Branch: CIVIL ENGINEERING _MOCK-E SOLUTIONS

01. Ans: 0.021 **(Range: 0.02 to 0.025)**

Sol: Approximate equation of Stoke's law

$$V_s = 900\, d^2$$
$$0.4 = 900.d^2$$
$$d = \sqrt{\frac{0.4}{900}} = 0.021 \text{ mm}$$

02. Ans: (a)

Sol: Initial prestress = P

Loss of stress due to anchorage slip = $E_s \dfrac{\Delta}{L}$

Percentage Loss of stress due to anchorage slip $\sigma_1 = \dfrac{E_s \frac{\Delta}{L}}{P} \times 100$

For constant P, Percentage Loss of stress due to anchorage slip

$\sigma \, \alpha \, (1/L)$

03. Ans: (B)

Sol: Sensitivity $= \dfrac{\text{undisturbed torque}}{\text{remoulded torque}} = \dfrac{600}{200} = 3$

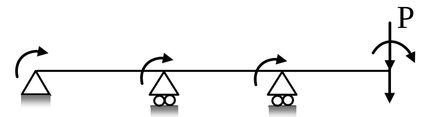
Sensitivity of Clays

< 1	Insensitive clays
1-4	Normal clays (low and medium sensitive)
4-8	Sensitive clays
8-15	Extra-sensitive clays
> 15	Quick clays

04. Ans: (C)

05. Ans: (A)

Sol: Number of joint j = 4



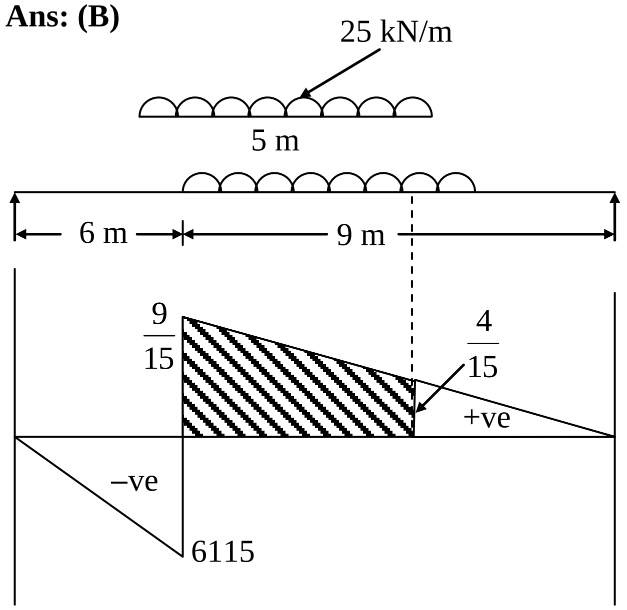
Number of members, m = 3

Number of independent external reaction components, r = 4

$$D_k = 3 \times 4 - (4 + 3) = 5$$

06. Ans: (B)

Sol:



Maximum SF_C = Intensity of UDL × Area of shaded ILD

$$= 25\left[\frac{\frac{9}{15} + \frac{4}{15}}{2}\right] \times 5$$

07. Ans: (C)

08. Ans: 125 **No range**

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

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

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

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

09. Ans: (D)

Sol: $Z_c = 1$ m

After the formation of crack, the force on the wall is caused only by the pressure below depth of tension crack. i.e. tensile stresses are neglected.

$\therefore$ Difference of between active force after formation of crack and before formation of crack = Negative pressure

$= \frac{1}{2}\times1\times6$

= 3 Kn

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

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

11. Ans: 56.5 **(Range: 55 to 57)**

Sol: Friction pile: $C_u = \frac{q_u}{2} = \frac{80}{2} = 40\ \text{kN/m}^2$

$$Q_{safe} = \frac{1}{F}[\pi.d.L.\alpha.C]$$

$$= \frac{1}{3}[3.14\times0.3\times9\times0.5\times40]$$

= 56.5 kN

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

$\therefore$ The given partial differential equation is elliptic type

13. Ans: 1389, Range: (1387 to 1391)

Sol: As per ICAO recommendation the basic runway length increased at a rate of 7% for 300 rise in elevation above MSL.

