Branch: CIVIL ENGINEERING _MOCK-D SOLUTIONS

01. Ans: (A)

02. Ans: 0.34 (Range 0.32 to 0.36)

Sol: Grade compensation for BG curve = 0.04% per degree curve

Total grade compensation = 0.04× 4 = 0.16%

∴ Gradient provided = 0.5 – 0.16 = 0.34%

03. Ans: (C)

Sol: As per IRC camber provided for WBM, heavy rainfall is 3% = $\frac{1}{33}$.

$\therefore$ Height of crown $=\frac{w}{2N}=\frac{3.8}{2\times 33}=0.0575$ m

= 57.5 mm ≃ 58mm

04. Ans: 618.15 Range: 618 to 619

Sol: $\frac{q_f}{q_p}=\frac{B_f}{B_P}$

$\frac{q_f}{287}=\frac{1.4}{0.65}$

q_f = 618.15 kN/m^2

05. Ans : 2.09 Range: 2 to 2.10

Sol : $S_n = \frac{C}{F_c.\gamma H}$

$0.181 = \frac{115}{F_c \times 20.2 \times 15}$

F_c = 2.10

06. Ans: 2 no range

Sol: The probability density function of uniform distribution is

$$f(x)=\begin{cases}1, & 0<x<1\\ 0, & otherwise\end{cases}$$

$$E(y) = E[-2\log_e x]$$

$$=\int_0^1 -2\log_e x\ f(x)\,dx$$

$$=-2\int_0^1 \log_e x\,dx$$

$$=-2\{x\log_e x - x\}_0^1$$

$$=-2\{(0-1)-(0)\}$$

$$= 2$$

07. Ans: 300 Range: 299.2 to 300

Sol: $Q=\frac{W.h}{F[S+C]}=\frac{22.5\times 1200}{6[2.54+12.5]}=300$ kN

08. Ans: (C)

Sol: $\because \underset{x\to 0}{Lt}\frac{\tan(ax)}{x}=a$

Now, $\underset{x\to 0}{Lt}\frac{\tan(4x)}{4x}=\frac{1}{4}\underset{x\to 0}{Lt}\frac{\tan(4x)}{x}$

$\therefore \underset{x\to 0}{Lt}\frac{\tan(4x)}{4x}=\frac{1}{4}(4)=1$

09. Ans: 0

Sol: There is no effect due to the change in level of water in the lake on effective stress at any point below the bed of lake.

10. Ans: (C)

11. Ans: (B)

Sol: In a short column subjected to pure axial loading , the strain variation is uniform with a value of 0.002.

12. Ans: 15.39 Range 15.2 to 15.5

Sol: F_v = weight of volume of liquid contained in semi-circular gate

$F_v = \rho g V$

$$= 1000 \times 9.8 \times \frac{\pi \times R^2}{2} \times 1$$

$F_v = 15.39$ kN

13. Ans: 1280 no range

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

$\because |K A_{n\times n}| = K^n |A_{n\times n}|$

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

$\Rightarrow |(-4) A_{4\times 4}| = (256)(5)$

$\therefore |(-4) A_{4\times 4}| = 1280$

14. Ans: 166.67 ppm Range: (166-167)

Sol: BOD = Depletion of oxygen × Dilution factor

$$= 3\text{ppm} \times \frac{100}{1.8}$$

= 166.67 ppm

15. Ans: (C)

16. Ans: (B)

Sol: Addition of water imparts permanent hardness.

17. Ans: 2000

Sol: $\frac{E}{R} = \frac{f_{max}}{y_{max}}$

$$\frac{200 \times 10^3}{100} = \frac{f_{max}}{1}$$

$f_{max} = 2000$ MPa

18. Ans: (B)

Sol: The condition for exactness of a differential equation

$M(x, y)\,dx + N(x, y)\,dy = 0$ is $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$

Given that $M(x, y) = 3xy^2 + k^2 x^2 y$ and $N(x, y) = kx^3 + 3x^2 y$

Consider $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$

$\Rightarrow 6xy + k^2x^2 = 3kx^2 + 6xy$

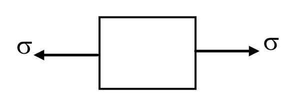
$\Rightarrow k^2 = 3k$ (or) $k^2 - 3k = 0$

$\Rightarrow k = 0, 3$

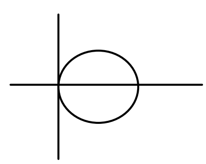
$\therefore$ The non zero value of k is 3

19. Ans: (B)

Sol: State of stress on the bottom fibre of a simply supported beam at mid span is in pure tension as shown below.



The corresponding Mohr's circle is touching to y-axis on positive side.



