

INDIAN SPACE RESEARCH ORGANISATION

2014

MECHANICAL ENGINEERING

SET A



1. Shock resisting steel should have higher  
(a) Stiffness (b) Hardness (c) Toughness (d) Shear strength

2. Let  $A = \begin{bmatrix} 0 & 0 & -1 \\ 0 & -1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$

The only correct statement about the matrix A is

- (a) A is a ZERO matrix (b)  $A^2 = I$   
(c)  $A^{-1}$  does not exist (d)  $A = (-1)I$ , where I is a Unit matrix

3. Let M be a 3 x 3 matrix satisfying:

$$M \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}, \quad M \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ -1 \end{bmatrix}, \quad \text{and} \quad M \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 12 \end{bmatrix}$$

Then the sum of the diagonal entries of M is:

- (a) 9 (b) 12 (c) 6 (d) 0
4. Angle made between vector  $\vec{c} = 2\vec{i} - 3\vec{j} + 4\vec{k}$  and the Z-axis  
(a)  $\frac{4}{\sqrt{29}}$  (b)  $\sin^{-1} \frac{4}{\sqrt{29}}$  (c)  $\cos^{-1} \left( \frac{4}{\sqrt{29}} \right)$  (d)  $\tan^{-1} \frac{4}{\sqrt{29}}$


5. Which of the following is the correct definition of the Reynolds number?

Where  $\rho$  = fluid density, U=velocity, L= Length and  
 $\mu$  = kinematic viscosity

- (a)  $\frac{\rho UL}{\mu}$  (b)  $\rho UL/\mu^2$  (c)  $\frac{UL}{\mu}$  (d)  $\frac{\rho UL^2}{\mu}$

6. A steam engine intakes 100gm of steam at 100°C per minute and cools it down to 20°C. Calculate the heat rejected by the steam engine per minute. (consider Latent Heat of vaporization of steam = 540 cal/gm and  $C_p = 1 \text{ cal/gm } ^\circ\text{C}$ )

- (a)  $6.2 \times 10^4 \text{ kCal}$  (b)  $62 \times 10^4 \text{ Cal}$   
(c)  $6.2 \times 10^4 \text{ Cal}$  (d)  $620 \times 10^4 \text{ kCal}$

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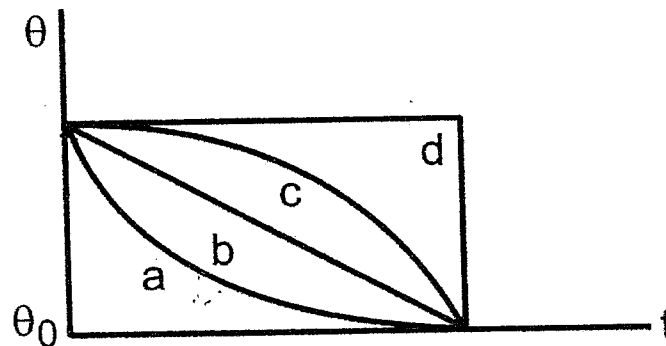
7. A heat engine operates between a cold reservoir at temperature  $T_2 = 300\text{ K}$  and a hot reservoir at Temperature  $T_1$ . It takes  $200\text{ J}$  of heat from the hot reservoir and deliver  $120\text{ J}$  of heat to the cold reservoir in a cycle. What will be the efficiency of the engine?

- (a) 30%      (b) 40%      (c) 60%      (d) 20%

8. Two bodies A and B having equal surface area are maintained at temperatures  $10^\circ\text{C}$  and  $20^\circ\text{C}$ . The energy of thermal radiations emitted in a given time by A and B are in the ratio:

- (a) 1: 1.15      (b) 1:2.5      (c) 1:4.2      (d) 1:5.6

9. A hot liquid is kept in a big room. Its temperature( $\theta$ ) is plotted as a function of time( $t$ ), which of the following curve may represent the plot?



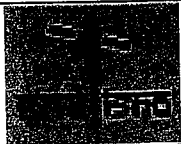
- (a) Curve d      (b) Curve b      (c) Curve c      (d) Curve a

10. Aluminum crystal structure is

- (a) FCC      (b) BCC      (c) HCP      (d) None of these

11. A spherical balloon is filled with  $3536\pi$  cubic meters of helium gas. If a leak in the balloon causes the gas to escape at the rate of  $70\pi$  cubic meters per minute, then the rate (in meters per minute) at which the radius of the balloon decreases 50 minutes after the leakage began is

- (a)  $\frac{1}{9}$       (b)  $\frac{1}{2}$       (c)  $\frac{2}{9}$       (d)  $\frac{35}{18}$

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12. Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is

- (a) 8%                      (b) 6%                      (c) 9%                      (d) 10%

13. A purse contains 4 copper coins and 3 silver coins. A second purse contains 6 copper coins and 4 silver coins. A purse is chosen randomly and a coin is taken out of it. What is the probability that it is a copper coin?

- (a)  $\frac{70}{82}$                       (b)  $\frac{35}{70}$                       (c)  $\frac{41}{82}$                       (d)  $\frac{41}{70}$

14. The Grashof number, Gr is defined as: (where g is gravitational acceleration,  $\beta$  is volumetric thermal expansion coefficient,  $\Delta T$  is temperature difference, L is characteristic length,  $\mu$  is the viscosity and  $\nu$  is kinematic viscosity.

