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Memory based

Questions & Solutions

Exam held on 06/02/2021

Forenoon Session

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SECTION-A GENERAL APTITUDE

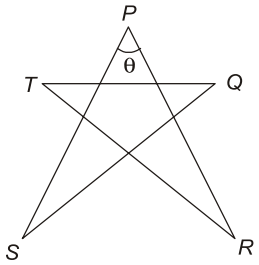
Q.1 Getting to the top is _____ than staying on top

(a) easier (b) easiest
(c) more easy (d) much easy

Ans. (a)
Easier

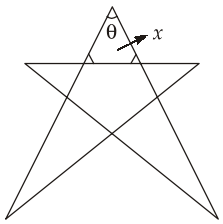
End of Solution

Q.2 In the given figure value of θ, when *PR*, *PS*, *QS*, *TR*, *TQ* are of equal length. θ = ?



(a) 36 (b) 108
(c) 72 (d) 45

Ans. 36



Sum of angle furmed at the pentagon = 540°

$$\text{Each angle of pentagon} = \frac{540}{6} = 108°$$

$$\angle x = 180 - 108 = 72°$$

Sum of angle of triangle = 180°

$$72° + 72° + \theta = 180°$$

$$\theta = 36°$$

End of Solution

Q.3 $\oplus$ and $\odot$ are two operators on numbers p and q such that $p \oplus q = \frac{p^2 + q^2}{pq}$ and $p \odot q = \frac{p^2}{q}$, if $x \oplus y = 2 \odot 2$, then $x =$ _____.

(a) y (b) $2y$

(c) $\frac{y}{2}$ (d) $\frac{3y}{2}$

Ans. (a)

$$x \oplus y = 2 \odot 2$$

$$\frac{x^2 + y^2}{xy} = \frac{2^2}{z}$$

$$x^2 + y^2 = 2xy$$

$$(x - y)^2 = 0$$

$$x = y$$

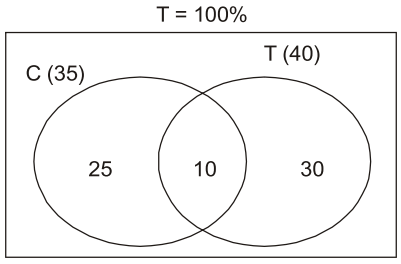
End of Solution

Q.4 In a company, 35% and the employees drink coffee, 40% drink tea and 10% drink both tea and coffee. What % of employees drink neither tea nor coffee?

(a) 25 (b) 35

(c) 40 (d) 15

Ans. (b)



Percent of employees drink neither tea nor coffee = 100 – 25 – 10 – 35 = 35

End of Solution

Q.5 Two paper M and N with same dimensions of 6 cm × 4 cm.
Operation 1: paper is folded exactly half by joining its shorter edges.
Operation 2: paper is folded half by joining its longer edges.
Now consider following:
Operation 1 done for M paper 3 times and Operation 2 done for N paper 3 times.
Find the ratio of perimeter of rectangle formed (N to M ratio).

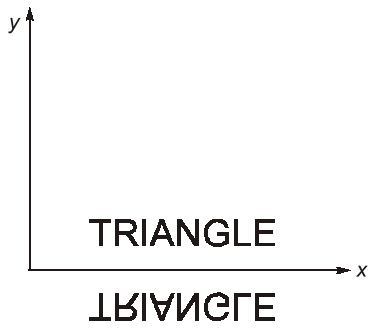
Solution:

	(6×4)	(4×6)
	↓	↓
	(3×4)	(2×6)
	↓	↓
	(1.5×4)	(1×6)
	↓	↓
	(0.75×4)	(0.5×6)
Perimeter	$= 2 \times 4.75$	$= 2\,(6.5)$
	$= 9.5$	$= 13$

End of Solution

Q.6 Find mirror image about x-axis

Solution:



End of Solution

Q.7 Either P marries Q or X marries Y. Among the option below, what is the absolute logical 'Negations' of this statement?

(a) Neither P marry Q nor X marry Y
(b) P does not marry Q and X marries Y
(c) P marries Q and X marries Y
(d) X does nor marry and P marries Q

Ans. (a)

End of Solution

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Q.8 Four persons P, Q, R and S are to be seat in a row, all are facing the same direction, but not necessary in the same order.
P and R can not seat adjacent to each other S could be seated to the right of Q. The number of distinct seating arrangement possible?

(a) 4 (b) 2
(c) 8 (d) 6

Ans. (b)

End of Solution

Q.9 $\lambda(p\,q)=\begin{cases}(p-q)^2 & p\geq q\\ p+q & p<q\end{cases}$

Calculate the value of $\dfrac{\lambda\{-(-3+2),(-2+3)\}}{\{-(-2+1)\}}$

Solution:

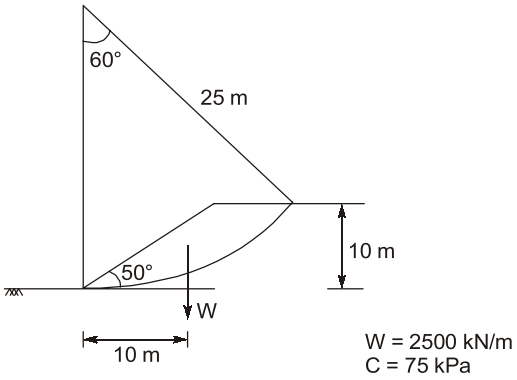
$$\frac{\lambda\{-(-3+2),(-2+3)\}}{\{-(-2+1)\}}=\lambda(1,1)=1^2-1^2=0$$

End of Solution

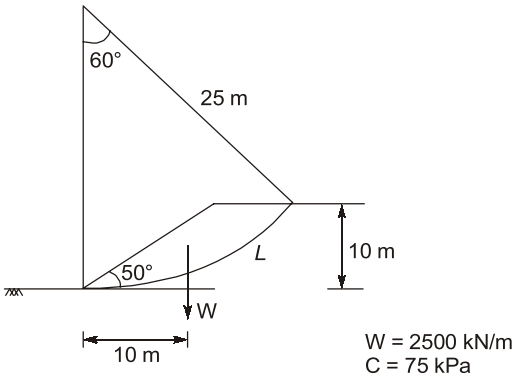
■■■■

SECTION-B TECHNICAL

Q.1 FOS = ?