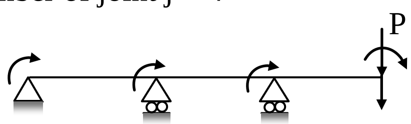
20. Ans: 144000 Range: 144000 to 144000

Sol: $$E_L = \underbrace{(60\times1000\times20)}_{\text{Area}}\times \underbrace{0.8}_{\text{pan coeff}}\times \underbrace{\frac{0.5}{100}}_{\frac{\text{m}}{\text{day}}}\times \underbrace{30}_{\text{day}}$$

$= 144000\ m^3$

21. Ans: (A)

Sol: Number of joint j = 4



Number of members, m = 3

Number of independent external reaction components, r = 4

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

22. Ans: (C) **23. Ans: (D)**

24. Ans: 0.25 no range

Sol: Given

$$\int_0^x f(t)\,dt = -2 + \frac{x^2}{2} + 4x\sin(2x) + 2\cos(2x)$$

Differentiating both sides of above w.r.t 'x',

we get $$\frac{d}{dx}\left[\int_0^x f(t)\,dt\right] = -0 + \frac{2x}{2} + 4\sin(2x) + 8x\cos(2x) - 4\sin(2x)$$

$$\Rightarrow \left(\frac{d}{dx}(x)\right)[f(x)] - \left(\frac{d}{dx}(0)\right).[f(0)] = x + 8x\cos(2x)$$

$\Rightarrow$ f(x) = x + 8x.cos(2x)

$$\therefore \frac{1}{\pi} f\left(\frac{\pi}{4}\right) = \frac{1}{\pi}\left[\frac{\pi}{4} + 8\left(\frac{\pi}{4}\right).\cos\left(\frac{2\pi}{4}\right)\right]$$

$$= \frac{1}{4} = 0.25$$

25. Ans: (D)

26. Ans: (B)

Sol: Given that $A = (a_{ij})_{n\times n}$,

where $$a_{ij} = \begin{cases} (n+1)^2 - i, & \forall\ i = j \\ 0, & \forall\ i \neq j \end{cases}$$

$$\Rightarrow A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

$$= \begin{bmatrix} 15 & 0 & 0 \\ 0 & 14 & 0 \\ 0 & 0 & 13 \end{bmatrix}_{3\times3} \quad \text{for } n = 3$$

$\Rightarrow A_{3\times3}$ is a diagonal matrix & its eigen values are its diagonal elements 15, 14, 13.

If $\lambda_1, \lambda_2, \lambda_3$ are the eigen values of $A_{3\times3}$ matrix then the eigen values of matrix $A^2_{3\times3}$ are λ_1^2, λ_2^2 and λ_3^2.

$\therefore$ The eigen values of a required matrix A^2 are $(15)^2$, $(14)^2$ and $(13)^2$ (i.e., 225, 196, 169)

27. Ans: 0.255 Range: 0.24 - 0.27

Sol:

Time (1)	Total stream flow in cumec (2)	Base flow in cumec (3)	Direct runoff = (2) – (3)
0	4.8	4.8	0
2	5.1	4.8	0.3
4	6.5	4.8	1.7
6	7.4	4.8	2.6
8	10.2	4.8	5.4
10	8.8	4.8	4
12	7.4	4.8	2.6
14	4.8	4.8	0

Catchment area , A = 400 ha

$= 400 \times 10^4\ m^2$

Volume of runoff, $V = \left[\frac{O_1 + O_n}{2} + \sum O\right]\Delta t$

$$= \left[\left(\frac{0+0}{2}\right) + (0.3 + 1.7 + 2.6 + 5.4 + 4 + 2.6)\right] \times 2 \times 60 \times 60$$

$= 11.95 \times 10^4\ m^3$

$$\text{Depth of Runoff} = \frac{\text{Volume of Runoff}}{\text{Catchment area}}$$

