MECHANICAL ENGINEERING _ MOCK - E __ Solutions

01. Ans: (C)

Sol: $H_n = e^{2n} H$

$\Rightarrow 1 = e^{2(4)} \times 10$

$\Rightarrow e^8 = 0.1$

$\Rightarrow e = \sqrt[8]{0.1}$

$\Rightarrow e = 0.75$

02. Ans: 3.0 (Range 2.9 to 3.1)

Sol: From continuity equation,

$$\rho_1 A_1 V_1 = \rho_2 A_2 V_2$$

or $1.5 \times 0.5 \times 3 = 0.75 \times 1 \times V_2$

$\Rightarrow V_2 = 3.0$ m/s

03. Ans: (A)

Sol: $E_b = \sigma T^4$ – black body

$E = \in\sigma T^4$ – All bodies

04. Ans: (A)

Sol: For a circular arc cam with roller follower the acceleration of follower in any position

$$a = f(r_f, \omega, r_r, \theta)$$

Where, r_f = flank radius, ω = cam speed,

r_r = roller radius, θ = cam angle

05. Ans: (B)

Sol: $\because L^{-1}\left\{\frac{\bar{f}(S)}{S}\right\} = \int_0^t L^{-1}\left\{\bar{f}(S)\right\}dt$

Now,

$$L^{-1}\left\{\frac{1}{S(S-1)}\right\} = L^{-1}\left\{\frac{\frac{1}{S-1}}{S}\right\} = \int_0^t L^{-1}\left\{\frac{1}{S-1}\right\}dt$$

$$\Rightarrow L^{-1}\left\{\frac{1}{S(S-1)}\right\} = \int_0^t e^t dt$$

$$\therefore L^{-1}\left\{\frac{1}{S(S-1)}\right\} = \left(e^t\right)_0^t = e^t - 1$$

06. Ans: (B)

Sol: Second law efficiency

$$(\eta_{II}) = \frac{\text{first law efficiency}}{\text{Carnot's efficiency}}$$

07. Ans: (b)

Sol: When a tool with nose radius is employed, the ideal roughness is directly proportional to square of the feed (f) inversely proportional to nose radius.

08. Ans: (D)

Sol: Principal plane is a plane on which shear stress must be zero and normal stress may or may not act.

09. Ans: 0.33 (Range 0.25 to 0.45)

Sol: Given data, $\mu = 0.3$, $2\theta = 90^\circ = \frac{\pi}{2}$

$$\mu' = \mu \times \frac{4\sin\theta}{2\theta + \sin 2\theta}$$

$$\mu' = 0.3 \times \frac{4\sin 45^\circ}{\frac{\pi}{2} + \sin 90^\circ} = 0.33$$

10. Ans: 125 No Range

Sol: Given that $|A_{4\times4}| = 5$

$$\because |adj(A_{n\times n})| = |A|^{n-1}$$

$$\Rightarrow |adj(A_{4\times4})| = |A|^{4-1} \quad \text{for } n = 4$$

$$\therefore |adj(A_{4\times4})| = |A|^3 = 5^3 = 125$$

11. Ans: (A)

Sol: A basic variable has zero value at optimality. When shadow prices are non zero then only we have increase in profit by going for extra units of that resource.

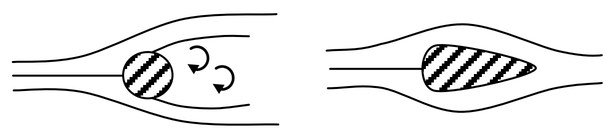
12. Ans: (D)

Sol:

- Chills are used in moulds to achieve directional solidification.
- The directional solidification in casting can be improved by using Chills and padding

13. Ans: (D)

Sol:

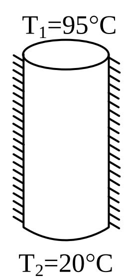


Before Streamlining After Streamlining

The process of streamling avoids the flow separation. The flow separation on the object leads to very high pressure drag due to low pressure in separated zone.

14. Ans: 1.18 (Range 1.10 to 1.25)

Sol:



Top or bottom surface area $(A) = \frac{\pi}{4}d^2$

$$= \frac{\pi}{4}(0.05)^2 = 1.96\times10^{-3}\,m^2$$

Heat transfer rate,

$$(Q) = \frac{T_1 - T_2}{\frac{L}{kA}} = \frac{95-20}{\frac{0.15}{1.2\times1.96\times10^{-3}}} = 1.18W$$

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15. Ans: (B)

Sol: Given;

N = 200 rpm, V_p = 37.7 m/min,

m = 2 mm

$$V_p = \omega r = \frac{2\pi N}{60} \times \frac{mT}{2}$$

$$T = \frac{37.7}{60} \times \frac{60}{2\pi \times 200} \times \frac{2}{\left(\frac{2}{100}\right)}$$

T = 30

16. Ans: (B)

Sol: Given

$$(4)\frac{\partial^2 u}{\partial x^2} + (-3)\frac{\partial^2 u}{\partial x \partial y} + (1)\frac{\partial^2 u}{\partial y^2} + (5)u = 0$$

If we compare the given partial differential equation with general partial differential equation

$$A\frac{\partial^2 u}{\partial x^2} + B\frac{\partial^2 u}{\partial x \partial y} + C\frac{\partial^2 u}{\partial y^2} + D\frac{\partial u}{\partial x} + E\frac{\partial u}{\partial x} + Fu = Q$$

then

we get A = 4, B = – 3 and C = 1

If $B^2 - 4AC < 0$ then the partial different equation is said to be elliptic type.