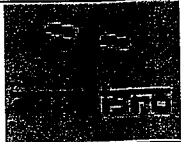
- (a)  $\frac{g\beta\Delta TL^3}{\mu^2}$                       (b)  $\frac{\rho^2 g\beta\Delta TL^3}{\mu^2}$                       (c)  $\frac{g\beta\Delta TL^3}{\nu^2}$                       (d)  $\frac{g\beta\Delta TL}{\nu^2}$

15. The Rayleigh number Ra, is defined as: (where Gr is Grashof Number, Pr is Prandtl Number and Re is Reynold Number)

- (a)  $Ra = Re Pr$                       (b)  $Ra = Gr Re$                       (c)  $Ra = Gr Pr$                       (d)  $Ra = Gr Pr/4$

16. For two bodies having direct impact, Co-efficient of restitution is given by

- (a)  $\frac{\text{Velocity of approach}}{\text{Velocity of separation}}$                       (b)  $\frac{\text{Velocity of Separation}}{\text{Velocity of approach}}$
- (c)  $\frac{\text{Initial velocity of the body}}{\text{Final velocity of the body}}$                       (d) None of the above

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17. A perfect frame is that which satisfies the equation (Assume  $n$ = No. Of members and  $j$ = No. Of joints)

- (a)  $n = 3j - 2$                       (b)  $n > 3(j - 1)$   
(c)  $n < 3(j - 1)$                       (d)  $n = (2j - 3)$

18. Tension in the cable supporting a lift of weight 'W' and having an acceleration of 'a' while going upward is (g is acceleration due to gravity)

- (a)  $W(1 + \frac{a}{g})$                       (b)  $W(1 - \frac{a}{g})$   
(c)  $W(2 + \frac{a}{g})$                       (d)  $W(1 + \frac{2a}{g})$

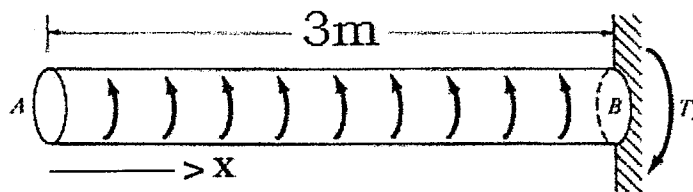
19. A body A of weight 10 Kg with its C.G. 25 cm from the axis of rotation is to be balanced by another body B of weight 5 Kg. The radius at which the C.G. of weight B should be placed is

- (a) 2 cm                      (b) 12.5 cm  
(c) 50 cm                      (d) None of these

20. In case of a horizontal beam loaded under bending, the point of inflexion or contra flexure corresponds to a point on the beam, where

- (a) Shear force is zero                      (b) Bending moment changes its sign  
(c) Shear force is maximum                      (d) None of the above

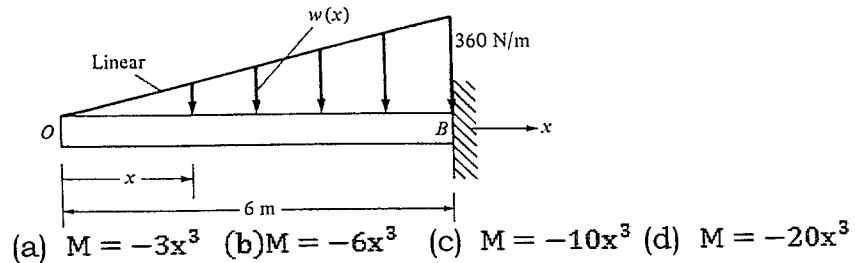
21. Shaft AB is 3 meter long and is free at the left end and fixed torsionally at the right end. It is subjected to variable torque as shown in the figure. The intensity of the torsional loading is given by  $q=2x$ . The internal torque T, as a function of x is



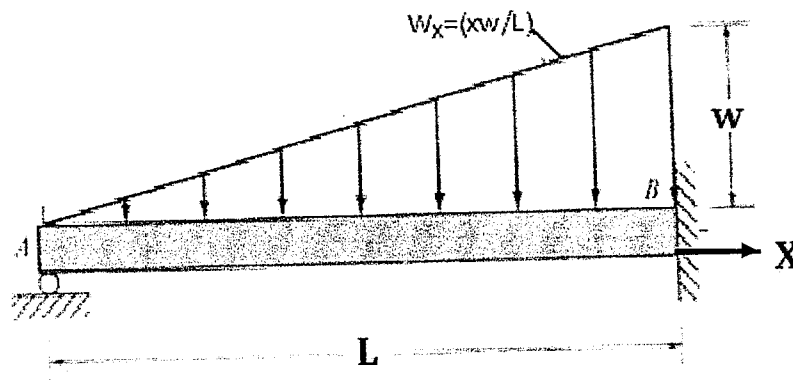
- (a)  $T = x^2$                       (b)  $T = 2x^2$                       (c)  $T = 4x^2$                       (d)  $T = 16x^2$

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22. A cantilever beam 6 meter long as shown in figure is subjected to a linearly varying loading which has a maximum ordinate of 360 N/m at the fixed end on the right. The moment as a function of  $x$  is



23. Consider the beam shown in figure. The beam is simply supported at its left end A and fixed at its right end B. It carries a load that varies in intensity from zero at support A to 'w' at support B according to the relation  $w_x = (x/L)w$ . The reaction component at A is

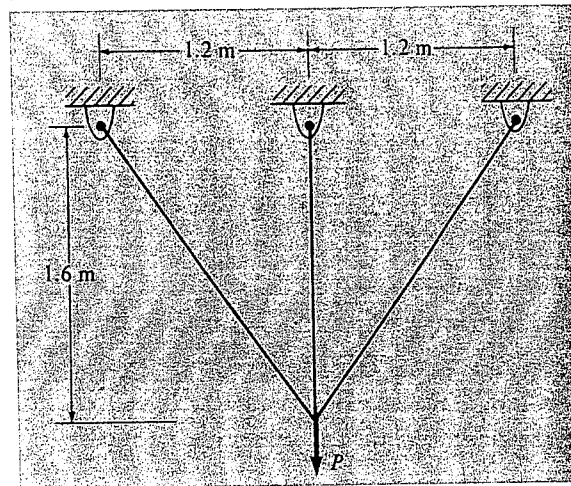


- (a)  $wL/10$  (b)  $2wL/5$  (c)  $5wL/2$  (d)  $wL/5$
24. A 4 meter long solid circular cylindrical shaft transmits 1600 kW at 500 rpm. The endurance limit of the material is 210 MPa and a factor of safety of 3 is to be used with respect to fatigue failure. Use  $G = 77.5$  GPa. The design diameter 'D' of the shaft in metre is

