Branch: CIVIL ENGINEERING _MOCK- F SOLUTIONS

01. Ans: 1231 Range: (1220 to 1235)

Sol: $C = \frac{1}{2}$ of compressive strength = 15 kN/m^2

$$Q_{gi} = n\left[A_b . CN_C + A_s .\alpha . C\right]$$

$$= 9\left[\frac{\pi}{4}(0.3)^2 \times 15 \times 9 + \pi\, 0.3 \times 10 \times 0.9 \times 15\right]$$

$$= 1231 \text{ kN}$$

02. Ans: 1 No Range

Sol: Let A = $\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix}$

A is the upper triangular matrix eigen value is 1 only

Consider (A – I) = $\begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & 3 \\ 0 & 0 & 0 \end{bmatrix}$

Clearly earth of (A – I) = 2

Geometric multiplicity of eigen value 1 = No. of linearly independent eigen vectors

= n – r

= 3 – 2 = 1

03. Ans: 0.75 Range: (0.74 to 0.76)

Sol: Exit gradient $i_{exit} = \frac{\Delta h}{b}$

Where Δh = head loss per potential drop

$$= \frac{h}{N_d} = \frac{18}{12} = \frac{3}{2}$$

b = width of last square = 2 m

$$i_{exit} = \frac{\frac{3}{2}}{2} = \frac{3}{4} = 0.75$$

04. Ans: (c)

Sol: Tension piles are also called uplift piles

05. Ans: (a)

Sol: $t \,\alpha\, a_v$

$$t \alpha \frac{1}{K}$$

- Settlement depends on magnitude of stress increase.
- Degree of consolidation depends on settlement.
- Consolidating time depends on degree of consolidation.

∴ Consolidating time depends on the magnitude of stress increases

06. Ans: (d)

07. Ans: (a)

Sol: Carbon-nitrogen ratio is the ratio of weight of carbon to the weight of nitrogen present in materials being composted. The preferred range is **20 – 35.** Lower values indicate the loss of nitrogen as ammonium gas and render composting impractical.

08. Ans: (d)

09. Ans: (b)

Sol: $h = \dfrac{2\sigma\cos\theta}{\gamma R} = \dfrac{4\sigma\cos\theta}{\gamma D}$

Given, h = 2 D,

$\theta = 0°$, $\sigma = 0.08$ N/m

$$2D = \frac{4\times 0.08}{10^4 D}$$

Or $D^2 = \dfrac{2\times 0.08}{10^4} = \dfrac{0.16}{10^4}$

$D = 0.4 \times 10^{-2}$ m = 4 mm

10. Ans: (c)

Sol: The line of action of the resultant hydrostatic force from the free liquid surface

$$= \frac{2}{3}\times 7 = \frac{14}{3}\text{m} = 4.67\,\text{m}$$

11. Ans: 96 No Range

Sol: Characteristic equation is $|A-\lambda I| = 0$

$$\begin{vmatrix} 1-\lambda & 0 & 0 \\ 0 & 2-\lambda & 1 \\ 2 & 0 & 3-\lambda \end{vmatrix} = 0$$

$\Rightarrow (1-\lambda)(2-\lambda)(3-\lambda) = 0$

$\therefore \lambda = 1, 2, 3$ are eigen values

Eigen values of A	Eigen values of $A^2 - 3A + 6I$
1	1 – 3 + 6 = 4
2	4 – 6 + 6 = 4
3	9 – 9 + 6 = 6

Determinate of $A^2 - 3A + 6I = 4 \times 4 \times 6$

= 96

12. Ans: (b)

13. Ans: (b)

Sol: Self weight deformation, $\delta\ell_{sw} = \dfrac{\gamma\ell^2}{2E}$

here $\delta\ell_{sw} \propto \ell^2$

Therefore, self weight deformation is directly proportional to square of the length.

Therefore,

If all the dimensions are doubled then elongation produced due to self weight increases by 4 times.