Here, $B^2 - 4AC = (-3)^2 - 4\,(4)\,(1) = -7 < 0$

∴ The given partial differential equation is elliptic type.

17. Ans: (C)

Sol: Fit is the relationship resulting from the dimensional difference between two parts before assembly. In this context, a fitting surface describes the surface of the assemble parts, which are in context or could come into contact due to movement.

18. Ans: (C)

Sol: For an isobaric process $v \propto T$. Apparently then the plot with volume as ordinate and temperature as abscissa will be a straight line through origin.

19. Ans: 2.5 (Range 2.4 to 2.6)

Sol: Given data:

$M = 12x - 3x^2$ kN–m, $(0 \le x \le 4\text{ m})$

A = 3600 mm^2

We know that, shear force,

$$F = \frac{dM}{dx} = 12 - 6x$$

At x = 1 m,

F = 12 – 6 × 1 = 6 kN

Also for rectangular section, $\tau_{max} = 1.5\,\tau_{avg}$

$$= 1.5\frac{F}{A} = 1.5 \times \frac{6000}{3600} = \frac{9000}{3600}$$

$$\Rightarrow \tau_{max} = 2.5\,\text{MPa}$$

20. Ans: (D)

Sol: $F_7 = \frac{D_6 + D_5 + D_4 + D_3 + D_2}{5}$

$= \frac{145 + 130 + 125 + 120 + 130}{5} = 130$

21. Ans: (C)

Sol: Given that $u = \frac{x^{3/2} + y^{3/2}}{4x - y}$

$\Rightarrow$ u(x, y) is a homogenous function with degree $n = \frac{3}{2} - 1 = \frac{1}{2}$

By Euler's theorem for homogeneous functions, we have the following result.

If u = f(x, y) is a homogeneous function with degree 'n' in x and y then

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

$$\therefore\ x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \frac{1}{2}u$$

22. Ans: (D)

Sol: Expulsion is an undesired event during resistance spot welding because the weld quality deteriorates. It is the ejection of molten metal from the weld nugget which usually occurs due to applying a high current for a short welding time.

23. Ans: (A)

Sol: $v = \frac{100 \times 10^3}{3600} \text{m/s} = 27.78 \text{m/s}$

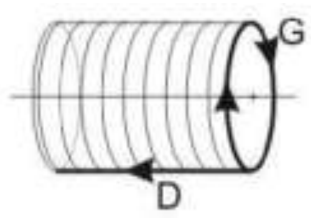
$P_{dyn} = \rho_{air} \times \frac{v^2}{2}$

$= 1.23 \times \frac{27.78^2}{2} = 474.6 \text{Pa} = \rho_w g h_w$

$\Rightarrow h_{water} = 48.38$ mm

24. Ans: (B)

Sol: A long straight cylindrical surface is obtained by a circle (G) being traversed in the direction (D) parallel to the axis as shown in Fig.



25. Ans: (B)

Sol: P(x = 2) = P(x = 3)

$\frac{\lambda^2 e^{-\lambda}}{2!} = \frac{\lambda^3 e^{-\lambda}}{3!}$

$\frac{\lambda^2 e^{-\lambda}}{2} = \frac{(\lambda^2)(\lambda)e^{-\lambda}}{6}$

$\Rightarrow \lambda = 3$

$P(x \neq 0) = 1 - P(x = 0)$

$= 1 - \frac{\lambda^0 e^{-\lambda}}{0!} = 1 - e^{-3}$

26. Ans: 975 (Range 970 to 980)

Sol:

By law of conservation of momentum

$(0.05)\times 200 = (1.95 + 0.05)\ V$

$\Rightarrow 10 = 2V$

$\Rightarrow V = 5$ m/s

By law of conservation of energy

$$\frac{1}{2}\left(\frac{1}{20}\right)200^2 = \frac{1}{2}(1.95+0.05)5^2 + E_{penetration}$$

$1000 = 25 + E_{penetration}$

$\Rightarrow E_{penetration} = 975$ J

27. Ans: (A)

Sol: Weight of the hollow cylinder

$$= \frac{\pi}{4}\left(0.6^2 - 0.4^2\right)\times 4\times 6 = 1.2\pi \text{ kN}$$