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(a)  $\sqrt[3]{\frac{69}{4375\pi^2}}$  (b)  $\sqrt[3]{\frac{4375}{96\pi^2}}$  (c)  $\sqrt[3]{\frac{69}{4735\pi^2}}$  (d)  $\sqrt[3]{\frac{96}{4375\pi^2}}$

25. A three bar truss to resist a service load  $P = 100$  kN is shown in the figure. Use a load factor of 2 and consider all three members to have equal cross-sectional areas. The yield stress of the material of which the members are fabricated is 400 MPa. The area of cross section of each truss member is




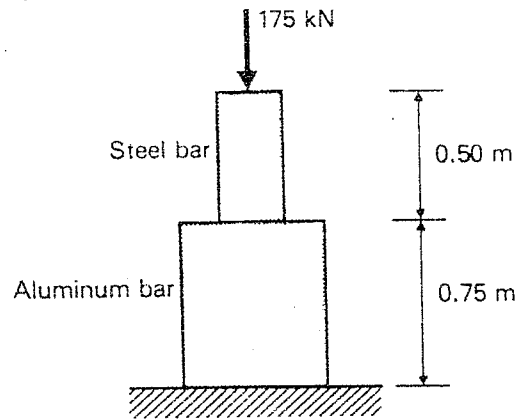
(a)  $\frac{25}{26}$  cm<sup>2</sup> (b)  $\frac{26}{25}$  cm<sup>2</sup> (c)  $\frac{25}{13}$  cm<sup>2</sup> (d)  $\frac{13}{25}$  cm<sup>2</sup>

26. A thin-walled cylinder with closed ends for which inner radius is 0.50 meter & outer radius is 0.52 meter, is subjected to internal pressure 2 MPa. The absolute maximum shearing stress on the inner surface of the cylinder shall be

(a) 37.5 MPa (b) 75 MPa (c) 26 MPa (d) 24 MPa

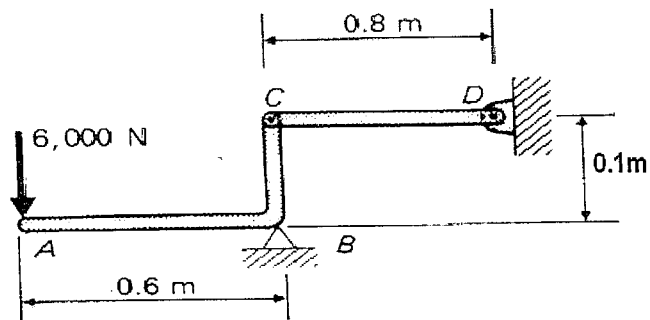
27. A 0.75 meter aluminium bar  $25 \times 10^{-4}$  m<sup>2</sup> in cross-sectional area is attached to a 0.50 meter steel bar  $15 \times 10^{-4}$  m<sup>2</sup> in cross-sectional area, as shown in the figure. Take E (Young's modulus) value of 200 GPa for steel & 70 GPa for aluminum. Total shortening due to an axial compressive force of 175 kN is

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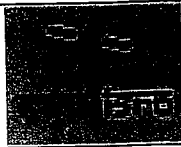


- (a)  $\frac{157}{168}$  mm    (b)  $\frac{175}{168}$  mm    (c)  $\frac{175}{186}$  mm    (d)  $\frac{157}{186}$  mm

28. Member CD of the assembly shown is an aluminium bar 0.80 meter long. Cross-sectional dimension of the bar is such that, its width is three times its thickness. For functional design of the bar CD, the allowable axial stress is 70 MPa, and the total elongation is not to exceed 0.72 mm. E value for aluminium is 70 GPa. Assume the connection at C does not reduce the net area of the bar. The thickness of the bar in metre is



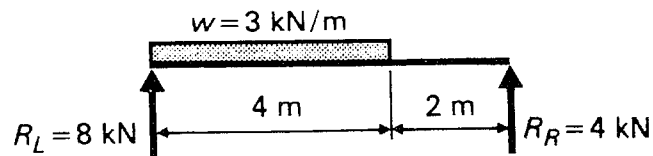
- (a)  $\frac{2}{\sqrt{21 \times 10^5}}$  m    (b)  $\frac{5}{\sqrt{21 \times 10^3}}$  m  
(c)  $\frac{2}{\sqrt{21 \times 10^3}}$  m    (d)  $\frac{3}{\sqrt{21 \times 10^3}}$  m

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29. A solid steel shaft transmits 40kW of power at a speed of  $\frac{75}{\pi}$  Hz. The internal torque needed in the shaft is

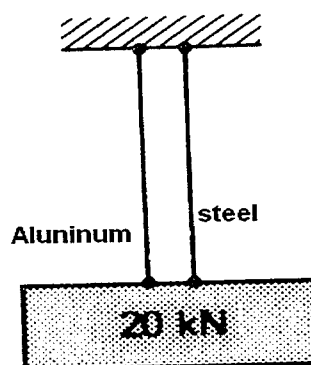
(a)  $\frac{812}{3}$  Nm (b)  $\frac{800}{3}$  Nm (c)  $\frac{541}{2}$  Nm (d)  $\frac{400}{3}$  Nm

30. A simply supported beam is shown in the figure below. The location of the point of maximum moment in the beam from reaction  $R_L$  is




- (a)  $\frac{3}{8}$  meter (b)  $\frac{8}{3}$  meter (c)  $\frac{18}{5}$  meter (d)  $\frac{21}{5}$  meter