14. Ans: 30.66 Range: (30 to 31)

Sol: d = 1.25 m, h = 100 m

$P = \rho \times g \times h = 1000 \times 9.81 \times 100$

= 981 kPa

Limiting tensile stress $\sigma_c = \dfrac{Pd}{2t} = 20$ MPa

$$\Rightarrow t = \frac{P\times d}{2\times\sigma_c} = \frac{981\times 1250\times 10^{-3}}{2\times 20}$$

t = 30.66 mm

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15. Ans: 97.25 mm, Range: (97.2 to 97.5)

Sol: Degree of curvature $D^o = 3^o$

For BG track G = 1.676 m

Radius of curvature = $\frac{1720}{D^\circ}$

$= \frac{1720}{3}$

= 573.333 m

Equilibrium super elevation,

$$(e) = \frac{GV^2}{127R}$$

$$= \frac{1.676 \times 65^2}{127 \times 573.333}$$

= 0.09725 m

= 97.25 mm

16. Ans: 53 No Range

Sol: $V(2x + 3y) = 2^2 V(x) + 3^2 V(y)$

$= (4 \times 2) + (9 \times 5)$

= 53

17. Ans: (c)

Sol: For thin bituminous surface in heavy rainfall IRC recommends camber of $\frac{1}{n} = \frac{1}{40}$

For single lane-road IRC recommends width of carriageway W = 3.75

$$y = \frac{2x^2}{nW}$$

$$x = \frac{W}{2}$$

$$y = \frac{W}{2n}$$

$$= \frac{3.75}{2 \times 40}$$

= 0.04687 m

= 46.87 mm

18. Ans: (b)

Sol: To avoid shrinkage cracks on the surface of rigid pavement reinforcement is provided near the top face of slab

19. Ans: 89.69 (Range: 89.5 – 90.5)

Sol: $N = \left(\frac{C_V}{E}\right)^2$

N = 8

$$C_V = \frac{\sigma}{x} \times 100$$

$$C_V = \frac{35}{120} \times 100 = 29.167\,\%$$

$$\therefore 8 = \left(\frac{29.167}{E}\right)^2$$

$\Rightarrow$ E = 10.31%

Error = 10.31 %

Accuracy = 100 – 10.31

= 89.69 %

20. Ans: (d)

Sol:

Bag -1	**Bag- 2**
5 Red	4 Red
7 Green	8 Green

By total probability $= \frac{1}{2} \times \frac{7}{12} + \frac{1}{2} \times \frac{8}{12}$

$= \frac{15}{24}$

21. Ans: (d)

22. Ans: (c)

Sol: Maximum allowable final deflection

= span/250 = 8000/250 = 32mm

23. Ans: (d)

Sol: Torsion reinforcement required when both the edges are discontinuous is 4 layers with each layer comprising of $\frac{3}{4}$ of main reinforcement.

Hence total torsion reinforcement at the edge

$= 4 \times \frac{3}{4} \times 603 = 1809\ mm^2$

24. Ans: (b)

Sol: Unsupported length of built up column

= L = 6.8 m

Effective length of column (Hinged at base and continuous support to be treated as fixed support, hence effective length KL=0.8L)

= KL = 0.8 L

= 0.8 × 6.8=5.44 m =5440mm

Effective slenderness ratio of laced built up column is increased by 5 % as per IS800:2007 in order to take care of the shear deformations due to unbalanced horizontal force in the lacing bars

Effective slenderness ratio = $1.05 \times \frac{K}{r_{min}}$

$$= 1.05 \times \frac{5440}{136} = 42$$

25. Ans: (d)

26. Ans: 399 **Range: (392 to 407)**

Sol:
$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100$$

$$45 = \frac{0.95 - e}{0.95 - 0.4} \times 100$$

e = 0.70

Consider unit surface area of sample stratum

$$e = \frac{V_v}{V_s} = \frac{V_1 - V_s}{V_s}$$

($V_1 = 5m^3$ By consider A = 1)

$$0.70 = \frac{5 - V_s}{V_s} \Rightarrow V_s = 2.94\,m^3$$

If soil stratum is densified to 70% relative density

$$70 = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100$$

$$0.70 = \frac{0.95 - e}{0.95 - 0.4}$$

e = 0.565

$$e = \frac{V_2 - V_s}{V_s}$$

$$0.565 = \frac{V_2 - 2.94}{2.94}$$

$V_2 = 4.601\ m^3$

Reduction in thickness

$$\Delta H = \left(\frac{V_1 - V_2}{A}\right) = \left(\frac{5 - 4.601}{1}\right) = 0.399\ m$$