Volume of water displaced,

$$\forall = \frac{1.2\pi}{10} = 0.12\pi \text{ m}^3$$

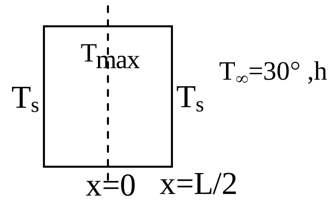
Therefore, depth of immersion,

$$d = \frac{0.12\pi}{\frac{\pi}{4}\left(0.6^2 - 0.4^2\right)}$$

$$= \frac{4\times 0.12}{0.2} = \frac{4\times 12}{20} = 2.4 \text{ m}$$

28. Ans: 158.72 (Range 157.50 to 160.50)

Sol:



Due to symmetry maximum temperature present is at centerline of the plate.

Energy balance:

$Q_{gen} = Q_{conv}$

$q_g\ AL = h(2A)(T_s - T_\infty)$

$$T_s = \frac{q_g L}{2h} + T_\infty$$

$$T_s = \frac{q_g L}{2h} + T_\infty$$

From known standard result

$$T_{max} = T_s + \frac{q_g L^2}{8k} = \frac{q_g L}{2h} + T_\infty + \frac{q_g L^2}{8k}$$

$$= \frac{5\times 10^5 \times 3\times 10^{-2}}{2\times 60} + 30 + \frac{5\times 10^5 \times \left(3\times 10^{-2}\right)^2}{8\times 15.1}$$

$T_{max} = 158.72°C$

29. Ans: 3.67 (Range: 3.6 to 3.8)

Sol: $\omega_{AB} = \dfrac{V_A}{AC} = \dfrac{6}{3} = 2$ rad/sec

$$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{B/A} + \vec{\omega}^2\vec{r}_{B/A}$$

$$a_B\hat{i} = -5\hat{j} + \left(\alpha\hat{k}\right)\times\left(3\hat{i} - 4\hat{j}\right) - 2^2\left(3\hat{i} - 4\hat{j}\right)$$

$$a_B\hat{i} = -(4\alpha - 12)\hat{i} + (3\alpha + 11)\hat{j}$$

$a_B = 4\alpha - 12$ .... (i)

$3\alpha + 11 = 0$ .... (ii)

$\alpha = -3.67$ rad/s^2

30. Ans: (D)

Sol: Let $f(z) = \dfrac{e^z + \sin(z)}{\left(z - \frac{\pi}{2}\right)^4} = \dfrac{\phi(z)}{(z - z_o)^{n+1}}$

Then the singular point of f(z) is $z = \dfrac{\pi}{2}$

Here, the singular point $z = \dfrac{\pi}{2}$ lies in the given region $\left|z - \dfrac{\pi}{2}\right| = 4$

Now, we can evaluate the given integral by using Cauchy's integral formula

i.e $\oint_C f(z)\,dz = \oint_C \dfrac{\phi(z)}{(z - z_o)^{n+1}} dz = \dfrac{2\pi i}{n!}\phi^{(n)}(z_o)$

$\Rightarrow \oint_C f(z)dz = \oint_c \dfrac{e^z + \sin(z)}{\left(z - \frac{\pi}{2}\right)^{3+1}} dz$

$\Rightarrow \oint_c f(z)dz = \dfrac{2\pi i}{3!}\phi'''\left(\dfrac{\pi}{2}\right) = \dfrac{2\pi i}{6}\left(e^z - \cos z\right)_{z=\frac{\pi}{2}}$

$\therefore \oint_c f(z)dz = \dfrac{\pi i}{3} e^{\pi/2}$

31. Ans: 0.497 (Range: 0.487 to 0.507)

Sol: The pressure remains constant at 120 kPa as the piston moves; the boundary work is determined to be

$W = mP_2(V_2 - V_1)$

$= 1.4 \times 120 \times (0.23669 - 0.23373)$

$= 0.497$ kJ

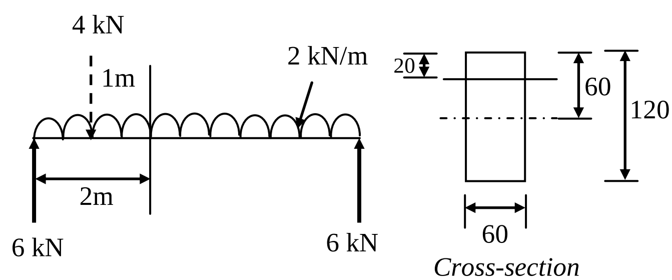
32. Ans: 37 (Range 36 to 38)

Sol: Given data:

L = 6 m, w = 2 kN/m,

b = 60 mm, d = 120 mm,

y = 120/2 – 20 = 40 mm,



Bending moment at the section of interest is given by,

$M = 6 \times 2 - (2 \times 2) \times 1 = 8$ kN.m

Bending stress,

$\sigma = \dfrac{M}{I} \cdot y = \dfrac{8 \times 10^6}{\left(\dfrac{60 \times 120^3}{12}\right)} \times (60 - 20)$