Solution:



$$FOS = \frac{M_R}{M_0} = \frac{C \times L \times r}{W\bar{X}}$$

$$= \frac{Cr^2\theta}{W\bar{X}} = \frac{75 \times 25^2 \times \pi}{3 \times 2500 \times 10} = 1.96$$

End of Solution

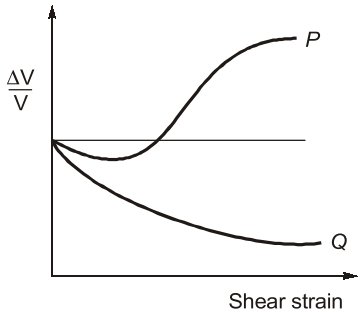
Q.2 Cohesion is equal to 30 kN/m^3, bulk density =17.5, internal friction angle 20 degree, determine the depth of unsupported cut?

Solution:

$$H_C = \frac{4C}{\gamma\sqrt{k_a}} = \frac{4 \times 30}{17.5 \times \sqrt{0.49}} = 9.79 \text{ m}$$

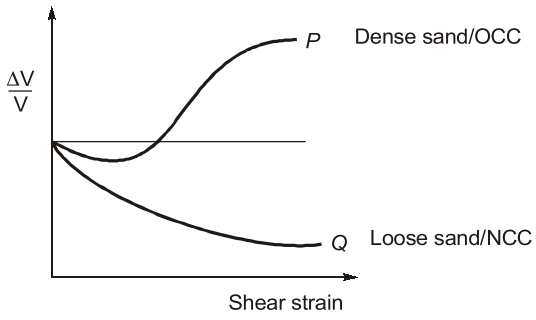
End of Solution

Q.3



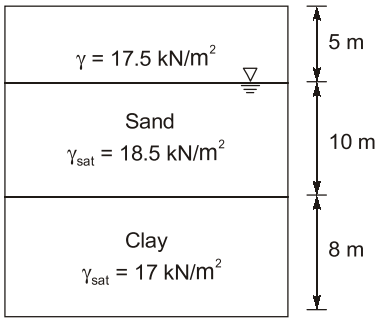
(a) P is dense over consolidated soil and Q is loose normal consolidated soil.

Solution:

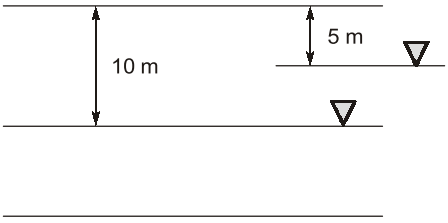


End of Solution

Q.4 Determine the over consolidation ratio at the centre of clay layer. The past watertable is 10 m below ground level and present watertable is 5 m below ground water.



Solution:



$(\bar{\sigma})_{Past} = 244.21\ kN/m^2$

$(\bar{\sigma})_{Present} = 202.66\ kN/m^2$

$$OCR = \frac{\text{Past}}{\text{Present}} = 1.2$$

End of Solution

Q.5 The bulk density of a partially saturated soil is 18.5 kN/m^3 with natural water content is 25%. The specific gravity of the soil particles is 2.65. Determine the unit weight when the soil is fully saturated. (Take γ_w = 9.81 kN/m^3)

(a) 20.12 (b) 19.03

(c) 22.12 (d) 18.64

Solution:

$$w_n = 25\%, \quad G = 2.65$$

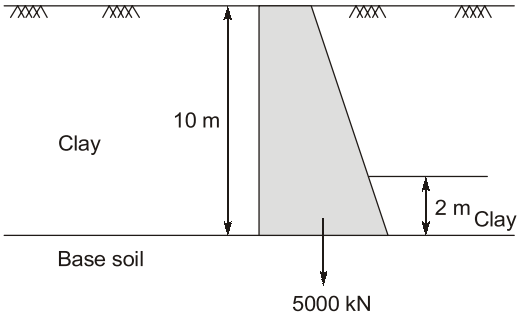
$$\gamma_b = \frac{(G+Se)}{1+e}\gamma_w \Rightarrow 18.5 = \frac{(G+wG)}{1+e}\gamma_w$$

$$e = 0.756$$

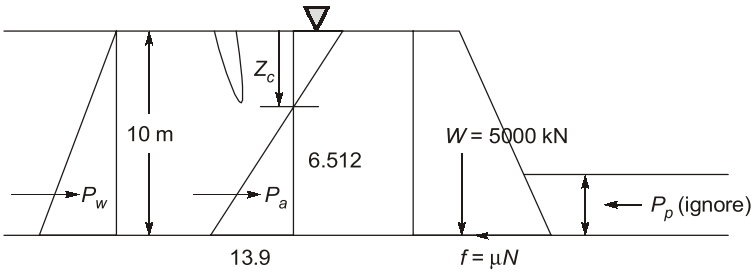
$$\gamma_{sat} = \left(\frac{G+e}{1+e}\right)\gamma_w = 19.03 \text{ kN/m}^3$$

End of Solution

Q.6 A retaining wall is having one sided field with soil of clayey soil of C_u = 30 kN/m^2 and unit weight γ = 17.2 kN/m^3 the weight of the retaining wall is 5000 kN and effective friction angle between resultant is 20°. The property of soil in downstream is same as that of upstream. Consider the tension crack is filled with water, what is the FOS against sliding.



Solution:



$$Z_c = 3.488$$

$$f = \mu N = (\tan\delta)\ W$$

$$P_w = 45.2, \quad P_w = \frac{1}{2}\gamma_w H^2 = 490.5 \text{ kN}$$

$$\text{FOS} = \frac{\mu N}{P_w + P_w} = \frac{(\tan\delta)(5000)}{45.2 + 490.5}$$

$$\text{FOS} = \frac{(\tan 20)(5000)}{45.2 + 490.5} = 3.28$$

End of Solution

Q.7 A saturated soil sample, initially acted upon by an effective pressure of 50 kPa, which was in equilibrium. After this suddenly the applied stress in increased to 150 kPa. What is the effective stress and pore water pressure?