31. A 20 kN weight is suspended by two wires as shown in the figure. The length of each wire is 2 meter. The steel wire (E value 200GPa) has an cross-sectional area of  $60 \times 10^{-6}$  m<sup>2</sup> and the aluminum wire (E value 70GPa) has an cross-sectional area of  $120 \times 10^{-6}$  m<sup>2</sup>. The stress in aluminum wire is



- (a)  $\frac{17}{102}$  GPa (b)  $\frac{7}{120}$  GPa (c)  $\frac{17}{120}$  GPa (d)  $\frac{7}{102}$  GPa



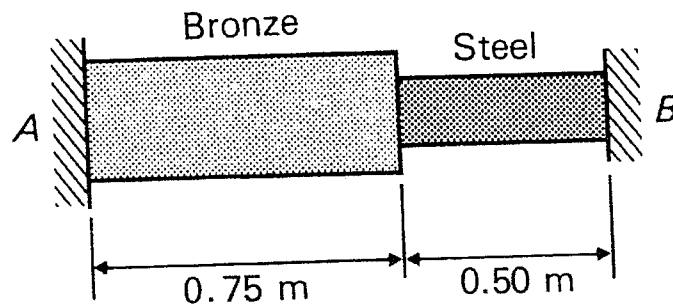
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32. A bar of bronze and a bar of steel are placed between two immovable supports, A & B as shown in the figure. The physical constants are: (where  $L$  = length of bars,  $A$  = cross-sectional area,  $\alpha$  = linear co-efficient of thermal expansion,  $E$  = Young's modulus)

Steel  
 $L = 0.5 \text{ m}$   
 $A = 6 \times 10^{-4} \text{ m}^2$   
 $\alpha = 12 \times 10^{-6} / ^\circ\text{C}$   
 $E = 200 \text{ GPa}$

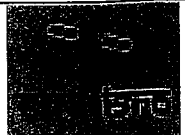
Bronze  
 $L = 0.75 \text{ m}$   
 $A = 12 \times 10^{-4} \text{ m}^2$   
 $\alpha = 20 \times 10^{-6} / ^\circ\text{C}$   
 $E = 100 \text{ GPa}$

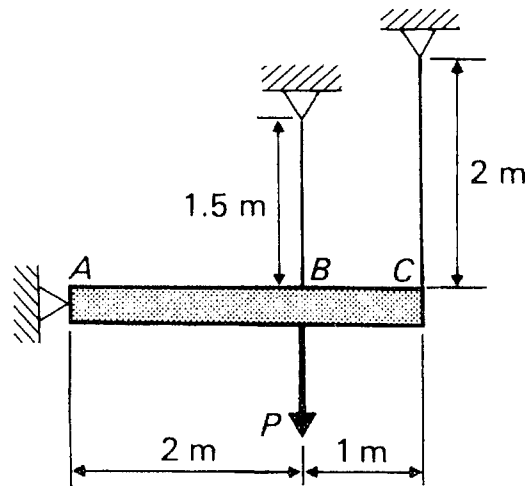
The stresses in the steel & bronze, when temperature drops by  $50^\circ\text{C}$  is



- (a) Tension      (b) Compression      (c) Shear      (d) None of these

33. A rigid bar with wires at B & C is shown in the figure below. The cross sectional area of the wire at B is  $3 \times 10^{-4} \text{ m}^2$  and at C is  $2 \times 10^{-4} \text{ m}^2$ . The wires are elasto- plastic with strength 250 MPa and  $E$  value 200 GPa. The ultimate load  $P$  that can be applied to the rigid bar, as shown is

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- (a) 50 kN      (b) 75 kN      (c) 100 kN      (d) 150 kN

34. The fundamental natural frequency of the cantilever beam with point load  $P$  acting at the free end, in rad/sec is

- (a)  $\sqrt{\frac{3EIg}{PL^3}}$       (b)  $\sqrt{\frac{PL^3}{3EIg}}$       (c)  $\frac{1}{2\pi} \sqrt{\frac{3EIg}{PL^3}}$       (d)  $\frac{1}{2\pi} \sqrt{\frac{PL^3}{3EIg}}$


35. The structure which has the highest packing of atoms

- (a) Hexagonal close packed lattice  
 (b) Body centred cubic lattice  
 (c) Face centred cubic lattice  
 (d) Both (a) & (c)

36. Elastic stress distribution in the cross section of a curved beam under pure bending is

- (a) Linear (b) Quadratic (c) Parabolic (d) Hyperbolic.

37. Dimension of shaft is  $100_{-0.00}^{+0.01}$  and corresponding Hole diameter is  $100_{-0.01}^{+0.02}$ . The maximum material condition of the fit is

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- (a) Shaft diameter:100.01 and hole diameter: 99.99  
 (b) Shaft diameter:100.00 and hole diameter: 99.99  
 (c) Shaft diameter:100.00 and hole diameter: 100.02  
 (d) Shaft diameter:100.005 and hole diameter: 100.015

38. Match List 1 with List-II and select the correct answer.

LIST-I (Process)	LIST-II (Property)
(P) Cold Rolling	(1) Indentation
(Q) Hardness	(2) Ductility
(R) Impact loads	(3) Malleability
(S) Wire drawing	(4) Resilience

- (a) P→4, Q→2, R→3, S→1      (b) P→3, Q→1, R→4, S→2  
 (c) P→1, Q→3, R→4, S→2      (d) P→3, Q→1, R→2, S→4

39. In case of steady incompressible laminar viscous flow between two stationary parallel plates, the velocity distribution is

- (a) Linear      (b) Quadratic      (c) Parabolic      (d) Hyperbolic

40. Two pipe lines of equal length are connected in series. The diameter of second pipe is two times that of first pipe, the ratio of head loss between first and second pipe is