$\Rightarrow \sigma \approx 37$ MPa

33. Ans: 13.33 (Range 12.5 to 14.5)

Sol: Given data,

Q = 2 N/mm^2, D_P = 100 mm,

b = 50 mm, G = 2

$$Q = \frac{2G}{G+1} = \frac{2\times 2}{2+1} = \frac{4}{3}$$

$F_w = D_p\ b\ Q\ k$

$= 100 \times 50 \times 2 \times \left(\frac{4}{3}\right)$

$= 13333.3$ N

$F_W = 13.33$ kN

34. Ans: (B)

Sol:

Month	CP	CD	Ending Inventory	Shortage	Cost	
					Inventory	Shortage
1	100	80	20	-	20 ×2=40	-
2	180	180	0	0	-	-
3	250	260	-	10	-	10×10 = 100
4	320	300	20	-	20×2=40	

Total cost = 40 + 40 + 100 = Rs 180

35. Ans: 43.75 (Range 42 to 44)

Sol: Let the duty cycle be D_r

$I_r = 300$ A

$I_d = 400$ A

$$\frac{D_d}{D_r} = \frac{I_r^2}{I_d^2} \Rightarrow D_d = \frac{I_r^2}{I_d^2} \times D_r$$

$$\Rightarrow D_d = \frac{300^2 \times D_r}{400^2} = \frac{9}{16} D_r$$

$$\therefore \text{Loss in time} = \frac{D_r - D_d}{D_r} \times 100$$

$$= \frac{D_r - \frac{9}{16}D_r}{D_r} \times 100$$

$$\left(1 - \frac{9}{16}\right) \times 100 = 43.75\ \%$$

36. Ans: (a)

Sol: Given that $\bar{f} = x^2\,\bar{i} + y^2\,\bar{j} + z^2\,\bar{k}$

New, (W.D) Work done = $\int_c \bar{f}.d\bar{r}$

where $\bar{f} = f_1\,\bar{i} + f_2\,\bar{j} + f_3\,\bar{k}$

& $\bar{r} = x\,\bar{i} + y\,\bar{j} + z\,\bar{k}$

$$\Rightarrow W.D = \int_A^B [f_1 dx + f_2 dy + f_3 dz]$$

$$\Rightarrow W.\ D = \int_{(0,0,0)}^{(3,6,10)} [x^2 dx + y^2 dy + z^2 dz]$$

$\Rightarrow$

$$W.D = \left(\frac{x^3}{3} + \frac{y^3}{3} + \frac{z^3}{3}\right)_{(0,0,0)}^{(3,6,10)} = \frac{(3)^3}{3} + \frac{(6)^3}{3} + \frac{(10)^3}{3}$$

$$\therefore\ W.D = \frac{1243}{3}$$

37. Ans: 2.28 (Range: 2.18 to 2.38)

Sol: Given data,

$\sigma_x = 100$ MPa,

$\sigma_y = 40$ MPa, $\sigma_z = 0$,

$\tau_{xy} = 50$ MPa, $\tau_{yz} = 25$ MPa,

$\tau_{zx} = 10$ MPa, $\hat{\sigma} = 300$ MPa

Using von Mises' criterion,

$$(\sigma_x-\sigma_y)^2+(\sigma_y-\sigma_z)^2+(\sigma_z-\sigma_x)^2+6(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2)=2\left(\frac{\hat{\sigma}}{FOS}\right)^2$$

$$\Rightarrow (100-40)^2+40^2+100^2+6(50^2+25^2+10^2)=2\times\frac{300^2}{(FOS)^2}$$

$\Rightarrow$ FOS = 2.28

38. Ans: (C)

Sol: From the given stream function

$\psi = -2x^2 + y$

$$u=\frac{-\partial\psi}{\partial y}=-1 \quad \text{and} \quad v=\frac{\partial\psi}{\partial x}=-4x$$

The condition for irrotational flow is

$$\omega_z=\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)=(-4-0)=-4\neq 0$$

Thus, flow is rotational.

Hence, Statement (1), is wrong.

Since, $u = -1 \neq 0$. So, there is no stagnation point

$\Rightarrow$ Statement (2) is correct.

Now, $V=\sqrt{u^2+v^2}=\sqrt{(-1)^2+(-4x)^2}$

$$V\Big|_{\substack{x=1\\y=2}}=\sqrt{1+16}=\sqrt{17}\text{ m/s} = 4.12 \text{ m/s}$$

$\Rightarrow$ Statement (3) is correct.