$\therefore$ Corrected runway length

$= 1260 + \frac{7\times440}{300\times100}\times1260$

= 1389.36 m

14. Ans: 7.898, Range: (7.5 to 8.2)

Sol: Breaking distance $= \dfrac{V^2}{254 f\eta}$

$$24.7 = \frac{70^2}{254 \times f \times 0.97}$$

$f = 0.805$

$a = f.g$

$= 0.805 \times 9.81$

$= 7.898 \text{ m/sec}^2$

15. Ans: (D)

16. Ans: (52.74)

Sol: $e_{sw} = \dfrac{100}{\dfrac{35}{800}+\dfrac{15}{1100}+\dfrac{10}{1250}+\dfrac{20}{950}+\dfrac{20}{650}}$

$= 853.18 \text{ kg/m}^3$

$M_{SW} = 30{,}000 \times 1.5 = 45000$ kg/day.

Volume occupied solid waste

$= \dfrac{45000}{853.18} = 52.74 \text{ m}^3$

17. Ans: (B)

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

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

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

$\Rightarrow \lambda = 3$

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

$= 1 - \dfrac{\lambda^0 e^{-\lambda}}{0\,!}$

$= 1 - e^{-3}$

18. Ans: (B) **19. Ans: (C)**

20. Ans: (B) **21. Ans:(D)**

22. Ans:(C)

23. Ans: (B)

Sol: $\sigma_x = 45$ MPa; $\sigma_y = (-)\ 60$ MPa

$\tau_{xy} = 30$ MPa

Major principal stress,

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

24. Ans: (C)

Sol: The actual rain-drop-impact is not simulated.

25. Ans: (B)

Sol: $p = \dfrac{1}{T} = \dfrac{1}{100}$

$q = 1 - p = 1 - \dfrac{1}{100} = \dfrac{99}{100}$

Probability that it will not occur in next 50 year $= q^n$

$= \left(\dfrac{99}{100}\right)^{50}$

$= 0.605$

$\approx 60\ \%$

26. Ans: (C)

Sol: For sandy soils

$$\frac{S_F}{S_P} = \left(\frac{B_F(B_p + 0.3)}{B_P(B_F + 0.3)}\right)^2$$

$$S_f = \left(\frac{1.2(0.4+0.3)}{0.4(1.2+0.3)}\right)^2 \times 15$$

$S_F = 29.4$ mm

For clayey soils,

$$\frac{S_F}{S_p} = \frac{B_F}{B_P}$$

$$S_F = \frac{1.2}{0.4}\times 15$$

$(S_F) = 45$ mm

$\therefore \quad (S_F)_{clay} - (S_F)_{sand} = 45 - 29.4 = 15.6$ mm

27. Ans: (C)

Sol: Maximum bending moment

$$M = \frac{w\ell^2}{8}$$

$$= \frac{50(4000)^2}{8} = 100\times 10^6 \text{ N - mm}$$

Section modulus required $= \dfrac{M}{\sigma_{bc}(\text{or})\sigma_{bt}}$

$$= \frac{100\times 10^6}{0.66\times 250} = 606.06\times 10^3 \text{mm}^3$$

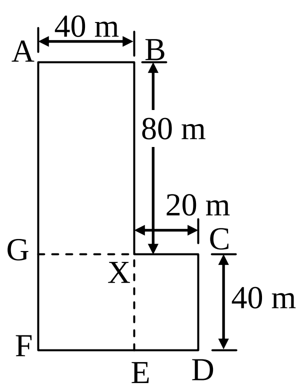
$= 606.06$ cm^3

From steel table, section modulus available

Hence ISMB 300

28. Ans: (C)

Sol: The settlement at point 'X' can be worked out as being the settlement caused by three rectangular loaded areas, at their corner as shown in figure below.