ΔH = 399 mm

27. Ans: (c)

Sol: Length of arc, AB

$$\hat{L} = 24 \times 65^o \times \frac{\pi}{180} = 27.23 \text{ m}$$

driving moment = M_o = 2518×11

= 27698 kN-m

Resisting moment = $M_r = C.\hat{L}.R$

= 50 × 27.23 ×24

= 32676 kN-m

$\therefore$ Factor of safety = $\frac{32676}{27698} = 1.18$

28. Ans: (a)

Sol: Put $x^3 = t \Rightarrow 3x^2\,dx = dt$

$$\Rightarrow x^2\,dx = \frac{dt}{3}$$

$x = 0 \Rightarrow t = 0$

$x = 2 \Rightarrow t = 8$

$$\therefore \int_0^2 x^2[x^3]dx = \int_0^8 [t]\frac{dt}{3}$$

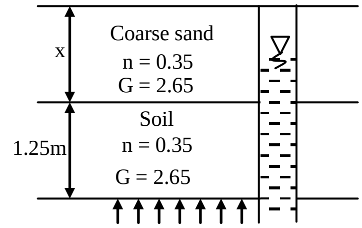
$$= \frac{1}{3}\int_0^8 [t]dt$$

$$= \frac{1}{3}\frac{8(8-1)}{2} = \frac{28}{3}$$

29. Ans: (d)

30. Ans: (b)

Sol: Let x be the depth of coarse sand required above existing soil



$$n = \frac{e}{1+e} = 0.35$$

$\Rightarrow$ 0.35 + 0.35 e = e

e = 0.5385

$$\gamma_{sat} = \left(\frac{G+e}{1+e}\right)\gamma_w$$

$$= \left(\frac{2.65+0.5385}{1+0.5385}\right)\times 9.81$$

$\gamma_{sat} = 20.33$ kN/m^3

$\gamma_{sub} = \gamma_{sat} - \gamma_w$

= 20.33 – 9.81 = 10.52 kN/m^3

$$FOS = \frac{\text{Downward Force}}{\text{Upward Force}}$$

$$= \frac{\text{Down ward force due to wt of soil}}{\text{Upward force due to 1.85 m seepage head}}$$

$$2 = \frac{(1.25+x)\times\gamma_{sub}}{1.85\gamma_w}$$

(1.25 + x) 10.52 = 1.85 × 9.81 × 2

$\Rightarrow$ x = 2.20 m

31. Ans: (b)

Sol: Sample A	**Sample B**
$e_o = 0.5$	$e_o = 0.65$
$\sigma_o' = 1$ kg/cm^2	$\sigma_o' = 1$ kg/cm^2
$\sigma_f' = 1.5$ kg/cm^2	$\sigma_f' = 1.5$ kg/cm^2
$e_f = 0.47$	$e_f = 0.625$
$t_A = t/3$	$t_B = t$
$H_1 = 45$ mm	$H_2 = 30$ mm
$K_1 = ?$	$K_2 = ?$

$$\frac{K_1}{K_2} = ?$$

As U = 50% is same for both samples

$$T_{v_1} = T_{v_2}$$

$$\left(\frac{C_v.t}{d^2}\right)_1 = \left(\frac{C_v.t}{d^2}\right)_2 \qquad C_v = \frac{K}{m_v.\gamma_w}$$

As change in pressure is also same

$$m_v = \frac{a_v}{1+e_o}$$

In both samples

$$m_v = \frac{\Delta e}{1+e_o} \times \frac{1}{\Delta\sigma'}$$

$\Delta\sigma'$ is constant

$$\left(\frac{K.t}{m_v.\gamma_w.d^2}\right)_1 = \left(\frac{K.t}{m_v.\gamma_w d^2}\right)_2$$

$$\left(\frac{K.t \times 1 + e_o \times \Delta\sigma'}{\Delta e \times \gamma_w \times d^2}\right)_1 = \left(\frac{K.t \times (1+e_o) \times \Delta\sigma'}{\Delta e \times \gamma_w \times d^2}\right)_2$$