39. Ans: (B)

Sol: L = 15 cm, W = 10 cm,

$T_s = 140°C$, $T_\infty = 20°C$

$L_c = L$

$$T_{avg}=\frac{T_s+T_\infty}{2}=353K, \beta=\frac{1}{T_{avg}}$$

For the given correlation :

$$Nu=\frac{hL}{k}=0.59[Gr\,Pr]^{\frac{1}{4}}$$

$$\frac{h\times 0.15}{0.03}=0.59\left[\frac{9.81\times\frac{1}{353}\times(140-20)\times(0.15)^3}{(21.09\times10^{-6})^2}\times 0.692\right]^{1/4}$$

$h = 7.63\ W/m^2K$

$Q = 2hA_s(T_s - T_\infty)$

$= 2\times7.63\times0.15\times0.1\times(140-20) = 27.48$ W

40. Ans: (A)

Sol: $$\omega=\frac{2\pi\times1500}{60}=157.08\text{ rad/s},\quad n=\frac{20}{5}=4$$

Velocity of piston (in m/s) is given by

$$V=\omega r\left[\sin\theta+\frac{\sin 2\theta}{2n}\right]$$

$$=157.08\times0.05\left[\sin 60+\frac{\sin 120}{2\times4}\right]$$

= 7.66 m/s

41. Ans: (D)

Sol: Size of cylinder = D = H

Side of cube = L

$$M=\frac{\text{Volume}}{\text{Surface Area}}$$

$$M_{Cyl} = \frac{\left(\frac{\pi}{4}D^2\right)H}{(\pi DH) + 2\left(\frac{\pi}{4}D^2\right)} = \frac{D}{6},$$

$$M_{Cube} = \frac{L^3}{6L^2} = \frac{L}{6}$$

$$\frac{\tau_{cyl}}{\tau_{cube}} = \left(\frac{D/6}{L/6}\right)^2 = \left(\frac{D}{L}\right)^2 \qquad (\because \tau = M^2)$$

42. Ans: (A)

Sol: Given $(x^2D^2 - 2\,x\,D + 2)\,y = 8$ ----- (1),

where $D = \frac{d}{dx}$

Let $x = e^z$ (or) $\log x = z$

and $xD = \theta,\ x^2D^2 = \theta(\theta - 1)$ .... (2)

where $\theta = \frac{d}{dz}$

Put (2) in (1), we get

$[\theta(\theta - 1) - 2\theta + 2]\,y = 8$

$\Rightarrow (\theta^2 - 3\theta + 2)\,y = 8$

$\Rightarrow f(\theta)\,y = Q(z)$

Where $f(\theta) = \theta^2 - 3\theta + 2$ & $Q(z) = 8$

C.F:

Consider auxiliary equation $f(m) = 0$

$\Rightarrow m^2 - 3m + 2 = 0$

$\Rightarrow m = 1, 2$

$\therefore$ The complementary function is

$y_c = c_1e^z + c_2e^{2z} = c_1\,x + c_2\,x^2$

P.I:

$\because Q(z) = 8 = 8\,e^{0z+0}$ $(\therefore Q(z) = ke^{az+b})$

Here,

$f(\theta) = f(a) = f(0) = (0)^2 - 3(0) + 2 = 2 \neq 0$

$\therefore$ The particular integral is

$$y_p = \frac{1}{f(a)}Q(z) = \frac{1}{2}(8) = 4$$

Hence, the general solution of the given differential equation is

$$y = y_c + y_p = c_1x + c_2x^2 + 4$$

43. Ans: 67 (Range 65.5 to 68.5)

Sol: Volume of air = Volume of room – Volume of electrical radiator

$= (75 - 0.05)\,m^3$

Mass of air $= \frac{101.325 \times (75 - 0.05)}{0.287 \times (273 + 6)}$

$= 94.84$ kg

Mass of oil $= 950 \times 0.05 = 47.5$ kg

We take "air + oil" to be our system and room boundary as system boundary.

By first law of thermodynamics for closed system,

$$Q - W = \Delta U = m_a\,c_v\,(t_f - t_i)_{air} + m_o\,c_{po}\,(t_f - t_i)_{oil}$$

Let the heater is switch on for t sec.

$-0.75 \times t - (-2.4 \times t) = 94.84 \times 0.717 \times (20 - 6) + 47.5 \times 2.2 \times (60 - 6)$

$\Rightarrow$ t = 3997 sec = 66.6 min ≈ 67 minutes.

44. Ans: (B)

Sol: Given data:

E = 100 GPa, μ = 0.25,

d = 30 mm, h = 3000 m

ρ = 1000 kg/m^3, g = 10 m/s^2

When the sphere is dropped into the sea, it will be subjected to hydrostatic state of stress.

$\sigma = P = \rho gh = 1000 \times 10 \times 3000 = 30$ MPa

Now, $\frac{\Delta V}{V} = \frac{3\sigma}{E}(1-2\mu)$

$\therefore\ 3\left(\frac{\delta d}{d}\right) = \frac{3\sigma}{E}(1-2\mu)$

$\therefore\ \left(\frac{\delta d}{30}\right) = \frac{30}{100\times10^3}(1-2\times0.25)$

$\therefore\ \delta d = 4.5\times10^{-3}$ mm

45. Ans: 17 (Range 17 to 17)

Sol: **Column transaction:**

4	3	2	4
0	0	0	1
1	4	1	0
3	3	0	4

Row transaction:

2	1	0	2
0	0	0	1
1	4	1	0
3	3	0	4

The location of zero entries do not allow assigning one machine to each job.