These three rectangular areas are:

1. Rectangle ABXG – having L = 80 m, B = 40 m; $\frac{L}{B} = 2$
2. Rectangle XCDE – having L = 40 m, B = 20 m; $\frac{L}{B} = 2$
3. Rectangle GXEF – having L = 40 m, B = 40 m; $\frac{L}{B} = 1$

The values of influence factor (I_f) to be used in equation for computing values of immediate settlement caused by these three rectangular areas at corner, are obtained from table given

For $\frac{L}{B} = 2$, I_f at corner = 0.77

For $\frac{L}{B} = 1$, I_f at corner = 0.56

Now use equation

$$S_i = \frac{q.B}{E}(1-\mu^2).I_f$$

Here q = 150 kN/m^2

E = 15 MN/m^2 = 15000 kN/m^2

μ = 0.5 (assume for soft clay)

$$\therefore \quad S_{i(1)} = \frac{q\times 40m}{E}(1-\mu^2)\times 0.77$$

$$S_{i(2)} = \frac{q\times 20m}{E}(1-\mu^2)\times 0.77$$

$$S_{i(3)} = \frac{q\times 40m}{E}(1-\mu^2)\times 0.56$$

Total settlement at X

$S_i = S_{i(1)} + S_{i(2)} + S_{i(3)}$

$$= \frac{q}{E}(1-\mu^2)\left[40\times 0.77 + 20\times 0.77 + 40\times 0.56\right]$$

$$= \frac{150}{15000}(1-0.5^2)[68.6]\text{m}$$

$= 0.686(1–0.25) = 0.515$ m

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29. 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 $= \frac{1243}{3}$

30. Ans: 19.3 (Range: 18.5 to 20)

Sol:

Weight of soil = 4.7 kg

$\therefore$ Dry unit weight of sand, $\gamma_d = \frac{W_{sand}}{V_{sand}}$

Weight of dry sand to fill calibration can W_{sand} = 6.75 kg

Volume of calibrating can V_{sand} = 4.5 litre

$\therefore (\gamma_d)_{sand} = \frac{6.75}{4.5} = 1.5\,\text{kg/litre}$

$\therefore$ Volume of hole required for filling

3.65 kg of dry sand $V_1 = \frac{3.65}{(\gamma_d)_{sand}}$

$= \frac{3.65}{1.5}$ = 2.43 litre

Volume of hole required for filling 3.65 kg sand = volume of hole extracted for 4.7 kg of soil

Bulk density of soil = $\frac{\text{Weight of soil}}{V_1}$

$= \frac{4.7}{2.43}\,\text{kg/litre}$

= 1.93 kg/litre= 19.3 kN/m^3

31. 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 $xD = \theta$, $x^2 D^2 = \theta(\theta - 1)$ $\Big\}$ .... (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

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

32. Ans: (D)

Sol: Length of drainage path, d= 20 m

$C_v = 5 \times 10^{-4}\ cm^2/sec$

For, U = 50%, $T_{v_1} = \frac{\pi}{4}\left[\frac{U\%}{100}\right]^2$

$= \frac{\pi}{4}\left[\frac{50}{100}\right]^2$

$= 0.196$

U = 90%, $T_{v_2} = 1.781 - 0.933\log_{10}(100 - U)$

$= 0.848$

$$t_1 = \frac{T_{v_1} d^2}{C_v} = \frac{0.196 \times (20 \times 100)^2}{5 \times 10^{-4} \times 3600 \times 24 \times 365}$$

= 49.72 years

$$t_2 = \frac{T_{v_2} d^2}{C_v} = \frac{0.848 \times (20 \times 100)^2}{5 \times 10^{-4} \times 3600 \times 24 \times 365}$$