- (a) 1:32      (b) 32:1      (c) 1:8      (d) 1:4

41. The velocity potential function  $\phi$  satisfy the Laplace equation :

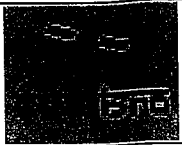
$$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2} = 0$$

Then the flow is

- (a) Unsteady, incompressible , rotational  
 (b) steady, compressible , rotational  
 (c) steady, incompressible , irrotational  
 (d) Unsteady, compressible , irrotational

42. For a two dimensional potential flow, the velocity potential is given by:  
 $\phi = 4x(3y-4)$  The numerical value of stream function at the point(2,3) is

- (a) 10 Units      (b) 20 Units      (c) 18 Units      (d) 16 Units

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43. The velocity distribution in a turbulent boundary layer is given by  $u/v = (y/\delta)^{1/7}$ . What is the displacement thickness  $\delta^*$

- (a)  $\delta$                       (b)  $\delta/7$                       (c)  $7\delta/8$                       (d)  $\delta/8$

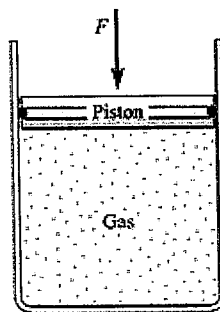
44. The specific weight  $W$  of ocean water changes according to the equation  $W = W_0 + C\sqrt{h}$ .  $W_0$  = Specific weight of ocean water at free surface and  $C$  is a constant. The pressure as a function of depth  $h$  is given by

- (a)  $W_0 h$                       (b)  $W_0 h + (5/2) C h$   
(c)  $W_0 h + (2/3) C h^{3/2}$                       (d)  $W_0 h - (2/3) C h^{2/3}$

45. The model of a propeller, 3 m diameter, cruising at 10 m/sec in air, is tested in a wind tunnel on a 1:10 scale model. If thrust of 50 N is measured on the model at 5 m/sec wind speed, then thrust on prototype will be

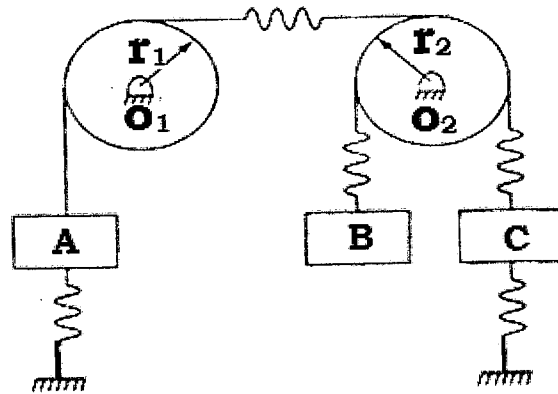
- (a) 20000 N                      (b) 2000 N                      (c) 5000 N                      (d) 500 N

46. As shown in Fig. below, an ideal gas is confined to a cylinder by a piston. The piston is pushed down slowly so that the gas temperature remains at 27°C. During the compression, 900 J of work is done on the gas. Find the entropy change of the gas.



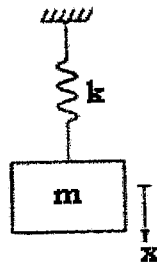
- (a) 3 J/K                      (b) -3 J/K                      (c) -6 J/K                      (d) 6 J/K

47. Determine the number of degrees of freedom used in the analysis of the mechanical system of below mentioned Figure.



- (a) 3                      (b) 7                      (c) 5                      (d) 4

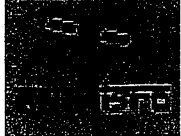
48. The difference in the Potential energies between two arbitrary positions downward displacements \$X\_1\$ and \$X\_2\$. (\$X\_2 > X\_1\$)



- (a)  $\frac{1}{2} k[x_1 - x_2]^2$                       (b)  $\frac{1}{2} k[(x_2)^2 - (x_1)^2]$   
(c)  $\frac{1}{2} k[(x_1)^2 - (x_2)^2]$                       (d)  $\frac{1}{2} k[x_1 - x_2]$

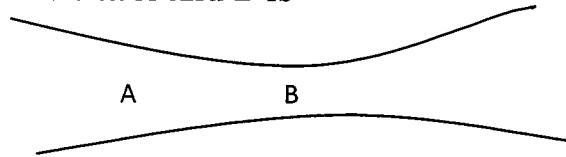
49. Water having kinematic viscosity of 0.01 stoke flows at a velocity of 2 m/sec in a pipe of 15 cm diameter. For dynamic similarity, the velocity of oil of kinematic viscosity of 0.03 stoke in a pipe of same diameter will be

- (a) 0.33 m/sec    (b) 0.66 m/sec    (c) 2 m/sec    (d) 6 m/sec

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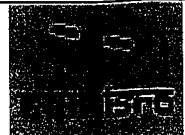
50. An inclined plate 2 m long and 1 m wide lies with its length inclined at  $45^\circ$  to the surface of water and its nearest edge is 1 m below it. If specific weight of water is  $1000\text{kg/m}^3$ , then total pressure force on the plate (in kg) is approximately
- (a) 2150                      (b) 2510                      (c) 3220                      (d) 3420

51. A liquid of density  $1200\text{ kg/m}^3$  is flowing steadily through a tube of varying cross section as shown below. The cross section at point A is  $1\text{ cm}^2$  and at B is  $20\text{ mm}^2$ . The points A and B are in the same horizontal plane. The speed of liquid at point A is  $10\text{ cm/sec}$ . The difference of pressure at A and B is