Draw the minimum number of horizontal and vertical lines that will cover all the zero entries.

Select the smallest uncovered element and subtract it from every uncover element, then add it to every element at the intersection of two lines.

2	1	0	2
0	0	0	1
1	4	1	0
3	3	0	4

Modified matrix:

1	0	0	1
0	0	1	1
1	4	2	0
2	2	0	3

1	[0]	0	1
[0]	0	1	1
1	4	2	[0]
2	2	[0]	3

Optimum assignment

Job A to work center 2

Job B to work center 1

Job C to work center 4

Job D to work center 3

The minimum cost of assignment

= 4 + 5 + 5 + 3 = Rs. 17

46. Ans: (B)

Sol: $\frac{\pi}{4}\times d_i^2\times h_i=\frac{\pi}{4}\times d_f^2\times h_o$

$\Rightarrow 0.5^2\times 1 = d_f^2\times 0.25$

$\Rightarrow d_f=\sqrt{\frac{0.5^2}{0.25}}=\frac{0.5}{0.5}=1m$

47. Ans: 0.125 [Range: 0.121 to 0.130]

Sol: $h_f=\frac{f\,LQ^2}{12.1D^5}$

$\Rightarrow h_f\propto\frac{Q^2}{D^5}$ as f and L are same for all pipes.

$\therefore \frac{h_{f3}}{h_{f1}}=\left(\frac{Q_3}{Q_1}\right)^2\times\left(\frac{D_1}{D_3}\right)^5 \quad \{\because f_1=f_3\ \&\ L_1=L_3\}$

$=\left(\frac{2Q_1}{Q_1}\right)^2\times\left(\frac{D_1}{2D_1}\right)^5=2^2\times 2^{-5}=1/8=0.125$

48. Ans: (A)

Sol: Given

$f(x, y) = 4x^2 + 9y^2 + 8x - 36y + 24$

$\Rightarrow p = f_x = 8x + 8$, $q = f_y = 18y - 36$

and $r = f_{xx} = 8$, $s = f_{xy} = 0$, $t = f_{yy} = 18$

consider p = 0 and q = 0 for stationary points

$\Rightarrow 8x + 8 = 0\ \&\ 18y - 36 = 0$

$\Rightarrow x = -1\ \&\ y = 2$

$\therefore$ (x, y) = (–1, 2) is a critical point of f(x, y)

At (x, y) = (–1, 2), r = 8 , s = 0 & t = 18

Here, $rt - s^2 = (8)(18) - (0)^2 = 144$

and $r = 8 > 0$

$\therefore$ (x, y) = (–1, 2) is a local point of minima.

Hence, the minimum value of the function

f(x, y) at (–1, 2) is f(–1, 2) = –16

49. Ans: 12 (Range 11.5 to 12.5)

Sol: 600 holes are punched in one hour

$\therefore$ one hole is punched in $\frac{3600}{600}=6\sec$

Hence, cycle time is 6 seconds.

$\text{Cycle time}=\frac{\text{Energy required, E}}{\text{Power}}$

$\Rightarrow \quad E = 6\times 3000 = 18000$ J

Now energy delivered by motor during actual punching

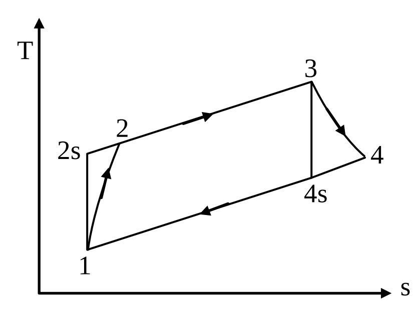
$= 2\times 3000 = 6000$ J

Energy delivered by flywheel

$= 13000 - 6000 = 12000$ J or 12 kJ

50. Ans: (A)

Sol:



Given data;

$T_1 = 310$ K, $P_1 = 100$ kPa,

$T_2 = 650$ K, $P_2 = 900$ kPa,

$T_3 = 1400$ K, $\xi = 0.8$, $\eta_T = 0.9$

$$r_p = \frac{900}{100} = 9$$

$$T_{4s} = \frac{T_3}{r_p^{\frac{\gamma-1}{\gamma}}} = \frac{1400}{9^{\frac{1.4-1}{1.4}}} = 748.66 \text{ K}$$