$$= \frac{11.95 \times 10^4}{400 \times 10^4}$$

$= 0.0298$ m= 2.98 cm

$$\phi_{index} = \frac{P_e - R}{t_e}$$

Rainfall, $P_e = 4$ cm

$$\phi_{index} = \frac{4 - 2.98}{4} = 0.255\ \text{cm/hr}$$

28. Ans: 163.35 (Range 162 to 165)

Sol: $V_1 = 72$ kmph = 20 m/s

$V_2 = 54$ kmph = 15 m/s

$$(SSD)_{car1} = \nu_1 t + \frac{\nu_1^2}{2gf\eta}$$

$$= 20 \times 2.5 + \frac{20^2}{2 \times 9.81 \times 0.7 \times 0.6}$$

= 98.54 m

$$(SSD)_{car2} = \nu_2 t + \frac{\nu_2^2}{2gf\eta}$$

$$= 15 \times 2.5 + \frac{15^2}{2 \times 9.81 \times 0.7 \times 0.6}$$

= 64.81 m

∴ Total sight distance required

$= SSD_1 + SSD_2$

= 98.54 + 64.81

= 163.35 m

29. Ans: 6.75 Range: 6.50 – 7.00

Sol: Radius of Plate 'a' = $\frac{30}{2} = 15\,\text{cm}$

$$p = \frac{P}{\pi a^2} = \frac{1490}{\pi \times 15^2} = 2.108\ \text{kg/cm}^2$$

p = contact pressure

For standard plate of Dia 75 cm:

Pressure on the surface is not uniformly distributed

$$E_s = 1.18 \frac{pa}{\Delta}$$

p = pressure

$E_s = 1.18$ Ka

∴ For a given sub grade E_s is constant

∴ Ka = constant

$K_{30}.\ a_{30} = K_{75}.\ a_{75}$

$$K_{30} = \frac{p}{\Delta} = \frac{2.108}{0.125} = 16.864\ \text{kg/cm}^3$$

$$16.864 \times 15 = K_{75} \times \frac{75}{2}$$

$\Rightarrow K_{75} = 6.7456$

$K_{75} \simeq 6.75\ \text{kg/cm}^3$

30. Ans: 2 Range: No Range

Sol: Given that $f(x, y) = x^2 + 2y^2$ .... (1)

with $y - x^2 + 1 = 0$ .... (2)

From (2), we write $y = x^2 - 1$ .... (3)

Put (3) in (1), we get

$f(x, y) = x^2 + 2y^2 = x^2 + 2(x^2 - 1)^2$

$= x^2 + 2[x^4 - 2x^2 + 1]$

Let $g(x) = 2x^4 - 3x^2 + 2$

Then $g'(x) = 8x^3 - 6x$ and $g''(x) = 24x^2 - 6$

Consider $g'(x) = 0$

$\Rightarrow 8x^3 - 6x = 0$

$\therefore$ x = 0, $\frac{\sqrt{3}}{2}, \frac{-\sqrt{3}}{2}$ are stationary points.

At x = 0, $g''(0) = -6 < 0$

At x = $\pm\frac{\sqrt{3}}{2}$, $g''\left(\pm\frac{\sqrt{3}}{2}\right) = 12 > 0$

$\therefore$ x = 0 is a local point of maxima.

Hence, the maximum value of the function f(x, y) at x = 0 is

$f(x, y) = f(x, x^2 - 1) = f(0, -1) = 0 + 2[0 - 0 + 1] = 2$

31. Ans: (C)

Sol: V= 80 kmph, H_t = 3 sec

$$q = \frac{3600}{H_t} = \frac{3600}{3} = 1200 \text{ Veh / hr}$$

q = k.V

$$k = \frac{1200}{80} = 15 \text{ km / veh}$$

Distance between two vehicle

$$= \frac{1000}{K} = \frac{1000}{15} = 66.67 \text{ m}$$

32. Ans: 52.58 Range: 52 to 53

Sol: The increase stress,

$$\overline{\sigma}_o + \Delta\overline{\sigma} = 60 + 70$$

$$= 130 \text{ kN/m}^2$$

$$\Delta H = \frac{C_r.H_o}{1+e_o}\log\frac{\overline{\sigma}_c}{\overline{\sigma}} + \frac{C_c.H_o}{1+e_o}\log\frac{\overline{\sigma}_o + \Delta\overline{\sigma}}{\overline{\sigma}_c}$$

$$\Delta H = \frac{0.03\times 4000}{1+0.87}\log\frac{110}{60} + \frac{0.23\times 4000}{1+0.87}\log\left(\frac{130}{110}\right)$$

$$\Delta H = 52.58 \text{ mm}$$

33. Ans: 13.14 (Range:13.10 to 13.20)

Sol:

$$w_s = \left[w_1 - \left(\frac{V_1 - V_d}{w_d}\right)\gamma_w\right]\times 100$$

$$w_1 = \left[\frac{w - w_d}{w_d}\right] = \left[\frac{29.4 - 17.5}{17.5}\right] = 0.68$$

$$w_s = \left[0.68 - \left(\frac{19.2 - 9.6}{17.5}\right)\times 1\right]\times 100 = 13.14\%$$