= 215.119

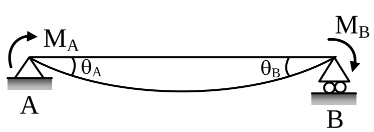
$t_2 - t_1$ = 215.119 – 49.72

= 165.399 years

$\simeq$ 165 years

33. Ans: (A)

Sol:



$$M_{AB} = 0 + \frac{2EI}{L}(2\theta_A + \theta_B)$$

$$M_{AB} = 0 + \frac{2EI}{L}(2\theta_B + \theta_A)$$

$$\frac{\theta_A}{\theta_B} = 2$$

$\theta_A = 2\,\theta_B$

$$\frac{M_{AB}}{M_{BA}} = \frac{2\theta_A + \theta_B}{2\theta_B + \theta_A} = \frac{4\theta_B + \theta_B}{2\theta_B + 2\theta_B} = \frac{5}{4} = 1.25$$

34. 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

35. Ans: (D)

Sol: d = 20 m

$A_1 = 35\ m^2$

$A_2 = 67\ m^2$

$A_3 = 110\ m^2$

Volume = $V = d\left[\frac{A_1 + A_3}{2} + A_2\right]$

$= 20\left[\frac{35 + 110}{2} + 67\right]$

$= 2790\ m^3$

36. Ans: (D)

Sol: Depth of water, $d_W = s \times d \times [F_c - W]$

$= 1.4 \times 1.4 \times [0.2 - 0.08]$

= 0.235 m

= 235 mm

Consumptive use of water for 8 days = $8 \times C_u$

$= 8 \times 3$

= 24 mm

Total depth of water to be stored in root zone

= 235+24

= 259 mm

Irrigation efficiency, η = 65%

Total depth of water supplied on the field

$$= \frac{259}{\eta} = \frac{259}{0.65}$$

$$= 398.46 \text{ mm}$$

∴ Nearest answer is 398 mm

37. Ans: (A)

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

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

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

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

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

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

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

$$= \frac{125}{671}$$

38. Ans: (A)

Sol:

Inflow		Outflow	
Item	Volume, m^3	Item	Volume, m^3
Surface inflo w = 12 × 3600 × 24 × 30	31,104,000	Surface outflow = 18 × 3600 × 24 × 30	46,656,000
Rainfall = $20\times10^6\times\frac{P}{100}$	200,000×P	Evaporation $=0.78\times20\times10^6\times\frac{20}{100}$	3,12,0000
Total inflow volume	31,104,000+200,000P	Seepage	1,640,000
		Total outflow volume	51,416,000

Total outflow volume – total inflow volume = Reduction in storage

51,416,000 – 31,104,000 – 200,000P

= 15,000,000

P = 26.56 cm

39. Ans: 108

Sol: e = 15 cm

V_{max} = 90 kmph

$\therefore$ D_{max} = 7.6 cm (Below 100 kmph)

As per Indian Railway, length of transition curve is maximum of following

(i) L = 7.2 × e
= 7.2 × 15
= 108 m

(ii) L = 0.073 D.V_{max}
= 0.073 × 7.6 × 90
= 49.932 m

(iii) L = 0.073 e. V_{max}
L = 0.073 × 15 × 90
= 98.55 m

$\therefore$ L = 108 m

Maximum of above 3 values

40. Ans: 15

Sol: Vehicle A : 2 min ⇒ 2 min/mile

Vehicle B : 5 min ⇒ 5 min/mile

Vehicle C : 5 min ⇒ 5 min/mile

Average travel time $= \dfrac{2+5+5}{3}$

= 4 min/mile

Average travel speed $= \dfrac{1}{4}$

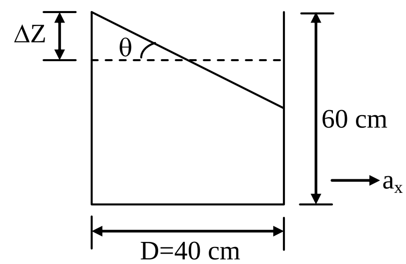
= 0.25 mile/min

= 15 mile/hr

41. Ans: (C)

Sol: We know that

$$\tan\theta = \frac{a_x}{g+a_z} = \frac{4}{9.81+0} = 0.4077$$



The maximum vertical rise of the free surface occurs at the back of the tank.