$$\eta_T = \frac{h_3 - h_4}{h_3 - h_{4s}}$$

$$\eta_T = \frac{T_3 - T_4}{T_3 - T_{4s}}$$

$$0.9 = \frac{1400 - T_4}{1400 - 748.66}$$

$T_4 = 812.55$ K

The heat transfer in regenerator

$= \xi \times (h_4 - h_2)$

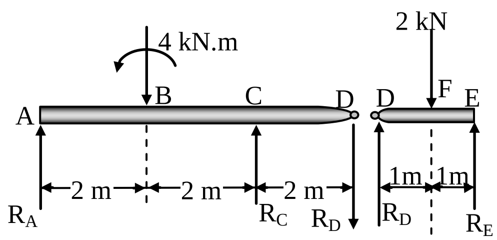
$= \xi \times c_p \times (T_4 - T_2)$

$= 0.8 \times 1.005 \times (812.55 - 650)$

$= 130.7$ kJ/kg

51. Ans: 2 (Range: 2 to 2)

Sol: Compound beam ABCDE can be divided into two parts as shown in the figure below:



Due to symmetry of the beam DE,

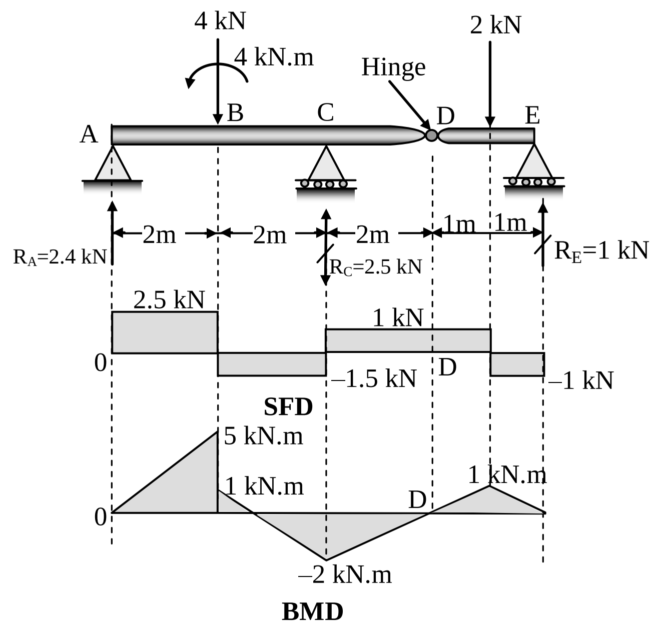
Reactions, $R_D = R_E = 1$ kN

Bending Moment:

$M_C = -R_D \times 2 = -2$ kN.m

Thus, it is concluded that magnitude of bending moment at point C is 2 kN.m.

Note: SFD and BMD are shown in the figure below for your reference.



52. Ans: (C)

Sol:
$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 5 \\ 10 \end{bmatrix}$$

$x' = -5$

$y' = -10$

53. Ans: (B)

Sol: $\eta_m = \frac{BP}{IP} = \frac{IP - FP}{IP}$

i.e. $\frac{IP - 20}{IP} = 0.75 \Rightarrow IP = 80\,kW$

BP = IP – FP = 80 – 20 = 60 kW

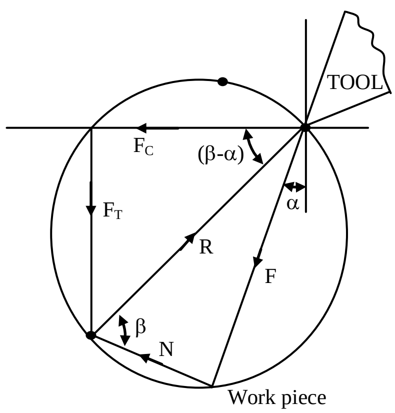
$\eta_{bth} = \frac{\text{Brake power}}{\text{Heat supplied}} = \frac{60}{180} = 33.33\%$

54. Ans: (A)

Sol: Fraction of energy with chip = $\frac{F \times V_c}{F_c \times V}$

$= \frac{F}{F_c} \times r$ -------(1)

From the merchant circle:



$F_c = R\cos(\beta - \alpha)$

$F = R\sin\beta$

$r = \frac{\sin\phi}{\cos(\phi - \alpha)}$

from equation (1)

Fraction of energy with chip = $\frac{F}{F_c} \times r$

$= \frac{R\sin\beta}{R\cos(\beta - \alpha)} \times \frac{\sin\phi}{\cos(\phi - \alpha)}$

$= \frac{\sin\phi\sin\beta}{\cos(\phi - \alpha)\cos(\beta - \alpha)}$

55. Ans: (A)

Sol: P(P) = P(Q) = P(R) = P(S) = $\frac{1}{6}$

$P = P(P^C)\ P(Q^C)\ P(R^C)\ P(S) + P(P^C)\ P(Q^C)\ P(R^C)\ P(S^C)\ P(P^C)\ P(Q^C)\ P(R^C)\ P(S) + \ldots\ldots\ldots\ldots$