34. Ans: 3.24

Sol: n_f = 4.5

n_d = 12

$$q = K.H.\frac{n_f}{n_d}$$

$= 5 \times 10^{-3} \times 10^{-2} \times 2 \times \frac{4.5}{12}$

$= 3.75 \times 10^{-5}$ cum/s/m length of the piling

$= 3.75 \times 60 \times 60 \times 24 \times 10^{-5}$

= 3.24 cum/day/m length

35. Ans: (B)

36. Ans: 1.52 Range: No Range

Sol: Consider $\int_C \bar{f}.d\bar{r} = \int_{(0,0)}^{(1,1)} \left[\sqrt{x}\,dx + \left(x + y^3\right)dy\right]$ .... (1)

Given that C: $x = t^2$, $y = t^3$, $0 \le t \le 1$
$\Rightarrow dx = 2t\,dt$, $dy = 3t^2\,dt$ .... (2)

Using (2), (1) becomes

$$\int_C \bar{f}.d\bar{r} = \int_{t=0}^{1} \left[(t)(2t)\,dt + \left(t^2 + t^9\right)\left(3t^2\right)dt\right]$$

$$\Rightarrow \int_C \bar{f}\,.\,d\bar{r} = \int_{t=0}^{1} \left[2t^2 + 3t^4 + 3t^{11}\right] dt$$

$$\Rightarrow \int_C \bar{f}\,.\,d\bar{r} = \left(\frac{2t^3}{3} + \frac{3t^5}{5} + \frac{3t^{12}}{12}\right)_0^1$$

$$\therefore \int_C \bar{f}\,.\,d\bar{r} = \left(\frac{2}{3} + \frac{3}{5} + \frac{3}{12}\right) = 1.52$$

37. Ans: (B)

Sol: Mass specific gravity, S = $\frac{\gamma_d}{\gamma_w}$

$$= \frac{1.4}{1} = 1.40$$

Readily available depth of water,

d_w = S.d [FC – OM]

$d_w = 1.40 \times 70$ [0.23 – 0.15] = 7.84 cm

Water to be applied $= \frac{d_w}{\eta_a} = \frac{7.84}{0.80} = 9.8\,\text{cm}$

38. Ans: (A)

Sol: The required MOI of the first horizontal stiffness

I = Ct_w^3

C = actual distance between vertical stiffener.

t_w = minimum thickness of web

C = 1200 mm

t = 10 mm

I = 1200 × 10^3

I = 1.2 × 10^6 mm^4

39. Ans: 12.14 Range: 12 to 13

Sol: Area of tensile steel = $4 \times \frac{\pi}{4} \times 16^2$

$= 804.25\,mm^2$

Limiting depth of neutral axis for Fe415 steel ($x_{u,lim}$)= 0.48d = 0.48 × 350 = 168mm

Actual depth of neutral axis(x_u)

0.36 f_{ck} bx_u = 0.87 f_y A_{st}

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b} = \frac{0.87 \times 415 \times 804.25}{0.36 \times 25 \times 200}$$

= 161.32 mm < $x_{u, lim}$

. Hence the section is under reinforced

Moment of resistance

= 0.36 f_{ck} bx_u (d – 0.42 x_u)

= 0.36 × 25 × 200 × 161.32(350 – 0.42 × 161.32) = 81.95 kNm

Working moment of resistance = 81.95/1.5

= 54.64kNm

Permissible service load = $\frac{54.64 \times 8}{6^2}$

= 12.14 kNm

40. Ans: 2.4 Range: 2.3 to 2.5

Sol: $\eta_0 = \frac{P}{\rho g Q H}$

$$Q = \frac{20 \times 10^6}{0.9 \times 10 \times 10^3 \times 36} = 61.728\,m^3/s$$

$$\psi = \frac{V_f}{\sqrt{2gH}}$$

$$V_f = \psi\sqrt{2gH}$$

$$= 0.6 \times \sqrt{2 \times 10 \times 36}$$

V_f = 16.099 m/s

$$Q = \frac{\pi}{4}\left(D_0^2 - D_h^2\right)V_f$$

$$\frac{D_0}{D_h} = 2.5$$

$$61.728 = \frac{\pi}{4} \times \left(D_0^2 - \frac{D_0^2}{(2.5)^2}\right) \times 16.099$$