- (a) 100 Pa                      (b) 170 Pa                      (c) 144 Pa                      (d) 180 Pa
52. A wooden plank ( sp. gravity =0.5) of  $1\text{ m} \times 1\text{ m} \times 0.5\text{ m}$  floats in water with  $1.5\text{ kN}$  load on it with  $1\text{ m} \times 1\text{ m}$  surface horizontal. The depth of plank lying below water surface shall be
- (a) 0.178 m                      (b) 0.250 m                      (c) 0.403 m                      (d) 0.5 m
53. Circulation is defined as the line integral of tangential component of velocity about a
- (a) Centre                      (b) close contour in a fluid flow  
(c) velocity profile                      (d) pressure profile
54. Unstable equilibrium of a floating body implies

- (a) Metacentre M is above centre of gravity G  
(b) Metacentre M is below centre of gravity G  
(c) Metacentre M coincides with centre of gravity G  
(d) None of these

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55. Viscosity has the dimension of

- (a)  $(MT^2) / L$  (b)  $M^2 / (LT)$  (c)  $M / (LT^2)$  (d)  $M / (LT)$

56. Which of the following flow is rotational (where  $u$  and  $v$  are velocity components in  $x$  and  $y$  directions respectively)

- (a)  $u = y ; v = (\frac{3}{2}x)$  (b)  $u = xy^2 . v = x^2y$   
(c) Both (a) and (b) (d) None of these

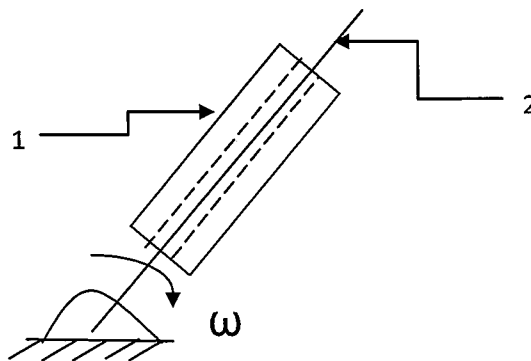
57. A pump running at 1000 rpm consumes 1KW and generates head of 10m of water. When it is operated at 2000rpm, its power consumption and head generated would be

- (a) 4 kW, 50m of water (b) 6 kW, 20m of water  
(c) 3 kW, 30m of water (d) 8 kW, 40m of water

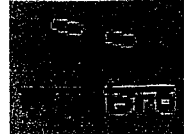
58. For irrotational fluid flow curl of velocity vector is

- (a) 0 (b)  $> 0$  (c)  $< 0$  (d) none of these

59. In the figure shown below, the relative velocity of link 1 with respect to link 2 is 15 m/s. The link 2 rotates at a constant speed of 150 rpm. The magnitude of coriolis component of acceleration of link 1 is



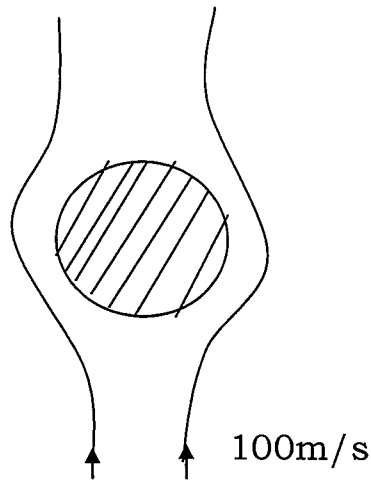
- (a)  $201 \text{ m/s}^2$  (b)  $239 \text{ m/s}^2$  (c)  $418 \text{ m/s}^2$  (d)  $471 \text{ m/s}^2$

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60. An oil of kinematic viscosity of 0.5 stokes flow through a pipe of 20 cm diameter. What is the velocity if the flow is critical?

- (a) 0.5 m/s (b) 0.9 m/s (c) 1.5 m/s (d) 2 m/s

61. A vertical air stream flowing at a velocity of 100 m/s supports a ball of 60 mm in diameter. Taking the density of air as  $1.2 \text{ kg/m}^3$  and kinematic viscosity as 1.6 stokes, the weight of the ball that is supported is (if coefficient of drag  $C_D = 0.8$ )




- (a) 20.2 N (b) 13.5 N (c) 30.1 N (d) 25.2 N

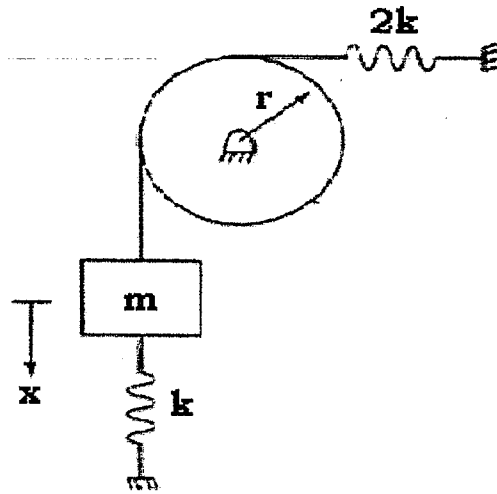
62. The velocity distribution for flow over a flat plate is given by  $U = (3/4)y - y^2$  in which  $u$  is the velocity in m/s at a distance  $y$  meter above the plate. If the dynamic viscosity of the fluid is 10 poise, then the shear stress at 0.2 m is

- (a)  $0.45 \text{ N/m}^2$  (b)  $0.35 \text{ N/m}^2$  (c)  $0.55 \text{ N/m}^2$  (d)  $0.25 \text{ N/m}^2$



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63. Determine  $m_{eq}$  and  $k_{eq}$  for the system in below Fig., when  $X$ , the downward displacement of the block, measured from the system's equilibrium position, is used as the generalized coordinate. Take  $I$  as the M.I. of the wheel.