(a) 50 kPa and 0 kPa (b) 50 kPa and 100 kPa

Ans. (b)

Stress is increased suddenly, hence entire change will be taken by water

$\Delta\bar{\sigma} = \Delta U = 100$ kPa .

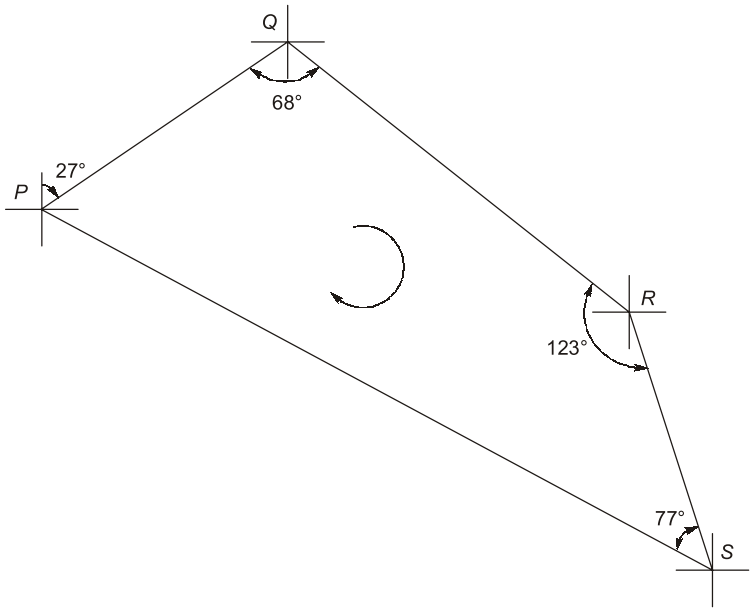
There will be no change in effective stress

$\therefore \quad \bar{\sigma} = 50$ kPa

End of Solution

Q.8 Traversing is carried out a closed traverse PQRS. The internal angles at vertices P, Q, R and S are measured 92°, 68°, 123°, 77° respectively. If F.B. of line PQ = 27°, FB of line RS =? (in degree).

Solution:



Forebearing of RS = 196° (CW)
Forebearing of RS = 218° (ACW)

End of Solution

Q.9 Which of the following options are correct?
(a) Basic principle of surveying is to work from whole to part
(b) Backbearing is equal to forebearing ±180

Solution:

End of Solution

Q.10 Calculate the effective gradient

Runway	Gradient
0-300	+1.2%
300-600	–0.7%
600-1100	+0.8%
1100-1400	–0.8%
1400-1700	–1.0%

Solution:

End of Solution

Q.11 Speed of vehicle is 80 km/hr and radius of curve 250 m if coefficient of friction fully utilized determine super elevation?

Solution:

$$v = 80 \text{ kmph}$$
$$R = 250 \text{ m}$$
$$e + f = \frac{v^2}{127R}$$
$$e + 0.15 = \frac{80^2}{127 \times 250}$$
$$e + f = \frac{v^2}{127R}$$
$$e + 0.15 = \frac{80^2}{127 \times 250}$$
$$e = 0.515 = 5.157\%$$

End of Solution

Q.12 A signalized intersection operates in two phases. The last time in 3 seconds per phase. The maximum ratios of approach flow to situation flow for the two phases are 0.37 and 0.40. The optimum cycle length using the Webster's method is

Solution:

$x = 2$, Lost time = 3 sec/Phase

Total lost time = $3 \times 2 = 6$ sec

$$\left.\begin{matrix} y_1 = 0.37 \\ y_2 = 0.40 \end{matrix}\right\}$$

$$y = 0.37 + 0.4 = 0.77$$

$$C_0 = \left(\frac{1.5L + 5}{1 - y}\right) = \left(\frac{1.5 \times 6 + 5}{1 - 0.77}\right) = 60.869 \text{ sec}$$

End of Solution

Q.13 Spot speed 40, 55, 60, 65 and 80 km/hr. Calculate space mean speed?

Solution:

$$V_s = \left(\frac{1}{\frac{1}{40} + \frac{1}{55} + \frac{1}{60} + \frac{1}{65} + \frac{1}{80}}\right)$$

$$= 56.99 \simeq 57 \text{ kmph}$$

End of Solution

Q.14 The most preferred curve for vertical alignment is

(a) Spiral

(b) Parabolic

(c) Circular (single radius)

(d) Circular (multiple radius)

Ans. **(b)**

End of Solution

Q.15 $v = 70 - 0.7K$ determine the time headway at maximum traffic volume.

Solution:

$$v = 70 - 0.7\ K$$

$$v = 70\left[1 - \frac{k}{\left(\frac{70}{0.7}\right)}\right]$$

$$v_f = 70 \text{ kmph}$$

$$K_j = \frac{70}{0.7} = 100 \text{ Veh/km}$$

$$q_{max} = \frac{1}{4} \times v_f \times K_j$$

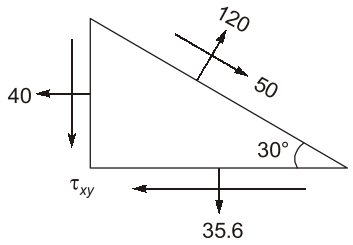
$$= \frac{1}{4} \times 70 \times 100 = 1750 \text{ Veh/hr}$$

$$q = \frac{3600}{t_h}$$

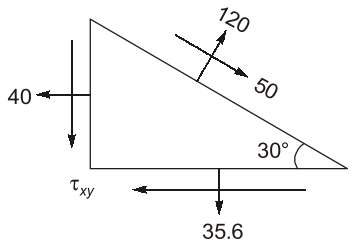
$$t_h = 2.05 \text{ sec}$$

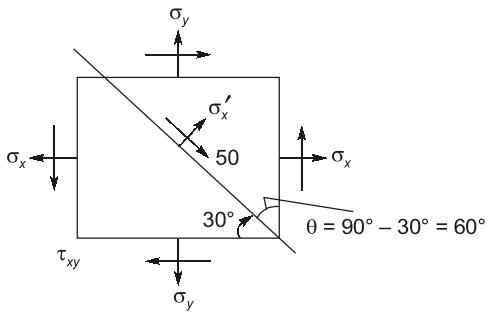
End of Solution

Q.16 Determine the absolute shear stress τ_{xy} from the given figure below:



Solution:





or $$\sigma_x' = \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta + \tau_{xy} \sin 2\theta$$

Here $\theta = 60°$

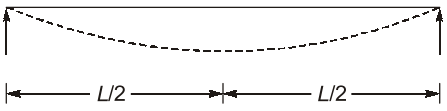
$$\sigma_x = 40 \text{ MPa}, \ \sigma_y = 35.6, \ \sigma_x' = 120, \ \tau_{x'y'} = -50$$

Substituting the values in above equation, we get

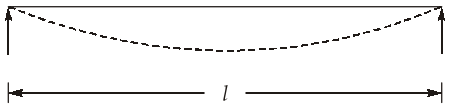
$$\tau_{xy} = 96.186 \text{ MPa}$$

End of Solution

Q.17 Find the curvature (in units) of the beam at the mid-point. The deflection equation of the beam is $y = x^2 - xl$



Solution:



Given, $y = x^2 - xl$

Curvature at mid section is $\frac{1}{R} = \frac{d^2y}{dx^2}$

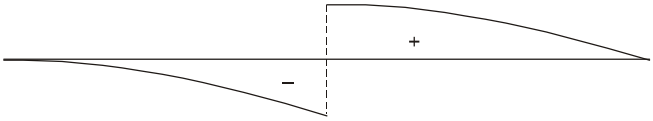
$$\frac{dy}{dx} = 2x - l$$

$$\frac{d^2y}{dx^2} = 2$$

End of Solution

Q.18 Draw ILD of shear force at G.

(a)



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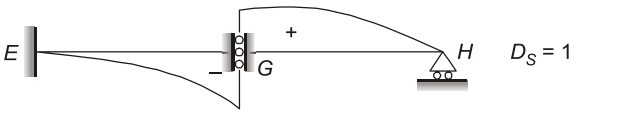
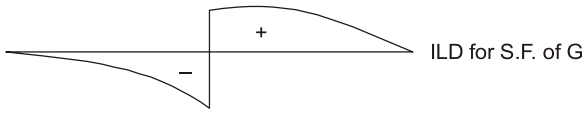
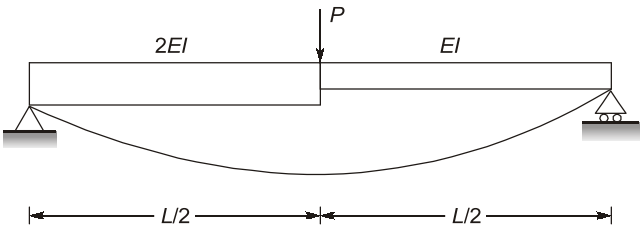




It's a curve.

End of Solution

Q.19 Find deflection under load P with stiffness method. (All values for E, I, P, L were given)



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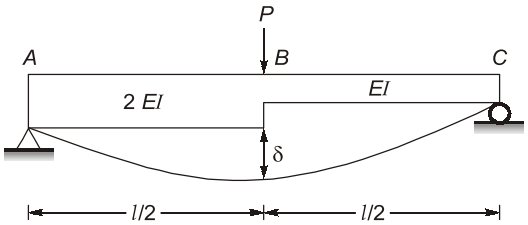
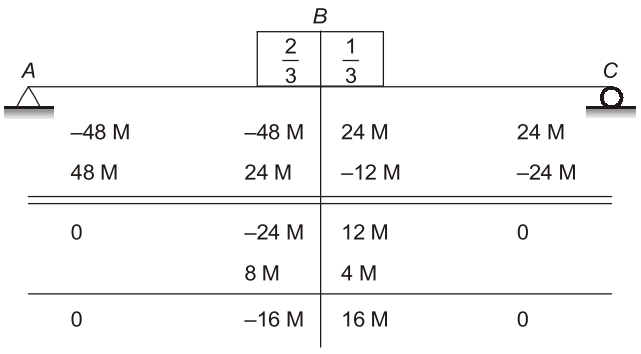


Joint	Member	R.S.	TRS	DF
B	BA	$\frac{3}{4}\cdot\frac{2I}{l/2}=\frac{3I}{l}$	$\frac{9I}{2l}$	$\frac{2}{3}$
	BC	$\frac{3}{4}\cdot\frac{I}{l/2}=\frac{3I}{2l}$		$\frac{1}{3}$

$$\overline{M_{AB}} = -\frac{6E(2I)\delta}{l^2} = -\frac{12EI\delta}{l^2/4} = -\frac{48EI\delta}{l^2} = -48 \text{ M (say)}$$

$$\overline{M_{BA}} = -48 \text{ M}$$

$$\overline{M_{BC}} = \frac{6EI\delta}{l^2/4} = \frac{24EI\delta}{l^2} = +24 \text{ M} = \overline{M_{CB}}$$



$$\Rightarrow \quad \frac{P}{2}\cdot\frac{l}{2}+M_{AB}+M_{BA}=0$$

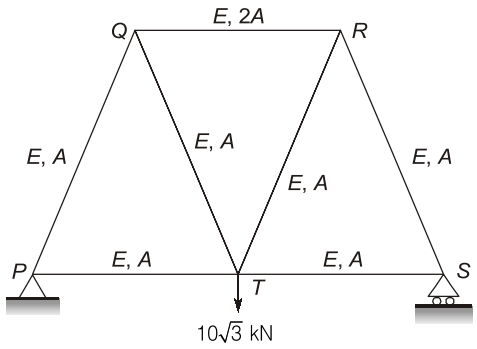
$$\Rightarrow \quad \frac{Pl}{4}+0-\frac{16EI\delta}{l^2}=0$$

$$\therefore \quad P=\frac{64EI\delta}{l^3}$$

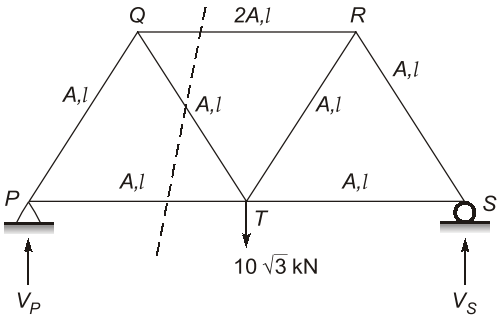
$$\Rightarrow \quad \delta=\frac{Pl^3}{64EI}$$

End of Solution

Q.20 What is the compressive stress in upper member QR? All members are of equal length.