D_0 = 2.4m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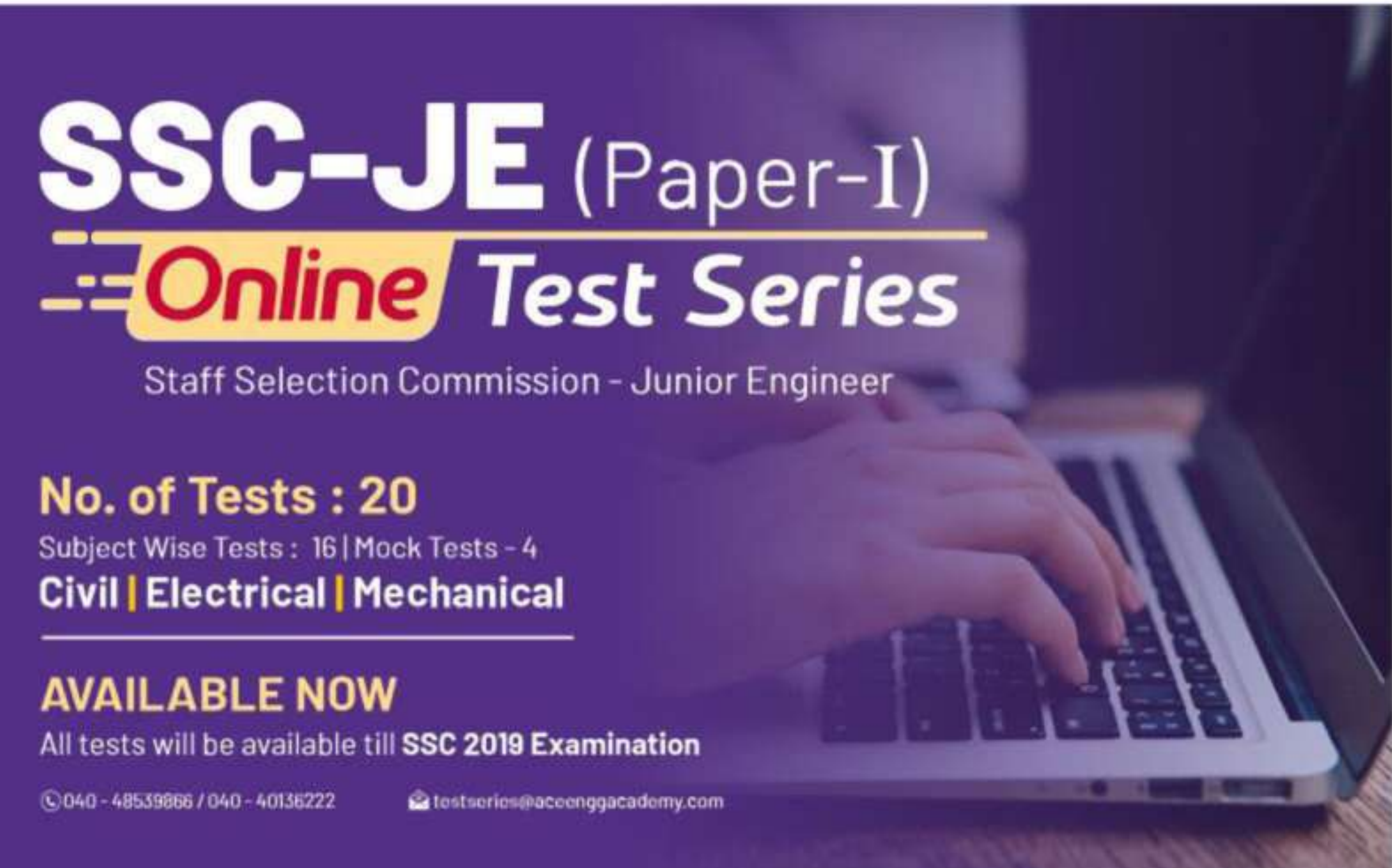
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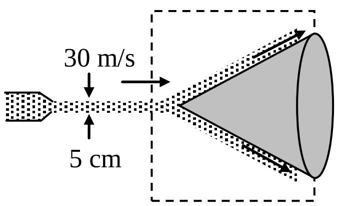
41. Ans: (A)

Sol: The mass flow rate of water jet is

$\dot{m} = \rho AV$

$$= 1000 \times \frac{\pi}{4} \times (0.05)^2 \times 30 = 58.9 \text{kg/s}$$



By momentum equation for steady flow

$F_{Rx} = \dot{m}V\cos\theta - \dot{m}V = \dot{m}V(\cos\theta - 1)$

$F_{Ry} = 0$ (Due to symmentry about x –axis)

Then $F_{Rx} = 58.9 \times 30 \times (\cos 45^o - 1)$

$= -518$ N

42. Ans: (B)

Sol: Given $\frac{d}{dx}\left(x\frac{dy}{dx}\right) = x$ .... (1)

With $y(1) = 0$ .... (2)

And $y'(1) = 0$ .... (3)

Now, integrating on both sides of (1), we get

$$x\frac{dy}{dx} = \frac{x^2}{2} + C_1$$

$\Rightarrow \frac{dy}{dx} = \frac{x}{2} + \frac{C_1}{x}$ .... (4)