$$\Delta Z_{max} = \frac{D}{2}\tan\theta = \frac{0.4}{2}\times 0.4077$$

= 0.082 m = 8.2 m

Therefore, the maximum initial water height in the tank to avoid spilling is

h_{max} = 60 – 8.2 = 51.8 cm

42. Ans: 0.026, (Range: 0.022 to 0.029)

Sol: For a horizontal pipe head loss is

$$\frac{P_1 - P_2}{\rho g} = h_f = \frac{fLQ^2}{12.1d^5}$$

$$\left(\text{reduced from } \frac{fLV^2}{2gd} \text{ and } V = \frac{4Q}{\pi d^2}\right)$$

$$\text{Or,}\quad f = \frac{\Delta P \times 12.1d^5}{\rho g \times LQ^2} = \frac{30\times10^3\times12.1\times(0.15)^5}{10^3\times9.81\times30(0.06)^2}$$

= 0.026

43. Ans: 5.82 (Range: 5.7 to 5.9)

Sol: Here the flow is taking place in an open channel

$\therefore$ Froude's law of similarity for distorted model is used

We know

$$V = \frac{1}{n}R^{2/3}.S^{1/2}$$

$$n = \frac{R^{2/3}.S^{1/2}}{V}$$

For Froude similarity

$$V_r = \sqrt{L_v}$$

R = y = L_v (Since wide rectangular channel)

$$\text{Slope (s)} = \frac{y}{x}$$

$$= \frac{L_v}{L_H}$$

$$\therefore \frac{n_m}{n_p} = \frac{(L_v)^{2/3}\left(\frac{L_V}{L_H}\right)^{1/2}}{\sqrt{L_v}}$$

$$\frac{n_m}{n_p} = \frac{(L_V)^{2/3}}{\sqrt{L_H}}$$

$$n_m = n_p \times \frac{\left(\frac{1}{50}\right)^{2/3}}{\sqrt{\frac{1}{1000}}} = 0.025 \times \frac{\left(\frac{1}{50}\right)^{2/3}}{\sqrt{\frac{1}{1000}}}$$

$n_m = 0.05824 = 5.82\times10^{-2}$

44. Ans: (C)

Sol: Average discharge per day

Q_{Avg} = Population × Per capita water demand

= 1,25,000 × 135

= 16.875×10^6 l/d

= 16.875 MLD

Since, the canal runs for 12 hours a day.

$$\text{Intake load per hr} = \frac{16.875}{12}$$

= 1.40625 ML/hr

$$= 1.40625 \times \frac{10^6}{10^3} \times \frac{1\text{hr}}{60\text{min}} \times \frac{1\text{min}}{60\text{sec}}$$

= 0.391 m^3/sec

45. Ans: 127.14 **(Range: 127-128)**

Sol: 1 μ bar = 10^5 μPa

455 μ bar = 455 × 10^5 MPa

Sound pressure level in dB

$$\text{SPL} = 20\log_{10}\frac{P}{P_o}$$

$$= 20\log_{10}\frac{455\times10^5}{20}$$

= 127.14 dB

46. Ans: 9000 **No range**

Sol: The quantity of sewage to be treated per day

= No. of persons × per capita sewage

= 6000 × 150

= 9,00,000 litres/day = 0.9 MLD

= 900 m^3/day

The BOD content per day

= 900 × 0.25

= 225 kg/day

The organic loading rate OLR = 300 kg/ha/day

The surface area required

$$= \frac{225\,\text{kg/day}}{300\,\text{kg/ha/day}}$$

= 0.75 ha

$$= 0.75\text{ha} \times \frac{10^4\,\text{m}^2}{1\text{ha}}$$

= 7,500 m^2

Capacity of the tank,

V = L × B × H

= 7500 × 1.2

V = 9,000m^3

47. Ans: 0.2 **(Range: 0.2 – 0.2)**

Sol: Average daily demand

Q_{Avg} = Population × Per capita water demand

= 75,000 × 160

= 12×10^6 L/D

= 12 MLD

For rapid sand filters;