Solution:



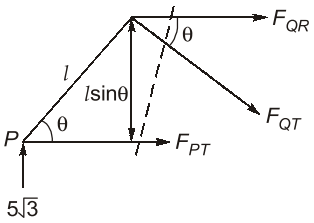
$$V_P+V_S=10\sqrt{3}$$

$$V_P\times 2l=-10\sqrt{3}l=0$$

$$\Rightarrow \quad V_P=5\sqrt{3}\text{ kN}$$

$$V_S=5\sqrt{3}\text{ kN}$$

$$\theta=60^\circ$$



$$\Sigma F_y = 0$$

$$\Rightarrow \quad F_{QT}\sin 60^\circ = 5\sqrt{3}$$

$$\Rightarrow \quad F_{QT}\cdot\frac{\sqrt{3}}{2} = 5\sqrt{3}$$

$$\Rightarrow \quad F_{QT} = 10 \text{ kN}$$

$$\Sigma M_p = 0$$

$$\Rightarrow \quad F_{QR}\,l\sin 60^\circ + F_{QT}\sin 60^\circ\, l\cos 60^\circ + F_{QT}\cos 60^\circ\, l\sin 60^\circ = 0$$

$$\Rightarrow \quad F_{QR}\cdot\frac{\sqrt{3}}{2} + 10\frac{\sqrt{3}}{2}\cdot\frac{1}{2} + 10\times\frac{1}{2}\cdot\frac{\sqrt{3}}{2} = 0$$

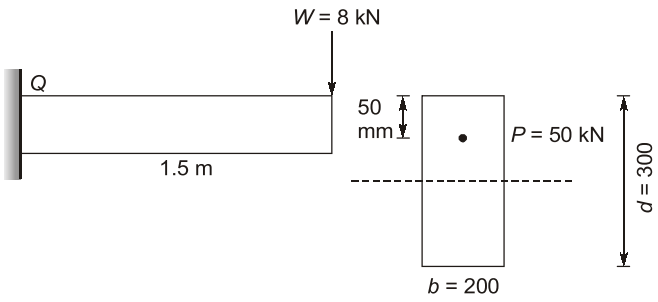
$$\Rightarrow \quad F_{QR}\frac{\sqrt{3}}{2} + 5\sqrt{3} = 0$$

$$\Rightarrow \quad F_{QR} = -10 \text{ kN}$$

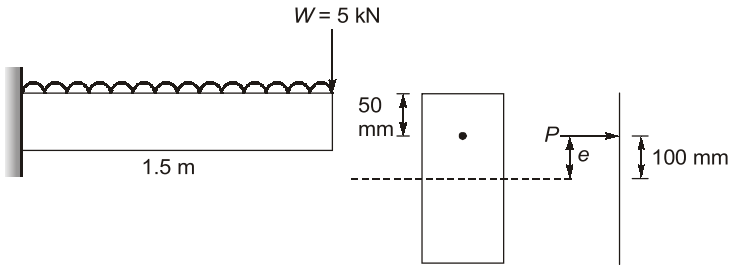
$$\Rightarrow \quad \sigma_{QR} = \frac{10}{2A} = \frac{5}{A} \text{ (Comp.)}$$

End of Solution

Q.21 The cantilever beam carries a point load 5 kN at the free end as shown below. A prestressed cable at a distance 50 mm from the top carries a prestressing force 50 kN. Determine the stress at fixed end *Q*.



Solution:



$$e = \frac{D}{2} - 50 = \frac{30}{2} - 50 = 100 \text{ mm}$$

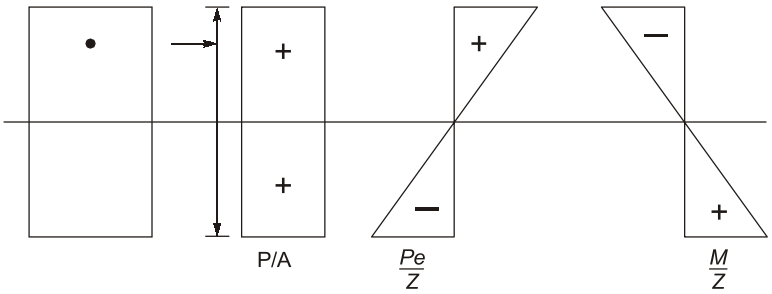
$$DL = 0.2 \times 0.3 \times 1.0 \times 25 = 1.50 \text{ kN/m}$$

$$P = 50 \text{ kN} = 50000 \text{ N}$$

$$W = 5 \text{ kN}$$

$$\text{Maximum BM} = \frac{WL^2}{2} + WL$$

$$= \frac{1.5 \times 1.5^2}{2} + 5 \times 1.50 = 9.1875 \text{ kNm}$$



$$\frac{P}{A} = \frac{50000}{200 \times 300} = 0.833 \text{ N/mm}^2$$

$$\frac{Pe}{Z} = \frac{5000 \times 100}{200 \times \frac{300^2}{6}} = 1.67 \text{ N/mm}^2$$

$$\frac{M}{Z} = \frac{9.1875 \times 10^6}{200 \times \frac{300^2}{6}} = 3.0625 \text{ N/mm}^2$$

$$\text{Stress at top} = \frac{P}{A} + \frac{Pe}{Z} - \frac{M}{Z}$$

$$= 0.833 + 1.67 - 3.0625$$
$$= -0.56 \text{ N/mm}^2$$

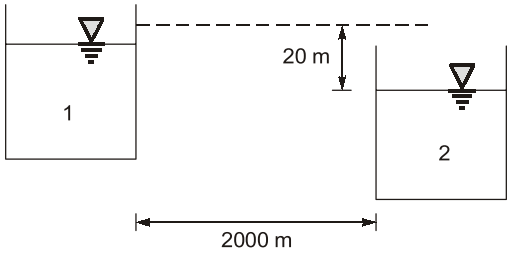
$$\text{Stress at bottom} = \frac{P}{A} - \frac{Pe}{Z} + \frac{M}{Z}$$
$$= 0.833 - 1.67 + 3.0625 = 2.2255$$
Say (2.23 N/mm^2) Maximum stress