Using (3), (4) becomes

$0 = \frac{1}{2} + \frac{C_1}{1}$ (or) $C_1 = \frac{-1}{2}$ .... (5)

Using (5), (4) becomes

$\frac{dy}{dx} = \frac{x}{2} - \frac{1}{2x}$

$\Rightarrow y = \frac{x^2}{4} - \frac{1}{2}\log x + c$ .... (6)

Using (2), (6) becomes

$0 = \frac{1}{4} - \frac{1}{2}(0) + C$ (or) $C = \frac{-1}{4}$ .... (7)

$\therefore$ The solution of (1) from (6) and (7) is

$y = y(x) = \frac{x^2}{4} - \frac{1}{2}\log(x) - \frac{1}{4}$

Hence, $y(2) = 1 - \frac{1}{2}\log(2) - \frac{1}{4}$

$= \frac{3}{4} - \frac{1}{2}\log(2)$

43. Ans: (A)

Sol: The spillway behaves like rectangular notch

$\therefore$ discharge per unit width

$(q)_a = \frac{2}{3} c_d \sqrt{2g} H^{3/2}$

H is head of water above crest level

$\therefore H = 153.5 - 150$

$H = 3.5$ m

$q = \frac{2}{3} \times 0.73 \times \sqrt{2 \times 9.81} \times (3.5)^{3/2}$

$q = 14.115$ m^3/sec/m

given depth at Toe is 0.44 m (y_1)

Let y be the required tail water depth then

$\frac{2q^2}{g} = y_1 y_2 (y_1 + y_2)$

$\frac{2 \times 14.115^2}{9.81} = 0.44 y_2 (0.44 + y_2)$

$y_2 = 9.39$ m

Answer can be obtained by substituting options.

44. Ans: 0.67 Range: 0.66-0.68

Sol: Freeman's formula:

$$Q = 1136\left(\frac{P}{5} + 10\right)$$

$$= 1136\left(\frac{168}{5} + 10\right)$$

= 49,529.6 lit/min

Buston's formula:

$$Q = 5663\sqrt{P}$$
$$= 5663\sqrt{168}$$
$$= 73{,}400.87 \text{ lit/min}$$

$$\frac{(Q)_{Freeman}}{(Q)_{Buston}} = \frac{49{,}529{,}6}{73{,}400{,}87} = 0.67$$

45. Ans: (A)

Sol: Average coefficient of runoff: k

$$k = \frac{\Sigma kA}{A}$$
$$= \frac{(0.87\times15)+(0.43\times18)+(0.23\times34)+(0.20\times17)+(0.15\times16)}{15+18+34+17+16}$$
$$= 0.3441$$

Rainfall intensity, $i = \frac{888}{30+45}$

$= 11.84$ mm/hr

Using Rational formula

$$Q_p = \frac{kiA}{360}$$
$$= \frac{0.3441\times11.84\times14}{360}$$
$$= 0.158 \text{ m}^3\text{/sec}$$

46. Ans: 0.11 Range: 0.1 to 0.2

Sol: Total possible outcomes for both faces even = (2, 2), (2, 4), (2, 6), (4, 2), (4, 4), (4, 6), (6, 2), (6, 4), (6, 6) = 9

Total favorable outcome for sum smaller than 6 = (2, 2)

P (sum is less than 6 given both faces are even) = $\frac{1}{9}$ = 0.11

47. Ans: (A)

Sol: $E = \frac{\sum P_i E_i}{100}$

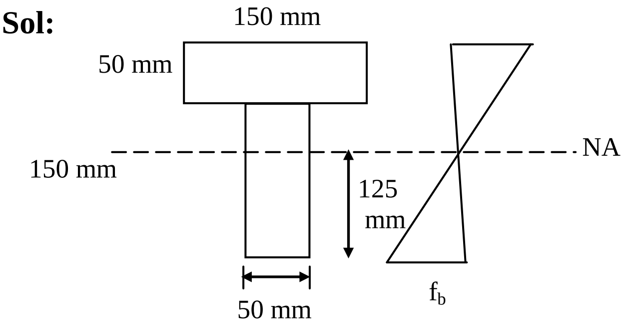
$$= \frac{(30\times6540)+(55\times17830)+(10\times7500)+(5\times21{,}300)}{100}$$

= 13,583.5 kJ/kg

48. Ans: (A)

49. Ans: (A)

Sol:



Bending stress at the bottom fibre of the beam is $f_b = \frac{M}{I}(y_b) = \frac{3400\times10^3}{5312.5\times10^4}(125)$

f_b = 8 MPa

Tensile/compressive force in the cross-section is = avg. stress ×area of the cross section below the neutral axis

$$= \left(\frac{8+0}{2}\right)(50\times125) = 25\text{ kN}$$

50. Ans: (C)

Sol: Slope at free end 'D' = slope due to loading '3P' at B + slope due to loading '2P' at C+ slope due to loading 'P' at D

$$= \frac{3PL^2}{2EI} + \frac{2P(2L)^2}{2EI} + \frac{P(3L)^2}{2EI}$$

$$= \frac{20PL^2}{2EI} = \frac{10PL^2}{EI}$$

51. Ans: (C)

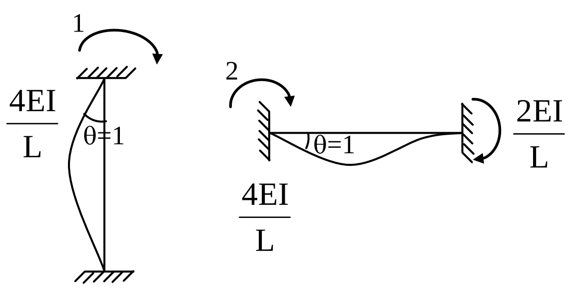
Sol: By analysis of bar chart critical path can not be found out.

The length of the bar for a particular activity has significance of time as bar chart is time scaled and the length of the bar will signify .

52. Ans: (D)

Sol: To generate stiffness matrix first fix all co ordinates

For Ist column



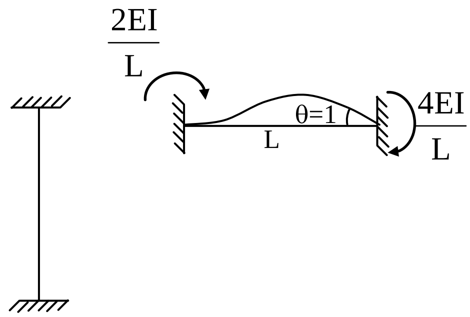
$$\therefore\ K_{11} = \frac{4EI}{L} + \frac{4EI}{L}$$

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

$K_{11} = 3.6EI$

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

For 2nd column:



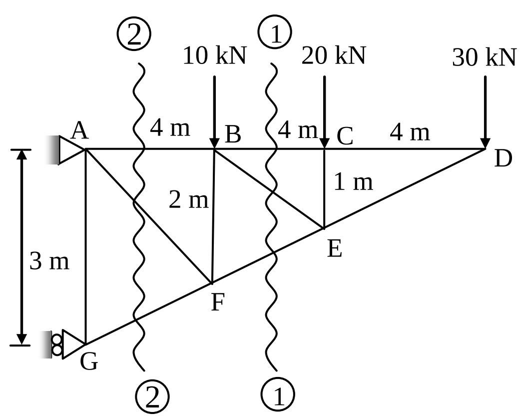
$$\therefore\ K_{12} = \frac{2E(2I)}{4} = EI$$

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

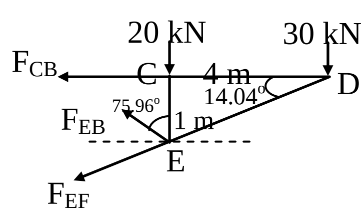
$$\therefore\ [K] = \begin{bmatrix} 3.6EI & EI \\ EI & 2EI \end{bmatrix}$$

53. Ans: (C)

Sol:



Cutting section (1) – (1)

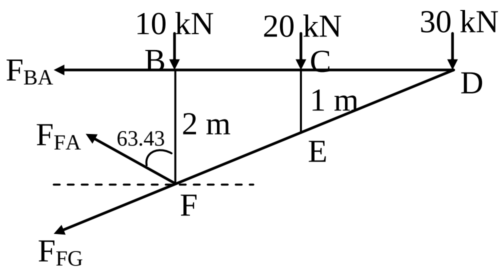


F_{EB} cos (75.96) × 4 + F_{EB} sin (75.96)× 1

= 20 × 4

or, F_{EB} = 41.23 kN (tensile)

Cutting section (2) – (2)



+□ $\Sigma M_D = 0$

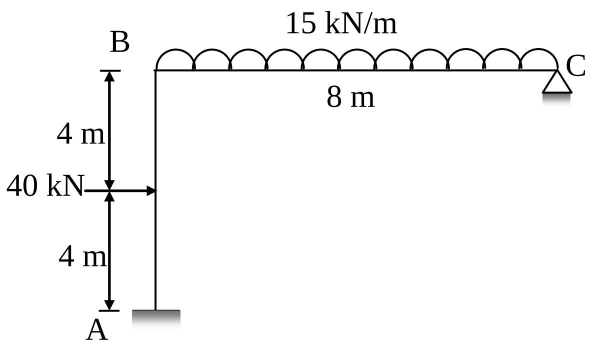
F_{FA} cos (63.43) × 8 + F_{FA} sin (63.43) × 2