- (a)  $K_{eq} = 3k, m_{eq} = m + \frac{I}{r^2}$     (b)  $K_{eq} = 3k, m_{eq} = mr^2 + I$   
(c)  $K_{eq} = 3k, m_{eq} = m - \frac{I}{r^2}$     (d)  $K_{eq} = k/3, m_{eq} = m + \frac{I}{r^2}$

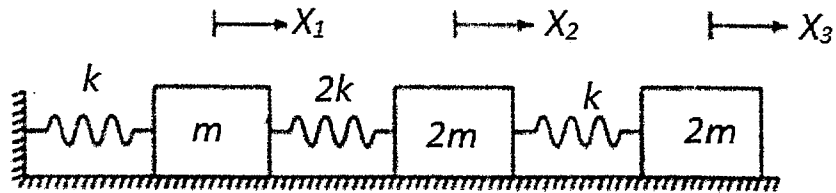
64. The system described by the following governing equation of motion, will have how many natural frequencies? ,

$$\begin{bmatrix} m & 0 \\ 0 & m \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} 2k & -k \\ -k & 3k \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$


- (a) 4    (b) 3    (c) 2    (d) 1



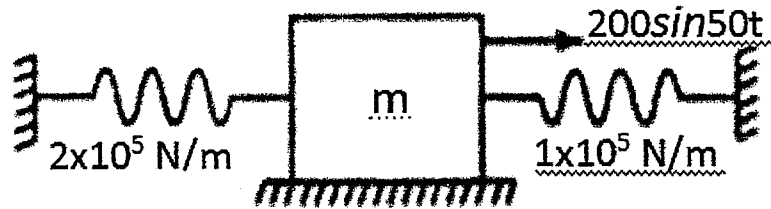
65. Find out the correct free body diagram for the middle mass for the given spring-mass system in below figure.



- (a)
- (b)
- (c)
- (d)

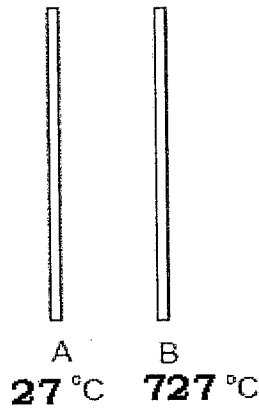
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66. For what value of  $m$  (mass) will resonance occur for the spring-mass system given below with the given spring constants?

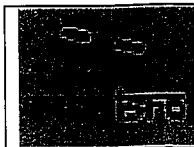


- (a) 85kg (b) 150kg (c) 100kg (d) 120kg

67. Surface A in the figure is coated with white paint and maintained at temperature of  $27^\circ\text{C}$ . It is located directly opposite to surface B which can be considered a black body and maintained at temperature of  $727^\circ\text{C}$ . Calculate the amount of heat that needs to be removed from surface A per unit area to maintain its constant temperature. (consider emissivity of the white paint = 1 and view factor=1,  $\sigma$  = Stefan – Boltzmann constant)



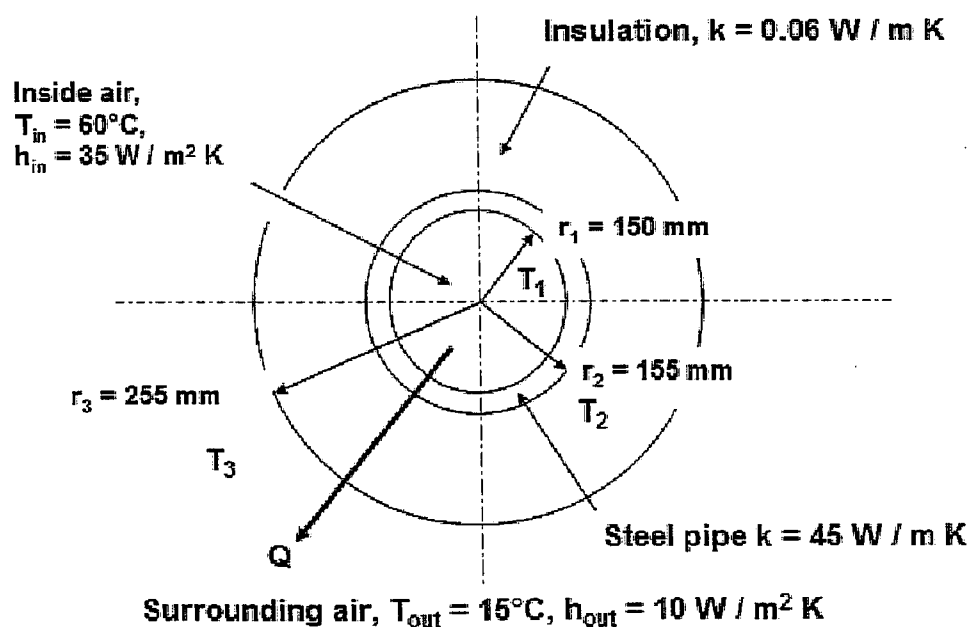
- (a)  $9919 \times 10^8 \sigma \text{ W/m}^2$  (b)  $9999 \times 10^8 \sigma \text{ W/m}^2$   
(c)  $9990 \times 10^8 \sigma \text{ W/m}^2$  (d)  $9909 \times 10^8 \sigma \text{ W/m}^2$




68. The convective heat transfer coefficient  $h$  is defined by the relationship ( $m$ =mass,  $C_p$ =specific heat,  $k$ = conductivity,  $q$ = heat flow rate,  $Nu$  = Nusselt Number,  $L$ =Thickness,  $\Delta T$  =Temperature difference)

(a)  $h = mC_p\Delta T$     (b)  $h = \frac{k}{L}$     (c)  $h = \frac{q}{\Delta T}$     (d)  $h = \frac{Nu K}{2L}$

69. The figure below shows a cross section through an insulated heating pipe which is made from steel ( $k=45$  W/m K) with an inner radius of 150mm and outer radius of 155 mm. The pipe is coated with 100 mm thickness of insulation having thermal conductivity of  $k=0.06$  W/m K. Air at inlet temperature  $T_i= 60^\circ\text{C}$  flow through the pipe has a value of convective coefficient  $h_i = 35$  W/m<sup>2</sup> K. The outside surface of the pipe is surrounded by air which is at  $15^\circ\text{C}$  and convective heat transfer coefficient on this surface has a value of  $h_o= 10$  W/m<sup>2</sup> K. Find the critical insulation radius?



