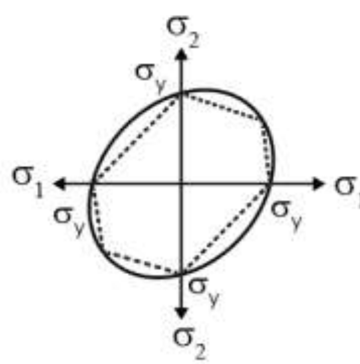
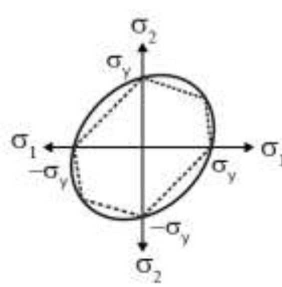
$\Rightarrow 24 + 48 = 24 + T_D$

$\Rightarrow T_D = 48$

63. Ans: (b)

Sol:

S. No.	Theory	Failure envelope shape
1.	**Maximum principal stress theory** $\sigma_1 < \sigma_y$ Failure envelope : Square	
2.	**Maximum shear stress theory** $\|\sigma_1 - \sigma_2\| < \sigma_y$ (or) $\sigma_1 < \sigma_y$ If $\sigma_2 = 0$ (or) $\sigma_3 = 0$ Failure envelope : Hexagon	

		
3.	**Maximum Principal strain theory** $\lvert\sigma_1 - \mu\sigma_2\rvert < \sigma_y$ Failure envelope : Rhombus	
4.	**Maximum distortion energy theory (or) maximum shear strain energy theory** $\lvert\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2\rvert < \sigma_y^2$ Failure envelope : Ellipse $\sigma_1 = \sigma_2$ major axis: $\sigma_1 = \sigma_y = \frac{a}{\sqrt{2}}$ $\sigma_1 = -\sigma_2$ minor axis: $\sigma_1 = \frac{\sigma_y}{\sqrt{3}} = \frac{b}{\sqrt{2}}$ $a = \sqrt{2}\ \sigma_y$ $b = \sqrt{\frac{2}{3}}\sigma_y$	
5.	**Maximum strain energy theory** $\sigma_1^2 + \sigma_2^2 - 2\mu(\sigma_1\sigma_2) < \sigma_y^2$ Failure envelope : Ellipse $\sigma_1 = \sigma_2$ major axis: $\sigma_1 = \frac{\sigma_y}{\sqrt{1-\mu}} \times \frac{1}{\sqrt{2}} = \frac{a}{\sqrt{2}}$	

	$\sigma_1 = -\sigma_2$ minor axis: $\sigma_1 = \frac{\sigma_y}{\sqrt{1+\mu}} \times \frac{1}{\sqrt{2}} = \frac{b}{\sqrt{2}}$ $a = \frac{\sigma_y}{\sqrt{1-\mu}}$ & $b = \frac{\sigma_y}{\sqrt{1+\mu}}$	

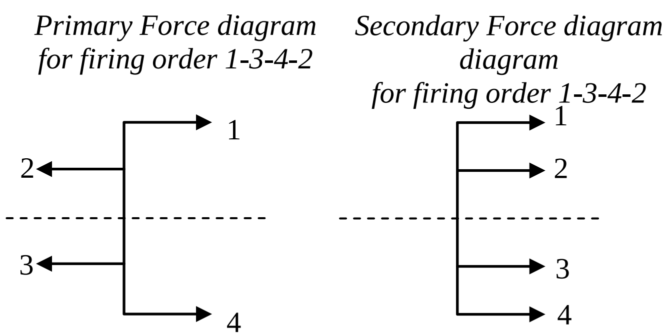
64. Ans: (d)

Sol: The firing order for in-line four cylinder four stroke engine is 1-3-4-2.

$$\beta = \frac{4\pi}{\text{no. of cylinders}} = \frac{4\pi}{4} = \pi$$

Magnitude of primary force = $mr\omega^2 \cos\theta$

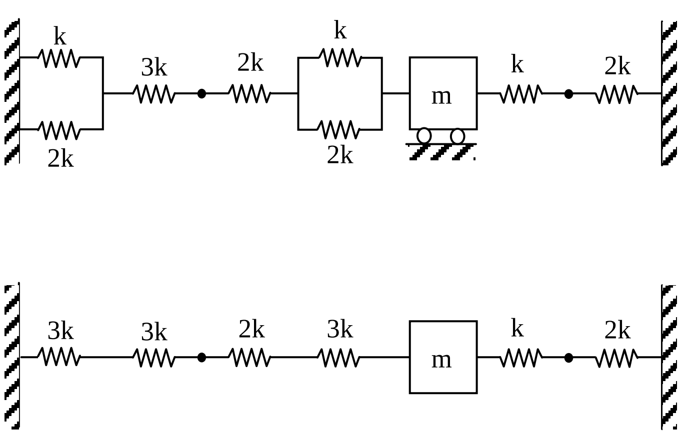
Magnitude of secondary force = $\frac{mr\omega^2 \cos 2\theta}{n}$

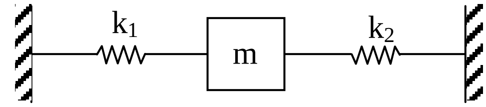


∴ From above diagram we can see that primary forces, primary couples and secondary couples are balanced whereas secondary forces are unbalanced.