Maximum daily demand, $Q_{max} = 2 \times Q_{avg}$

= 2 × 12

$$= 24\text{MLD} \times \frac{10^6\,\text{L}}{\text{d}} \times \frac{1\text{d}}{24\text{hr}}$$

= 10^6 L/hr

Area of filter beds

$$\text{required } = \frac{Q_{max}}{\text{Rate of filtration}}$$

$$= \frac{10^6}{5000}$$

= 200 m^2

$$\text{Area of each unit} = \frac{200}{2}$$

A = 100 m^2

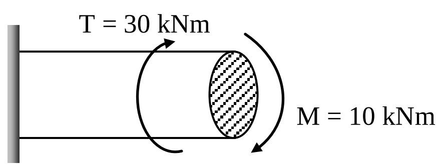
Total area of the perforations

= 0.2% × Filter area

$$= \frac{0.2}{100} \times 100 = 0.2\ \text{m}^2$$

48. Ans: 137.1 **Range: (136 – 138)**

Sol:



Normal stress developed in the bar due to moment is

$$\sigma = \frac{32M}{\pi d^3}$$

Shear stress developed in the bar due to torque is

$$\tau = \frac{16T}{\pi d^3}$$

Maximum shear stress,

$$\tau_{max} = \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= \frac{16}{\pi d^3}\sqrt{M^2 + T^2}$$

As per maximum shear stress theory,

$$\tau_{max} \le \frac{\sigma_y}{2(Fos)}$$

$$\frac{16}{\pi d^3}\sqrt{(30^2 + 10^2)} \times 10^6 \le \frac{250}{2 \times 2}$$

d ≤ 137.1 mm

49. Ans: (B)

Sol: Since the loading is uniformly varied load (1^o), SFD will be 2^o curve.

Hence option (A) and (D) are eliminated

Vertical Reaction at support(s)

$$= \frac{1}{2} \times 12 \times 3 - 10$$

= 8 kN

We know that $\frac{ds}{dx} = w$ (loading)

At fixed support, since there is loading, the slope of SFD is non zero.

∴ option (B) is the S.F.D of given beam.

50. Ans: 32.13°C **(Range: 32.10 to 32.16)**

Sol: $P_{Cr} = \frac{\pi^2 EI}{L^2}$

(∵ both ends are pinned

∴ $l_{eff} = L$)

Axial compressive force in bar

P = (E α ΔT) A

$P = P_{cr}$

$$\therefore \quad A(E\alpha\Delta T)=\frac{\pi^2 EI}{L^2}$$

$$\Delta T=\frac{\pi^2 I}{\alpha A L^2}=\frac{\pi^2}{\alpha\times\frac{\pi d^2}{4}\times L^2}\left(\frac{\pi d^4}{64}\right)$$

$$\Delta T=\frac{\pi^2\times d^2}{\alpha\times 16\times L^2}=\frac{\pi^2\times(100)^2}{12\times 10^{-6}\times 16\times(4000)^2}$$

$\Delta T = 32.13°$

51. Ans: (D)

Sol: Average shear stress $=\dfrac{V}{bd}$

$$=\frac{100\times 10^3}{200\times 200}=2.5\,\text{MPa}$$

Square section is a particular case of rectangular section

$\therefore$ Maximum shear stress = 1.5 τ_{avg}

= 1.5 × 2.5

= 3.75 MPa

52. Ans: 6.274 (Range: 6 to 7)

Sol: For 1 cu.m of final mix (dense)