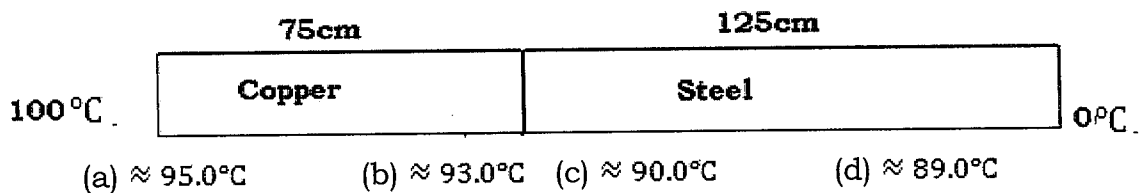
- (a) 14.00mm    (b) 3.00mm    (c) 20.00 mm    (d) 6.0 mm

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70. Graphene is

- (a) A two dimensional material consisting of a single layer of carbon atoms arranged in a honeycomb or chicken wire structure.
- (b) A tube-shaped material made of carbon, having a diameter measuring on the nanometre scale.
- (c) Completely non-transparent material.
- (d) None of the above.

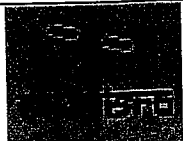
71. A bar of Cu of length 75 cm and a steel bar of 125 cm length are joined together end to end. Both the bars are having same diameter of 2 cm. The free ends of the Cu and the steel bars are maintained at 100°C and 0°C respectively. The curved surfaces of the bars are thermally insulated, what is the approximate temperature at Cu-steel junction? (consider conductivity K of Cu= 400 J s<sup>-1</sup> m<sup>-1</sup>°C<sup>-1</sup> and K for steel 50 Js<sup>-1</sup> m<sup>-1</sup> °C<sup>-1</sup> )

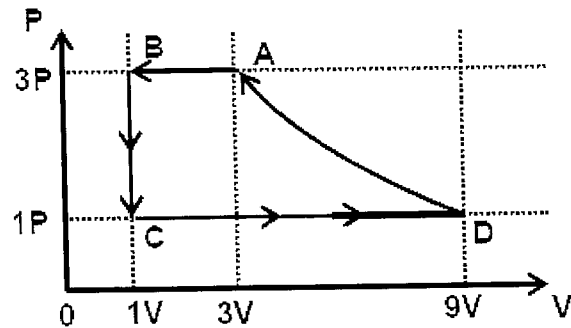


72. A sample of gas ( $\gamma=1.5$ ) is taken through an adiabatic process in which the volume is compressed from 1600 cm<sup>3</sup> to 400 cm<sup>3</sup>. If initial pressure is 150 kPa, then how much will be the final pressure in the process?

- (a) 1200kPa
- (b) 1000kPa
- (c) 1100kPa
- (d) 1400kPa

73. One mole of a monatomic gas is taken through a cycle ABCDA as shown in the P-V diagram. Column II give the characteristics involved in the cycle. Match the process A→ B with the processes given in Column II.

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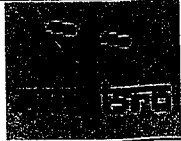
- |   |  |
|---|--|
| <p>Column I</p> <p>(A) Process A → B</p> <p>(B) Process B → C</p> <p>(C) Process C → D</p> <p>(D) Process D → A</p> | <p>Column II</p> <p>(p) Internal energy decreases</p> <p>(q) Internal energy increases.</p> <p>(r) Heat is lost</p> <p>(s) Heat is gained</p> <p>(t) Work is done on the gas</p> |
|---|--|

Process A → B signifies

- (a) p, q      (b) r, s      (c) p, r, t      (d) q, t

74. Strain energy  $U$ , in the case of axially loaded bar is expressed as.  
 (where  $P$  is axial load,  $L$  is bar length,  $A$  is cross-section area of the bar,  $E$  is Young's Modulus of the bar,  $\sigma$  is axial stress,  $\delta L$  is elongation due to axial load)

- (a)  $\frac{P^2 L^2}{2AE(\delta L)}$
- (b) Area under stress versus strain diagram of axially loaded bar
- (c)  $\frac{\sigma}{2} \frac{(\delta L)}{L}$       (d)  $\frac{P^2 L}{2AE}$

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75. Which of the following statements is correct, in case of a curved beam?
- Neutral axis is nearer to centre of curvature compared to centroidal axis.
  - Neutral axis is farther to centre of curvature compared to centroidal axis.
  - Neutral axis matches with centroidal axis.
  - Neutral axis shifts above or below centroidal axis depending on loading conditions.
76. A Mohr's circle reduces to a point when the body is subjected to
- Pure shear
  - Uniaxial stress only
  - Equal and opposite axial stress on two mutually perpendicular planes, the planes being free of shear.
  - Equal axial stress on two mutually perpendicular planes, the planes being free of shear.
77. To drill holes of size 0.025mm, which is the most appropriate process?
- Plasma drilling
  - CNC drilling
  - LASER Drilling
  - Electro Discharge drilling
78. Perforation in Aluminum plate occurs when it is connected with the Mild steel plate and exposed to the same environment. This phenomenon is explained by
- Galvanic corrosion
  - cold welding corrosion
  - crevice corrosion
  - high temperature corrosion
79. A mixture of chemical compounds or elements that have a single chemical composition and solidifies at the lowest temperature than any other composition made up of the same ingredients.
- Phase balanced system
  - Eutectic system
  - Binary thermally balanced system
  - intrinsic system.
80. Which type of Gear meshing should be employed to transmit torque to a linear force?
- Epicyclic Gear
  - Helical Gear
  - Bevel Gear
  - Rack and pinion