$$\frac{K_1.t/3 \times (1+0.5)}{(0.5-0.47) \times 45^2} = \frac{K_2.t \times (1+0.65)}{(0.65-0.625) \times 30^2}$$

$$\frac{K_1}{K_2} = 8.91$$

32. Ans: (c)

Sol:

$$TH = Ca^{++} \times \frac{50}{20} + Mg^{++} \times \frac{50}{12}$$

$$= 90 \times \frac{50}{12} + 45 \times \frac{50}{12}$$

= 562.5 mg/*l*it as $CaCO_3$

TH > TA

CH = TA = 350 mg/*l*it as $CaCO_3$

NCH = TH – CH = 562.5 – 350

= 212. 5 mg/*l*it as $CaCO_3$

33. Ans: (b)

Sol: $\int_{-\infty}^{\infty} x e^{-x^2} dx$

Let $f(x) = xe^{-x^2}$

$$f(-x) = -xe^{-x^2} = -f(x)$$

$\therefore$ f(x) is odd function

$\therefore$ The value of given integral is zero.

34. Ans: (b)

Sol:

$$\frac{100}{S_{Solids}} = \frac{\%\text{of volatile solids}}{S_{volatile}} + \frac{\%\text{of non}-\text{volatile solids}}{S_{non-volatile}}$$

$$\frac{100}{S_{Solids}} = \frac{65}{2.1} + \frac{35}{2.8}$$

$S_{solids} = 2.3$

$$\frac{100}{S_{sludge}} = \frac{\%\text{of solids}}{S_{solids}} + \frac{\%\text{of water}}{S_{water}}$$

$$= \frac{2}{2.3} + \frac{98}{1}$$

$S_{sludge} = 1.011$

$$S_{sludge} = \frac{\rho_{sludge}}{\rho_{water}}$$

$$1.011 = \frac{\rho_{sludge}}{1000}$$

$\rho_{sludge} = 1{,}011 \text{ kg/m}^3$

35. Ans: (b)

Sol: Specific weight $= \frac{\text{Weight}}{\text{Volume}}$

$$\gamma = \frac{W}{V}$$

Let us take weight of 100 kg of MSW

Component	Percent by weight	Specific weight (kg/m^3)
Food waste	50	$\frac{50}{300} = 0.167\,m^3$
Dirt and Ash	30	$\frac{30}{500} = 0.06\,m^3$
Plastics	10	$\frac{10}{65} = 0.154\,m^3$
Wood and yard waste	10	$\frac{10}{125} = 0.08\,m^3$

Total average $\gamma = \frac{W}{V} = 217\ kg/m^3$

36. Ans: (b)

Sol:

Average water demand = 200 *l*pcd

Population = 6, 00, 000

Average total water demand

Q = population × per capita demand

= 6,00,000 × 200

= 120×10^6

= 120 MLD

Q_{max} = 1.8 × Average water demand

= 1.8 × 120 = 216 MLD

Q_{max} hourly = 2.7 × Average water demand

= 2.7 × 120 = 324 MLD

Coincidental draft = max daily water demand + fire demand

= 216 + 50 = 266 MLD

Total demand = coincidental draft (or) max hourly water demand which ever is more

∴ Total demand = 324 MLD

37. Ans: (14.32) Range : 14.25-14.40

Sol: Q = 16 m^3/s/m width

$$q = \frac{Q}{b} = 16\,m^3/s/m$$

$y_1 = 0.25$ m

$Q = A_1V_1 \Rightarrow Q = by_1V_1$

$$\frac{Q}{b} = y_1V_1$$

$16 = 0.25 \times V_1$

$$V_1 = \frac{16}{0.25} = 64\,m/s$$

$$F_1 = \frac{V_1}{\sqrt{gD}} = \frac{V_1}{\sqrt{gy_1}} = \frac{64}{\sqrt{9.81\times 0.25}} = 40.867$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left[-1+\sqrt{1+8F_1^2}\right]$$

$$= \frac{1}{2}\left[-1+\sqrt{1+8\times 40.867^2}\right]$$

$\Rightarrow y_2 = 14.32429$ m

$\simeq$ 14.324 m

38. Ans: (c)

Sol: Given

$$f(x) = \frac{\pi^2}{3} - 4\left(\frac{\cos x}{1^2} - \frac{\cos 2x}{2^2} + ...\right)\text{clearly}$$

f(x) is continuous at x = 0

($\because \underset{x\to 0}{\text{Lt}}$ f(x) = 0) the four series converges to

f(0)