End of Solution

Q.22 Find the time taken in days by a pollutant to reach from reservoir 1 to 2.
Given K = 25 m/per day, n = 0.3 head difference 20 m, length 2 km time taken in days

Solution:

$$k = 25 \text{ m/d}, \; n = 0.3$$



$$V = ki$$
$$V_s = \frac{V}{n}$$
$$t = \frac{l}{V_s}$$
$$i = \frac{20 \text{ m}}{2000 \text{ m}} = 0.01$$
$$t = 2400 \text{ day}$$

End of Solution

Q.23 Which of the following statements are true?
(a) Combustion is endothermic process which occur in the presence of abundant supply of oxygen.
(b) Combustion is exothermic process which occur in the absence of oxygen.
(c) Pyrolysis is endothermic process which occur in the absence of oxygen.
(d) Pyrolysis is exothermic process which occur in the absence of oxygen.

Ans. (c)

End of Solution

Q.24 Which is liquid form of air pollutants?

(a) Mist and spray
(b) Smoke and smog
(c) Mist and smog
(d) Dust

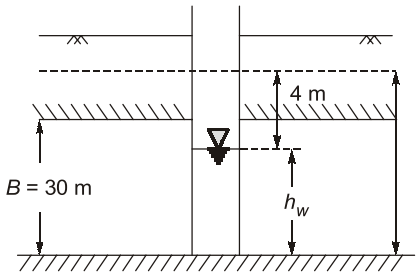
Ans. (a)

End of Solution

Q.25 Q = 40 lps
Dia. of well = 20 cm
k = 25 m/day
Constant drawdown = 4 m in 30 m
Confined aquifer hydraulic conductivity (in m/day) is

Solution:

Q = 40 lps ; Dia. of well = 20 cm ; k = 25 m/day



$$Q = \frac{2\pi kB(H - h_w)}{\ln(R/r_w)}$$

$$40 \times 10^{-3} = \frac{2 \times 3.14 \times k \times 30 \times 4}{\ln\left(\frac{245}{0.1}\right)}$$

So, $k = 4.142 \times 10^{-4}$ m/sec = 35.78 m/day

End of Solution

Q.26 Incoming discharge in PST from at in ASP = ?
Q = 12 cumecs, X = 3000 mg/l and thickning has to be done till 12000 mg/l and rate was something 3.2 m^2/h and area needed was asked.

Solution:

End of Solution

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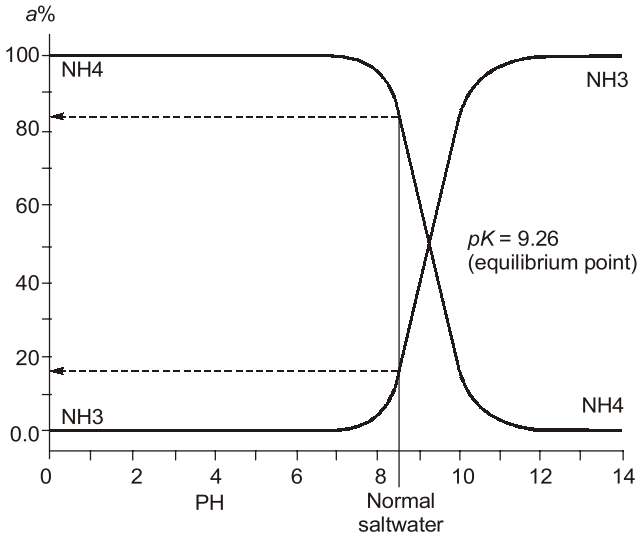
Q.27 NH_4^+ and NH_3. These are present at certain concentration
(a) (In pH = 7) then the concentration of NH_4^+ and NH_3 are the same
(b) If pH = 7 then NH_3 dominant
(c) If pH below = 9.25 then NH_4^+ dominant
(d) If pH above 9.25 then NH_4 dominant

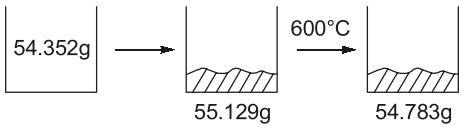
Ans. (c)



End of Solution

Q.28 50 ml volume of sample empty weight of crucible = 54.352 gm
After 100°C weight of crucible + residue is 55.129 gm
After 600°C (1 hr muffle furnace) weight of crucible + residue is 54.783 gm
Find the concentration of volatile solids in mg/*l*.

Solution:

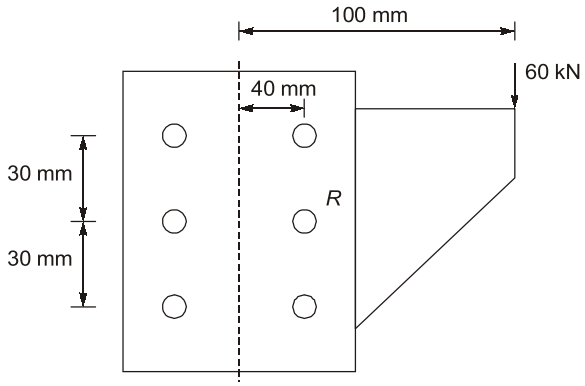


Volatiles solids weight = 55.129 – 54.783 = 0.346 gm (in 50 ml)

So, in one litre = $\frac{346}{0.05} = 6920$ mg/litre

End of Solution

Q.29 A column attached with bracket carrying a load of 60 kN. Resultant force to be found on a bolt *R*