65. Ans: (b)

Sol:





$$\Rightarrow \frac{1}{k_1} = \frac{1}{3k} + \frac{1}{3k} + \frac{1}{2k} + \frac{1}{3k} = \frac{1}{k}\left[\frac{2+2+3+2}{6}\right] = \frac{9}{6k}$$

$$\therefore k_1 = \frac{2k}{3}$$

$$\Rightarrow \frac{1}{k_2} = \frac{1}{k} + \frac{1}{2k} = \frac{3}{2k}$$

$$\therefore k_2 = \frac{2k}{3}$$

$$k_{eq} = k_1 + k_2 = \frac{2k}{3} + \frac{2k}{3} = \frac{4k}{3}$$

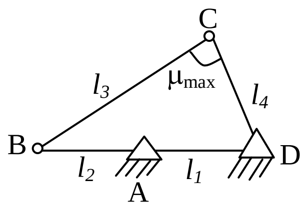
$$k_{eq} = \frac{4 \times 6000}{3} = 8000 \text{ N/m}$$

66. Ans: (a)

Sol: When a ductile material is subjected to repeating (or) cycle loads, progressive and localized deformations occur leading to the development of residual strains in the material. When the accumulated strain energy exceeds the toughness, the material fractures and this failure called as fatigue occurs at a load much less than the ultimate load of the structure. The failure load decreases with increase in the number of loadings. Thus, both the statements are correct and statement (II) is the correct explanation of statement (I).

67. Ans (c)

Sol:



Maximum transmission angle occurs when input crank is parallel (180°) with the fixed link.

68. Ans: (d)

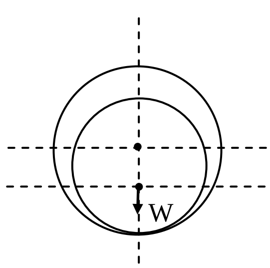
Sol: Wilfred Lewis equation is used to determine the bending strength of gear tooth. Thus, the statement (I) is incorrect and statement (II) is correct.

69. Ans: (a)

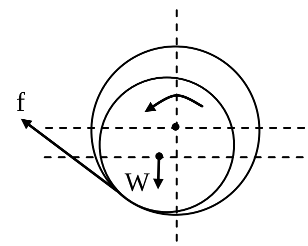
Sol: Since involute curve does not exist within base circle, interference is always possible if base circle radius is larger than dedendum circle radius.

70. Ans: (c)

Sol: At rest the position of journal inside bearing is shown below.



At low speed, there is metal to metal contact and due to this frictional force is very high which shifts the journal towards left.



where, f = Friction force, W = Load

Wedging action are dominant at high speed and move the journal toward right.

Thus, the statement (I) is correct and statement (II) is incorrect.

71. Ans: (a)

Sol: Hammer blow is the maximum vertical unbalanced force caused by the balanced counter mass. Its value is $mr\omega^2$. It varies as square of the speed. At higher speed hammer blow could exceed static load on wheels and there is danger of wheels beings lifted above rails.

72. Ans: (b)

Sol: According to Soderberg equation

$$\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{yt}} = \frac{1}{\text{Factor of safety}}$$

S_e = Endurance strength

σ_a = Stress amplitude,

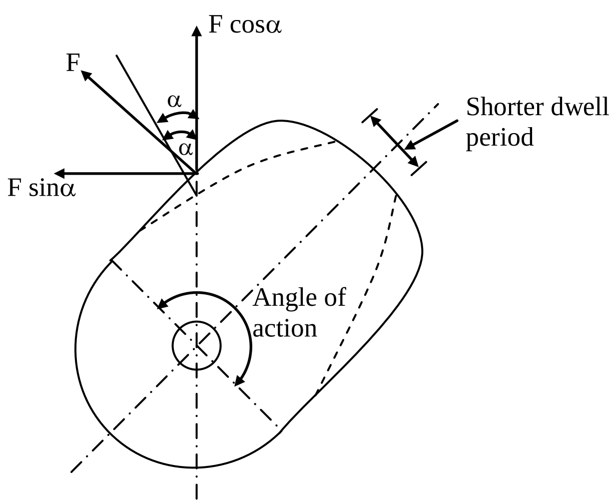
σ_m = means stress.

Thus, both the statements are correct, but statement (II) is not the explanation of statement (I).

73. Ans: (c)

Sol: A high value of pressure angle is not desired because it might jam the follower.

The force exerted by a cam on the follower is always normal to the surface of the cam at the point of contact. The vertical component (F$\cos\alpha$) lifts the follower whereas the horizontal component of force exerted by the cam on the follower exert lateral pressure on the bearing. At high pressure angle the lateral pressure on the bearing is also high and might jam the follower in the bearings.



74. Ans: (c)

Sol: Form factor is high for gear and it carries more Torque. Thus, statement (II) is incorrect and statement (I) is correct.

75. Ans: (c)

Sol:

- Body centrode is the locus of the I-centre of fixed body relative to moving body.
- Space centrode is the locus of the I-centre of the moving body relative to the fixed body.

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