= 10 × 8 + 20 × 4

or, F_{FA} = 29.81 kN (tensile)

54. Ans: (D)

Sol:



$$MF_{AB} = -MF_{BA} = -\frac{P\ell}{8} = -40\times\frac{8}{8} = -40 \text{ kNm}$$

$$MF_{BC} = -MF_{CB} = -\frac{w\ell^2}{12} = -\frac{15\times 8^2}{12} = -80 \text{ kNm}$$

$$M_{AB} = MF_{AB} + \frac{4EI}{\ell}\theta_A + \frac{2EI}{\ell}\theta_B - \frac{6EI}{\ell^2}\Delta$$

$= -40 + 0.25 \text{ EI } \theta_B \quad (\theta_A = 0, \Delta = 0)$

$$M_{BA} = 40 + \frac{4EI}{\ell}\theta_B + \frac{2EI}{\ell}\theta_A - \frac{6EI}{\ell^2}\Delta$$

$= 40 + 0.5EI\theta_B$

$$M_{BC} = MF_{BC} + \frac{4EI}{\ell}\theta_B + \frac{2EI}{\ell}\theta_C - \frac{6EI}{\ell^2}\Delta$$

$= -80 + 0.5EI\theta_B + 0.25\theta_C$

$$M_{CB} = MF_{CB} + \frac{4EI}{\ell}\theta_C + \frac{2EI}{\ell}\theta_B - \frac{6EI}{\ell^2}\Delta$$

$= 80 + 0.25EI\theta_B + 0.5EI\theta_C$

55. Ans: (C)

Sol: Weight mean

$$= 47^o 40' + \frac{40\times 1 + 38\times 2 + 37\times 2}{1+2+2}$$

$= 47^o\ 40'\ 38''$

$\therefore$ variance $\nu_1 = 47^o\ 40'\ 40' - 47^o\ 40'\ 38''$

$= 2''$

$\nu_2 = 47^o\ 40''\ 38'' - 47^o\ 40'\ 38''$

$= 0$

$\nu_3 = 47^o\ 40''\ 37' - 47^o\ 40'\ 38''$

$= -1$

Standard deviation:

$$\therefore\ \sigma_w = \pm\sqrt{\frac{\Sigma(wv)^2}{n-1}}$$

$$= \pm\sqrt{\frac{(1\times 2)^2 + (2(-1))^2}{3-1}} = \sqrt{\frac{8}{2}}$$

$= \pm\ 2''$

56. Ans: (B)

Sol: (so) is wrong because they mean the same.

57. Ans: (C)

58. Ans: (A)

59. Ans: (D)

Sol: Capacity of the tank = (12×13.5)=162 litres

Capacity of each bucket = 9 litres.
Number of buckets needed = 162/9 =18

60. Ans: (D)

Sol: Volume of Cuboid = length × breadth × height

Number of cuboids

$$= \frac{(Volume\ of\ cuboids)\ formed\ from}{(Volume\ of\ cuboids)\ taken}$$

$$= \frac{18\times15\times12}{5\times3\times2} = 108$$

61. Ans: (B)

Sol: **At the most case:** Let the numbers be {–45, 1, 1, 1, ……, 1}.

Average is 0. So, at the most 44 numbers may be > 0.

At the least case: Let the numbers be {45, –1, –1, –1, …., –1}.

Average is 0. So, at the least 1 number may be > 0.

62. Ans: (B)

Sol: Perimeter = Distance covered in 8 min.

$$= 12000 \times \frac{8}{60}\ \text{m} = 1600\ \text{m}.$$

Let length = 3x metres and breadth = 2x metres.

Then, 2(3x + 2x) = 1600 or x = 160.

∴ Length = 480 m and Breadth = 320 m

∴ Area = (480 x 320) m^2 = 153600 m^2

63. Ans: B

Sol: Consider CP as 100%.

Loss 15% ⇒ So, SP = 85%

Gain 15 % ⇒ So, New SP = 115%

Given 115% – 85% = 30% = 450

$$\frac{100}{30}\times450 = 1500$$

64. Ans: (A)

Sol: GDP at the beginning of 2013 is equal to the GDP at the end of 2012

⇒ GDP growth rate in 2012 = 7%

GDP at the end of 2011 = GDP at the beginning of 2012 = $1 trillion

∴ GDP at the beginning of 2013

$$= \frac{100+7}{100}\times1\ trillion$$

$$= \frac{107}{100} = \$1.07\ trillion$$

65. Ans: (A)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