Solution:

$$F_1 = \frac{P}{n} = \frac{60}{6} = 10 \text{ kN}$$

$$F_2 = \frac{P \cdot e}{\Sigma r_i^2} \times r_R = \frac{60 \times 100 \text{ mm}}{4 \times 50^2 + 2 \times 40^2} \times 40$$

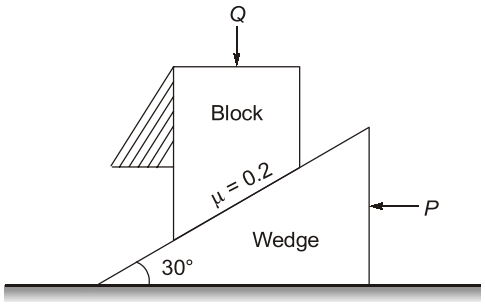
$$F_2 = \frac{60 \times 100 \times 40}{10000 + 3200} = \frac{60 \times 100 \times 40}{13200} = \frac{200}{11} \text{ kN}$$

$$F_R = F_1 + F_2$$

$$= 10 + \frac{200}{11} = \frac{310}{11} = 28.2 \text{ kN}$$

End of Solution

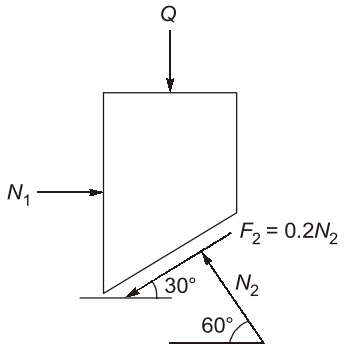
Q.30



Force *P* is sufficiently greater than *Q* then find *P* in terms of *Q* when block is just in impending motion and $P = \alpha Q$, then find α
where block and wedge has negligible weight as compared to *P* and *Q*.

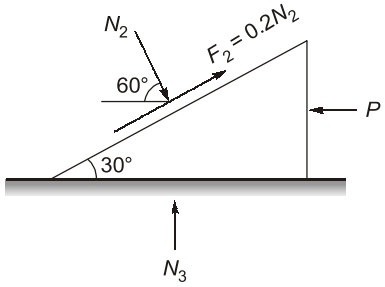
(a) $\alpha = 0.6$ (b) $\alpha = 0.8$
(c) $\alpha = 2$ (d) $\alpha = 0.9$

Solution:



$$\sum Y = 0 \Rightarrow$$
$$N_2 \sin 60° - 0.2\, N_2 \sin 30° - Q = 0$$
$$Q = 0.766\, N_2 \quad \ldots(i)$$

F.B.D. of wedge



$$\sum X = 0 \Rightarrow$$
$$0.2N_2 \cos 30° + N_2 \cos 60° - P = 0$$
$$P = 0.67\, N_2$$
$$\Rightarrow \quad P = 0.67 \times \frac{Q}{0.766}$$
$$\Rightarrow \quad P = 0.875Q \simeq 0.9Q$$
$$P = \alpha\, Q$$
$$\Rightarrow \quad \alpha = 0.9$$

End of Solution

Q.31 Gypsum is added in concrete mixture for
(a) enhancing strength
(b) increasing workability
(c) heat of hydration
(d) prevent quick setting

An.s (d)

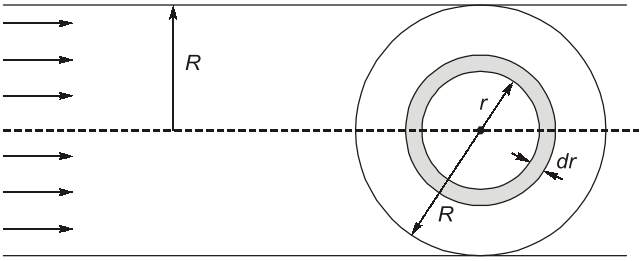
End of Solution

Q.32 A fluid flowing steadily in a circular pipe of radius R has a velocity that is everywhere parallel to the axis (center line) of the pipe. The velocity distribution at a section is $u = U\left(1-\frac{r^2}{R^2}\right)$, where r is the radial distance as measured from the pipe axis and U is the max. velocity at $r = 0$. The average velocity of the fluid in the pipe is

(a) $\frac{U}{3}$ (b) $\frac{5U}{6}$

(c) $\frac{U}{2}$ (d) $\frac{U}{4}$

Solution:



$$u = U\left(1-\frac{r^2}{R^2}\right)$$

$$\dot{m} = \int_0^R \rho(2\pi r dr)u = 2\pi\rho U\int_0^R\left(1-\frac{r^2}{R^2}\right)rdr$$

$$\rho\left(\pi R^2\right)\bar{u} = 2\pi\rho U\left[\frac{R^2}{2}-\frac{R^4}{R^2\times 4}\right]$$

$$\bar{u} = \frac{U}{2}$$

$\bar{u}$ = Mean velocity

U = Max velocity

End of Solution

Q.33 Kinematic viscosity is dimensionally represented as

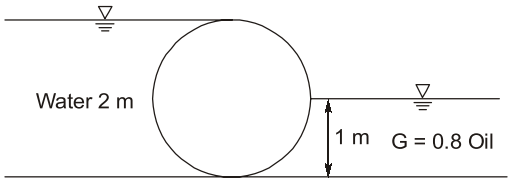
(a) $\frac{M}{L^2T}$ (b) $\frac{T^2}{L}$

(c) $\frac{L^2}{T}$ (d) $\frac{M}{LT}$

Ans. (c)

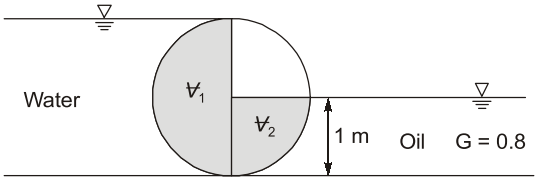
End of Solution

Q.34 For a circular cylinder of diameter 2 m, length 3 m, calculate the ratio of net vertical and horizontal forces due to liquid on cylinder. Weight of the cylinder is 25 kN.