1.50 to 1.55 cm of loose ingredients with the required proportion we want to add

Take average of 1.50 to 1.55

$$=\left(\frac{1.55+1.50}{2}\right)=1.525$$

For 1: 2: 4 cement concrete

Cement = $\dfrac{1.525}{1+2+4}=\dfrac{1.525}{7}=0.2178\ \text{m}^3$

Density of concrete = 1440 kg/m^3

No.of bags = $\dfrac{0.2178\times 1440}{50}$

= 6.274 bags

53. Ans: (C)

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

Moment of resistance = 0.138 f_{ck} bd^2

= 0.138 × 25 × 200 × 400^2 = 110.4 kNm

Working moment of resistance = 110.4/1.5

= 73.6kNm

Maximum bending moment in fixed beam

= wl^2/12

Permissible service load $=\dfrac{73.6\times 12}{6^2}$

= 24.53 kN/m

54. Ans: (B)

Sol: Nominal shear stress = τ_v = $\dfrac{V_u}{bd}$

= 350 × 1000/(350 × 550)

= 1.818MPa

Shear strength of concrete

τ_c = 0.5MPa < 1.818MPa.

$\Rightarrow \tau_v > \tau_c$

Hence shear reinforcement is to be designed.

Shear force to be resisted by stirrups and bent up bars = $(\tau_v - \tau_c)\times$ bd

= (1.818-0.5) × 350 × 550

= 253.75kN

Shear resistance of bent up bars

$V_{us} = 0.87 f_y A_{sv} \sin\alpha$

= 0.87 × 415 × (2 × π ×20^2/4) ×sin45^o

= 160.41 kN

Shear force to be resisted by stirrups

= 253.75–160.41 = 93.34kN

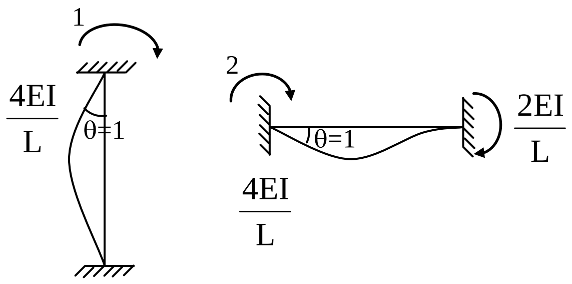
However, Stirrups have to be designed to resist minimum half of the design Shear force

= 253.75/2 = 126.875 kN

55. Ans: (D)

Sol: To generate stiffness matrix first fix all co ordinates

For Ist column



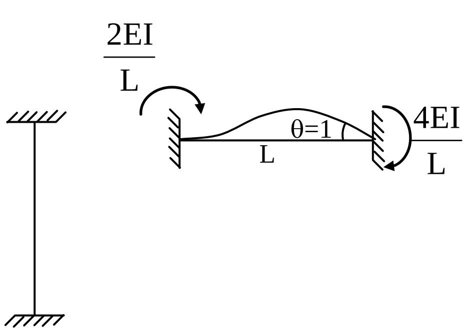
$$\therefore\ K_{11} = \frac{4EI}{L} + \frac{4EI}{L}$$

$$= \frac{4E(2I)}{5} + \frac{4E(2I)}{4}$$

$$K_{11} = 3.6EI$$

$$K_{21} = \frac{2E(2I)}{4} = EI$$

For 2nd column:



$$\therefore\ K_{12} = \frac{2E(2I)}{4} = EI$$

$$K_{22} = \frac{4E(2I)}{4} = 2EI$$

$$\therefore\ [K] = \begin{bmatrix} 3.6EI & EI \\ EI & 2EI \end{bmatrix}$$

$= 54.167$ kN

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

$\therefore$ Their present ages are 24 & 28 respectively

Ratio of ages after 4years = 24 + 4 : 28 + 4 = 7 : 8

64. Ans: (B)

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

Expenditure in year 2015 (in 000') = 3075

$\Rightarrow$ Required % increase

$= \frac{(3800-3075)}{3075}\times100$

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

65. Ans: (B)