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{1}{1^2}+\frac{1}{2^2}-\frac{1}{3^2}+.....=\frac{\pi^2}{12}$$

39. Ans: (b)

Sol: Given

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

$$u=-\frac{\partial\psi}{\partial y}=+2y \text{ and } v=+\frac{\partial\psi}{\partial x}=+2x$$

but $u=-\frac{\partial\phi}{\partial x}=+2y$

so, integrating w.r.t. x,

$\phi = -2xy + f(y)$

$$\frac{\partial\phi}{\partial y}=-2x+f'(y)=-2x$$

or $f'(y) = 0$

so, $f(y) = C$ where, C is a constant.

Thus, $\phi = -2xy + C$

40. Ans: (a)

Sol: Hagen –Poiseuille flow

d = 100 mm,

u_{max} = 120 m/min = $\frac{120}{60}=2\text{m/s}$

$\mu = 70 \times 10^{-3}$ Pa.s. $\rho = 920$ kg/m^3

$$V_{avg}=\frac{u_{max}}{2}=1\text{m/s}$$

1. Volume flow rate,

$$Q=\frac{\pi}{4}\times 0.1^2\times 1=0.785\times 10^{-2}\text{m}^3/\text{s}$$

$= 4.71 \times 10^2$ *l*/min …….. RIGHT

2. Shear stress of the fluid at the pipe wall surface

$$\tau=\frac{-dP}{dx}\frac{R}{2}$$

but,

$$\frac{\Delta P}{L}=\frac{32\mu V}{d^2}=\frac{32\times 70\times 10^{-3}\times 1}{0.1^2}=2.24\times 10^2$$

$$\tau=2.24\times 10^2\times\frac{0.05}{2}=5.6\,\text{N/m}^2 \text{ ……….}$$

RIGHT

3. Darcy friction coefficient is

$$\text{Re}=\frac{\rho Vd}{\mu}=\frac{920\times 1\times 0.1}{70\times 10^{-3}}=1314$$

Flow is laminar

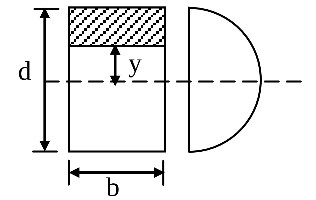
$$f=\frac{64}{\text{Re}}=0.048 \text{ …………. RIGHT}$$

4. Re = 1314 ……………… WRONG

Thus, the correct statements are 1, 2 and 3.

41. Ans: (c)

Sol: At a distance y from neutral axis



$$\tau=\frac{6F}{bd^3}\left(\frac{d^2}{4}-y^2\right)$$

Case (1): (y = d/4)

$$\therefore \tau_1=\frac{6F}{bd^3}\times\left(\frac{d^2}{4}-\frac{d^2}{16}\right)$$

$$=\frac{6F}{bd^3}\times\frac{3d^2}{16}$$

$$\tau_1=\frac{9}{8}\frac{F}{bd}$$

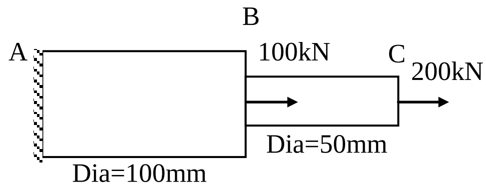
Case (2): y = 0

$$\Rightarrow \tau_2 = \frac{6F}{bd^3} \times \frac{d^2}{4} = \frac{6F}{4bd}$$

$$\therefore \frac{\tau_1}{\tau_2} = \frac{9}{8} \times \frac{4}{6} = \frac{36}{48} = \frac{3}{4}$$

42. Ans: (b)

Sol:



P_2 = 300 kN P_1 = 200 kN

$$\sigma_2 = \frac{P_2}{A_2} = \frac{300 \times 1000}{\frac{\pi}{4}(100)^2}$$

$$\sigma_1 = \frac{P_1}{A_1} = \frac{200 \times 1000}{\frac{\pi}{4}(50)^2}$$

σ_2 = 38.2 MPa

σ_1 = 101.86 MPa ≅ 102 MPa

∴ Max tensile stress σ_1 = 102 MPa

43. Ans: (b)

Sol: $$\varepsilon_z = \frac{\sigma_z}{E} - \mu\frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E}$$

$$\frac{\delta z}{z} = -\frac{\mu}{E}\left[\sigma_x + \sigma_y\right] \quad (\because \sigma_z = 0)$$

$$\delta z = -z\frac{\mu}{E}\left[\sigma_x + \sigma_y\right]$$

$$= \frac{-10 \times 0.3}{200 \times 10^3}[150 + 200]$$

δz = 5.25 μm

44. Ans: 6419.75, Range: (6410 to 6425)

Sol: W = 1300 kg

$$\text{Braking distance} = \frac{V^2}{2gf}$$

$$50\,\text{m} = \frac{(22.22)^2}{2 \times 9.81 \times f}$$

$$f = \frac{22.22^2}{2 \times 9.81 \times 50} = 0.503$$

f = 0.5039

P = W. f

= 1300 × 0.50339

= 654.409 kg

P = 6419.75 N

45. Ans: (b)

Sol: Given f(d) y = Q(x) ....(1)

where f(d) = D^2+3D+2

and Q(x) = cos(x)

C.F: Consider A.E, f(m) = 0

⇒ m^2+3m+2=0

⇒ m = –1, –2

∴ $y_c = c_1e^{-x} + c_2e^{-2x}$

P.I: Here, Q(x) = cos(x) = cos(ax+b)

and f(d) = $\phi(D^2)$ = $\phi(-a^2)$ = ϕ (–1) = (–1) + 3D + 2 = 1 + 3D ≠ 0

Now,

$$y_p = \frac{1}{1+3D} \times \frac{1-3D}{1-3D}\cos(x) = \frac{1-3D}{1-9D^2}\cos(x)$$

$$\Rightarrow y_p = (1-3D)\left[\frac{1}{1-9(-1)}\cos x)\right]$$

$$= (1-3D)\left(\frac{1}{10}\cos(x)\right)$$

$$\therefore\ y_p = \frac{\text{cox}(x)}{10} + \frac{3}{10}\sin x$$

Hence, the general solution of (1) is $y = y_c + y_p$

$$\text{i.e., } y = c_1e^{-x} + c_2e^{-2x} + \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

46. Ans: (d)

Sol: $y_1 = \frac{q_1}{s_1} = \frac{300}{1200} = 0.25$

$$y_2 = \frac{q_2}{s_2} = \frac{400}{1400} = 0.286$$

$$Y = y_1 + y_2$$

$$Y = 0.536$$

$$C_0 = \frac{1.5L+5}{1-Y} = \frac{1.5\times 20+5}{1-0.536} = 75.38\,\text{sec}$$