$= \frac{1}{6}\left(\frac{5}{6}\right)^3 + \left(\frac{1}{6}\right)\left(\frac{5}{6}\right)^7 + \ldots\ldots\ldots.$

$= \left(\frac{1}{6}\right)\left(\frac{5}{3}\right)^3 \left\{1 + \left(\frac{5}{6}\right)^4 + \left(\frac{5}{6}\right)^8 + \ldots\ldots\ldots\right\}$

$= \left(\frac{1}{6}\right)\left(\frac{5}{6}\right)^3 \left\{\frac{1}{1 - \left(\frac{5}{6}\right)^4}\right\}$

$= \left(\frac{1}{6}\right)\left(\frac{5}{6}\right)^3 \left\{\frac{6^4}{6^4 - 5^4}\right\}$

$= \left(\frac{1}{6}\right)\left(\frac{5^3}{6^3}\right)\left\{\frac{6^4}{6^4 - 5^4}\right\}$

$= \frac{125}{671}$

56. Ans: (C)

Sol: (Passive voice - verb in past participle form)

57. Ans: (C)

Sol: 'between.... to' is wrong. 'between.......and'.

58. Ans: (D)

Sol: Suggestion is friendly/ smooth

Demand is unfriendly/Rough

Take is smooth

Grab is Rough

59. Ans: (C)

Sol: Let the four numbers be

x, x + 2, x + 4, and x + 6.

$\Rightarrow$ x + x + 2 + x + 4 + x + 6 = 36

$\Rightarrow$ 4x + 12 = 36

$\Rightarrow$ x = 6

Therefore, the numbers are 6, 8, 10 & 12.

Therefore, the sum of their squares = $6^2 + 8^2 + 10^2 + 12^2 = 36 + 64 + 100 + 144 = 344$.

60. Ans: (A)

Sol: We know that an ordinary year has 1 odd day and a leap year has 2 odd days.

During this period, namely 2005, 2006, 2007, 2008, 2009, 2010.

Total number of odd days = (1 + 1 + 1 + 2 + 1 + 1) days = 7 = 0 odd days.

Hence, the calendar for 2005 will serve for the year 2011 too.

61. Ans: (D)

Sol: The solution to this problem can be obtained only with more information like ratio of the length of the rectangle to its breadth.

62. Ans: B

Sol: Amount = $\left[7500\times\left(1+\frac{4}{100}\right)^2\right]$

$= \left(7500\times\frac{26}{25}\times\frac{26}{25}\right)$

= 8112

So, compound interest

= (8112 – 7500) = 612

63. Ans: (C)

Sol: Let their present ages be 6x and 7x respectively. Then, their age difference = ‘x’ years

i.e. 4 = ‘x’ years

Their present ages are 24 & 28 respectively

Ratio of ages after 4years

= 24 + 4 : 28 + 4 = 7 : 8

64. Ans: (B)

65. Ans: (B)

Sol: Expenditure in year 2016 (in 000') = 3800

Expenditure in year 2015 (in 000') = 3075

$\Rightarrow$ Required % increase

$$= \frac{(3800-3075)}{3075}\times 100$$

$$= \frac{725}{30.75} = \frac{29}{1.23} = 23.57\%$$

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Engg. Mathematics : 20 Q	Numerical Ability : 20 Q	Verbal Ability : 10 Q

Syllabus for 3rd/4th Year & Passed-out Students - Technical Paper

EEE		ECE / IN		CS & IT		CE		ME / PI	
Subject	No. of Questions	Subject	No. of Questions	Subject	No. of Questions	Subject	No. of Questions	Subject	No. of Questions
Networks	5 Q	Networks	6 Q	DS,PL& Algorithm	10 Q	SOM	5 Q	SOM	6 Q
Control System	5 Q	Control System	6 Q	DBMS	5 Q	FM & HM	5 Q	FM & HM	5 Q
Analog Electronics	4 Q	Analog Electronics	5 Q	Computer Networks	5 Q	Geo Technical Engg.	7 Q	TOM	6 Q
Digital Electronics	5 Q	Digital Electronics	5 Q	Operating System	6 Q	Environmental	7 Q	Machine Design	4 Q
Electrical Machines	8 Q	Signal & Systems	5 Q	Computer Organization	4 Q	Transportation	4 Q	Thermal	7 Q
Power System	7 Q	EDC & VLSI	5 Q	Theory of Computation	6 Q	RCC& STEEL	6 Q	Heat Mass Transfer	4 Q
Power Electronics	6 Q	Communications	8 Q	Digital Electronics	4 Q	Surveying	6 Q	Production	8 Q
Engg. Maths	5 Q	Engg. Maths	5 Q	Engg. Maths	5 Q	Engg. Maths	5 Q	Engg. Maths	5 Q
Numerical / Verbal Ability	5 Q	Numerical / Verbal Ability	5 Q	Numerical / Verbal Ability	5 Q	Numerical / Verbal Ability	5 Q	Numerical / Verbal Ability	5 Q

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