Solution:

Net vertical force due to liquid



$$F_V = F_{V_1} + F_{V_2}$$

$$= \rho_w g \forall_1 + \rho_{oil} g \forall_2$$

$$= 10^3 \times 9.81 \times \frac{\pi (1)^2 \times 2}{2} + 800 \times 9.81 \times \frac{\pi}{4}(1)^2 \times 3$$

$$= 64.7199 \text{ kN} \uparrow$$

Net horizontal force due to liquid

$$F_H = F_{H_1} + F_{H_2}$$

$$= 10^3 \times 9.81 \left(\frac{2}{2}\right)(2 \times 3) - 8009.81 \times \frac{1}{2}(1 \times 3)$$

$$= 47.088 \text{ kN } (\rightarrow)$$

$$\frac{F_V}{F_H} = \frac{64.7199}{47.088} = 1.374$$

End of Solution

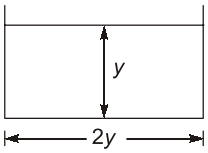
Q.35 If water is flowing at the same depth in most hydraulically efficient triangular and rectangular channel sections then the ratio of hydraulic radius of triangular section to the rectangular section is

(a) 1 (b) $\sqrt{2}$

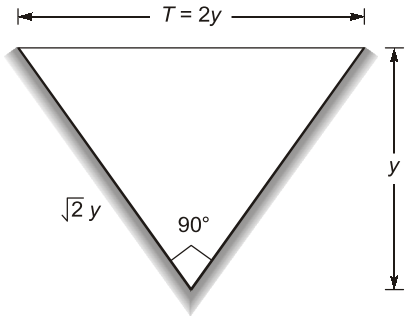
(c) $\frac{1}{\sqrt{2}}$ (d) 2

Ans. (c)

Most efficient rectangular channel



$$R = \frac{A}{P} = \frac{(2y)y}{4y} = \frac{y}{2}$$



$$R = \frac{A}{P} = \frac{\frac{1}{2} \times 2y \times y}{2\sqrt{2}\,y} = \frac{y}{2\sqrt{2}}$$

$$\frac{R_{\Delta}}{R_{\square}} = \frac{\frac{y}{2\sqrt{2}}}{\frac{y}{2}} = \frac{1}{\sqrt{2}}$$

End of Solution

Q.36 $P = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, Q \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$. Then find $Q^T.P^T$

Solution:

$$(PQ)^T = Q^T P^T$$

$$PQ = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 2 & 1 \\ 4 & 3 \end{bmatrix}$$

$$Q^T P^T = (PQ)^T = \begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix}$$

End of Solution

Q.37

x	y
0	4.1
0.5	6.3
1	2.1
1.5	4.2
2.0	3.9
2.5	4.2

Find area enclosed using Simpson's 1/3rd rule

Solution:

$$I = \int_0^{2.5} f(x)dx = \frac{h}{3}\left[y_0 + y_5 + 4(y_1 + y_3)\right] + 2(y_2 + y_4)$$

$$= \frac{0.5}{3}\left[4.1 + 4.2 + 4(6.3 + 4.2) + 2(2.1 + 3.9)\right]$$

$$= 10.38$$

End of Solution

Q.38 Using Trapezoidal's rule find $\int_0^1 e^x dx$ by dividing it into 4 equal intervals

Solution:

$$\int_0^1 e^x dx$$

Given : $n = 4,\ a = 0,\ b = 1,\ h = \frac{b-a}{x} = 0.25$

x	0	1/4	1/2	3/4	1
y	1	$e^{1/4}$	$e^{1/2}$	$e^{3/4}$	e^1

$$I = \int_0^1 e^x \cdot dx = \frac{h}{2}\left[y_0 + y_4 + 2(y_1 + y_2 + y_3)\right]$$

$$= 1.726$$

End of Solution

Q.39 Solve $\iiint 8xyz\,dV$ for limits [3, 4] × [2, 3] × [0, 1].

Solution:

$$I = \iiint 8xyz\,dv = ?$$

$$= 8\int_{x=2}^{3}\int_{y=1}^{3}\int_{z=0}^{1} xyz\,dx\,dydz$$

$$= 40 \text{ units}$$

End of Solution

Q.40 Solve the differential equation $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=0$, y(0) = 1, y(1) = 3

Solution:

$$\frac{d^2y}{dx^2}+\frac{2dy}{dx}+y=0$$

$$y(0) = 1$$
$$y(1) = 3$$
$$(D^2 + 2D + 1)y = 0$$

Auxiliary equation,

$$m^2 + 2m + 1 = 0$$
$$\Rightarrow \quad (m + 1)^2 = 0$$
$$\Rightarrow \quad m = \pm 1$$

So, $CF + PI = (C_1 + C_2 x)e^{-x}$

$$y(0) = 1 \Rightarrow C_1 = 1$$
$$y(1) = 3 \Rightarrow C_2 = 3e - 1$$

So, $y = [1 + (3e - 1)x]e^{-x}$

End of Solution

Q.41 $\lim_{x\to 1}\left(\frac{1}{\ln x}-\frac{1}{(x-1)}\right)$

Solution:

$$\lim_{x\to 1}\left[\frac{1}{\ln(x)}-\frac{1}{x-1}\right] = \lim_{x\to 1}\left[\frac{(x-1)-\ln x}{(x-1)\ln x}\right]=\frac{1}{2}$$

End of Solution

Q.42 Find the rank of $A = \begin{bmatrix}1 & 2 & 2 & 3\\ 3 & 4 & 2 & 5\\ 5 & 6 & 2 & 7\\ 7 & 8 & 2 & 9\end{bmatrix}_{4\times 4}$

Solution:

$R_2 \to R_2 \to 3R_1$
$R_3 \to R_3 \to 5R_1$

$$\begin{bmatrix}1 & 2 & 2 & 3\\ 0 & -2 & -4 & -4\\ 0 & -4 & -8 & -8\\ 0 & -6 & -12 & -12\end{bmatrix}$$

$R_3 \rightarrow R_3 \rightarrow 2R_2$
$R_4 \rightarrow R_4 \rightarrow 3R_2$

$$\begin{bmatrix} 1 & 2 & 2 & 3 \\ 0 & -2 & -4 & -4 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$p(A) = 2$

End of Solution

■■■■