47. Ans: (a)

Sol: $\text{tyre pressure} = \frac{\text{wheel load}}{\pi a^2}$

$$a = \sqrt{\frac{\text{wheel load}}{\pi\times\text{tyre pressure}}}$$

$$= \sqrt{\frac{40\times 1000}{\pi\times 0.5\times 10^6}}$$

$$= 0.1595 \text{ m}$$

$$a = 15.95 \text{ cm}$$

$$\Delta = 1.5\frac{p.q}{E}$$

$$= \frac{1.5\times 0.5\times 10^6\times 0.1595}{20\times 10^6}$$

$$= 5.986\times 10^{-3} \text{ m}$$

$$= 0.5986 \text{ cm} \approx 0.6 \text{ cm}$$

48. Ans: 63.5 **Range: 63-64**

Sol: Total rainfall

$$P = (3.5+6.5+8.5+7.8+6.4+4.0+4.0+6.0)\times\frac{30}{60}$$

$$= 23.35 \text{ cm}$$

Total rainfall excess, R

$$R = [(6.5-4.5)+(8.5-4.5)+(7.8-4.5)+ (6.4-4.5)+(6.0-4.5)]\times\frac{30}{60}$$

$$= 6.35 \text{ cm}$$

$$= 63.5 \text{ mm}$$

49. Ans: 5.91 **Range: 5.5 – 6.5**

Sol: Actual velocity, $V_a = \frac{\text{distance}}{\text{time}}$

$$= \frac{75\times 100}{18\times 60\times 60}$$

$$= 0.116 \text{ cm/sec}$$

Discharge velocity, $V = n\times V_a = 0.4\times 0.116$

$$= 0.0464 \text{ cm/sec}$$

Hydraulic gradient, $i = \frac{0.6}{75} = 8\times 10^{-3}$

Coefficient of permeability, $K = \frac{V}{i} = \frac{0.0464}{8\times 10^{-3}}$

$$= 5.8 \text{ m/sec}$$

Intrinsic permeability,

$$K_o = \frac{K\upsilon}{g} = \frac{58\times 0.01}{9.81\times 100} = 5.91\times 10^{-5} \text{ cm}^2$$

50. Ans: (c)

Sol: $H_A = H_B = H$ ↶ –ve ↷ +ve

$BM_C = 0$ [Left side]

$$V_A \times 25 - H \times 15 - 10 \times 25 \times \frac{25}{2} = 0$$

$$V_A = \frac{15H + 3125}{25} \rightarrow (1)$$

$BM_C = 0$ [Right side] ↶ –ve ↷ +ve

$$-V_B \times 25 + H \times 10 + 10 \times 25 \times \frac{25}{2} = 0$$

$$V_B = \frac{10H + 3125}{25} \rightarrow (2)$$

$V_A + V_B = 10 \times 50$

$$\frac{15H + 3125}{25} + \frac{10H + 3125}{25} = 10 \times 50$$

H = 250 kN

51. Ans: (a)

Sol: Given f(d)y = Q(x) …………(1)

where $f(d) = D^2 + 4D + 4$

& $Q(x) = x^4 e^{-2x} = e^{-2x}.x^4 = e^x . V(x)$

$$\text{Now, } y_P = \frac{1}{f(D)}\left[e^{-2x} x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{f(D-2)} x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{(D-2)^2 + 4(D-2) + 4} x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1(x^4)}{D^2}\right]$$

$$\therefore y_p = e^{-2x}.\frac{x^6}{30}$$

52. Ans: (a)

Sol: A unit rotation is applied at joint B, while holding joint C in the restrained position. The resultant forces on the structure can be computed.

The moment developed at joint B will be equal to the sum of the moments induced in members BA and BC

$$K_{11} = \frac{4EI}{5} + \frac{4EI}{8} = \frac{13EI}{10} = 1.3EI$$

The moment developed at joint 'C' will be equal to the sum of the moments induced in the members connected at the joint.

$$K_{21} = \frac{2EI}{L} = \frac{2EI}{8} = 0.25EI$$

The force at joint 'C' will be the sum of the moments developed in all the members connected to the joint.

$$K_{22} = \frac{4EI}{8} + \frac{4EI}{7} + \frac{4EI}{4}$$

= 0.5EI + 0.57EI + EI

= 2.07 EI

$$K = \begin{bmatrix} 1.3EI & 0.25EI \\ 0.25EI & 2.07EI \end{bmatrix}$$

53. Ans: 150 m Range: 149 - 150

Sol: $r_1 - r_2 = \frac{r_1 h}{H}$

Hence r_1 = 112.2 mm r_2 = 81.6 mm

H = 800 – 250 = 550 m

$$\text{Hence } 0.1122 - 0.0816 = 0.1122 \times \frac{h}{550}$$

h = 150 m

54. Ans: (c)

Sol: Correction due to earth curvature

$$= C_c = \frac{d^2}{2R}(-ve)$$

Correction due to refraction

$$= C_R = \frac{md^2}{R}(+ve)$$

Net correction $= -\frac{d^2}{2R} + \frac{md^2}{R}$

$$= -\frac{d^2}{2R}(1-2m) \text{ i.e. negative}$$

Minimum elevation $'h' = \frac{d^2}{2R}(1-2m)$

$$= \frac{80^2}{2\times 6400}(1-2\times 0.08)$$

= 0.42km

= 420m

55. Ans: 0.413 **Range [0.410-0.415]**

Sol : Flexural bond stress = $\frac{V_u}{\Sigma O \times z}$

V_u = shear force

Dead load = 25 × 0.2 × 0.45 = 2.25kN/m

Live load = 8kN/m

Total load = 10.25kN/m.

Shear force at support = $10.25 \times \frac{6}{2}$

= 30.75kN

$\Sigma O = 6 \times \pi \times 12 = 226.19$ mm

Z = lever arm

Actual depth of neutral axis:

$0.36\, f_{ck}\, bx_a = 0.87\, f_y\, A_{st}$

$$0.36 \times 20 \times 200 \times x_a = 0.87 \times 415 \times 6 \times \frac{\pi}{4}\times 12^2$$

x_a = 170.14 mm

Limiting depth of neutral axis for Fe415 steel ($x_{u,lim}$)= 0.48d = 0.48 × 400 = 192mm

Lever arm = d – 0.42x_a = 400 – (0.42 × 170.14) = 328.54mm

Flexural bond stress

$$= \frac{30.75\times 1000}{226.19\times 328.54} = 0.413 \text{ MPa}$$

56. Ans: (d)

Sol: 'Cut out for' means designed to be so. 'Cut up' means 'to be emotionally upset'. 'Cut down' means 'to kill somebody' or 'to make something fall down by cutting it at the base'. 'Cut off' means 'separated from the rest of the world'.

57. Ans: (c)

58. Ans: (a)

59. Ans: (d)

Sol: Let principle be 1. then amount after 10 years = 3 × 1 = 3

∴ Simple interest = 3 - 1 = 2

∴ Rate of interest $= \frac{2\times 100}{1\times 10} = 20\%$

60. Ans: (c)

Sol: Note that 20 – 14 = 6; 25 – 19 = 6;

35 – 29 = 6; 40 – 34 = 6.

Required number = L.C.M. of (20, 25, 35 and 40) – 6.

20=2*2*5
25=5*5
35=1*5*7
40=2*2*2*5

$= (2 \times 2 \times 2 \times 5 \times 5 \times 7) - 6$

$= 1400 - 6 = 1394$

61. Ans: (c)

Sol: The angle subtended by an arc at the centre of the circle is twice the angle subtended by the arc at any point on the remaining part of the circle.

$\therefore \angle BOC = 2\angle BAC = 2 \times 50^0 = 100^0$

Now in ΔBOC

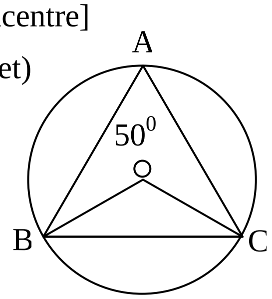
OB = OC [radii of circumcentre]

$\therefore \angle OBC = \angle OCB = x$ (let)

$\therefore x + x + 100^0 = 180^0$

$\Rightarrow 2x = 80^0$

$\Rightarrow x = 40^0$



62. Ans: (a)

Sol: At 4:10 the hour hand is a head of minute hand

Given that n = 4 and x = 10

Then according to the formula required angle

$$= \left\{30\left(n - \frac{x}{5}\right) + \frac{x}{2}\right\}^0$$

$$= \left\{30\left(4 - \frac{10}{5}\right) + \frac{10}{2}\right\}^0$$

$$= \{(30 \times 2) + 5\}^0 = (60 + 5)^0 = 65^0$$

63. Ans: (b)

Sol: Total cost (in Rs) of journey to Town A

$= 4300 + 3100 + 4000 + 6000 = 17400$

Average cost $= \frac{17400}{4}$ = Rs. 4350

64. Ans: (a)

Sol: Maximum cost (in Rs) of journey from Delhi to town A = By Train 4 = Rs. 6000

Similarly, for town B = Rs. 6300

Town C = Rs. 5600 and Town D = Rs. 5700

$\Rightarrow$ Maximum cost = 6000 + 6300 + 5600 = Rs. 23600

65. Ans: (d)