MADE EASY

GATE 2024

CIVIL ENGINEERING

Exam held on
04/02/2024
(Afternoon Session)

Memory based
Questions & Solutions

Corporate Office : 44-A/1, Kalu Sarai, New Delhi - 110016
MADE EASY Centres : • Delhi • Hyderabad • Bhopal • Jaipur • Pune • Kolkata
9021300500
www.madeeasy.in

SECTION - A GENERAL APTITUDE

Q.1 If the sum of the first 20 consecutive positive odd number is divided by 20^2, the result is

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

(c) 1 (d) 20

Ans. (c)

The sum of first n odd natural number = n^2

$\therefore$ Result is $\frac{20^2}{20^2} = 1$

End of Solution

Q.2 The ratio of the number of girls to boys in class VIII is the same as the ratio of the number of boys to girls in class IX. The total number of students in class VIII and IX is 450 and 360 respectively. If the number of girls in classes VIII and IX is the same, then the number of girls in each class is

(a) 175 (b) 150

(c) 200 (d) 250

Ans. (c)

	Class VIII	Class IX
Total students	450	360
Number of girls	G	G
Number of boys	450 – G	360 – G

According to question,

$$\frac{G}{450-G} = \frac{360-G}{G}$$

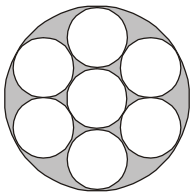
$$G^2 = 360 \times 450 - 450\,G - 360\,G + G^2$$

$$810\,G = 360 - 450$$

$$G = \frac{360 \times 450}{810} = 200$$

End of Solution

Q.3 Seven identical cylindrical chalks sticks are fitted tightly in a cylindrical container.



The length of the container is equal to the length of the chalk sticks. The ratio of the occupied space to the empty space of the container is

(a) $\frac{9}{2}$ (b) 3

(c) $\frac{7}{2}$ (d) $\frac{5}{2}$

Ans. **(c)**

Volume of outer cylinder = $\pi R^2 h$

Volume of smaller cylinder = $\pi r^2 h$

$R = 3r$

Ratio of occupied space to empty space

$$= \frac{7 \times \pi r^2 h}{9\pi r^2 h - 7 \times \pi r^2 h} = \frac{7}{2}$$

End of Solution

Q.4 A student was supposed to multiply real number R with another positive real number q. Instead, the student divided R by q the percentage error in the student's answer is 80%, the value of q is

(a) $\sqrt{2}$ (b) $\sqrt{5}$

(c) 5 (d) 2

Ans. **(b)**

$$\frac{R \times q - \frac{R}{q}}{R \times q} = \frac{80}{100} = \frac{4}{5}$$

$$\frac{Rq - \frac{R}{q}}{Rq} = \frac{4}{5}$$

$$1 - \frac{1}{q^2} = \frac{4}{5}$$

$$\frac{1}{q^2} = \frac{1}{5}$$

$$q = \sqrt{5}$$

End of Solution

Q.5 Arrange in same order :

Drizzle → Rain → Downpour

? → Quarrel → Feud

(a) Bicker (b) Beg

(c) Pither (d) Dedge

Ans. (a)

Bicker → To argue about un-important thing or issue

Quarrel → Angry, argument or diagreement

Feud → Angry or serious argument between two people that continues for long period of time.

End of Solution

Q.6 Consider the following statements and conclusions:

Statement-1: All heroes are winners.

Statement-2: All winners are lucky people.

Conclusion-1: All lucky people are heroes.

Conclusion-2: Some lucky people are heroes.

Conclusion-3: Some winner are heroes.

Which of the following statement is correct?

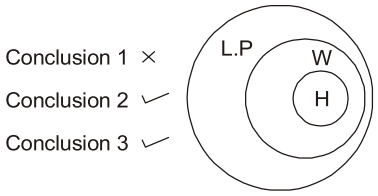
(a) Conclusion 1 and Conclusion 2 only

(b) Conclusion 2 and Conclusion 3 only

(c) Conclusion 1 and Conclusion 3 only

(d) Conclusion 1, 2 and 3

Ans. (b)



End of Solution

■■■■

MADE EASY

Announcing

FOUNDATION COURSE

For ESE+GATE 2025 • GATE 2025

The foundation batches are taught comprehensively which cover the requirements of all technical-syllabus based examinations.

- Classes by experienced & renowned faculties.
- Similar teaching pedagogy in offline & online classes.
- Systematic subject sequence.
- Efficient teaching with comprehensive coverage.
- Exam oriented learning ecosystem.
- Interaction facility for doubt removal.
- Time bound syllabus completion.
- Concept of problems solving through workbooks.
- Comprehensive & updated study material.
- Regular performance assessment through class tests.

OFFLINE BATCHES AT DELHI

Commencing from

- **CE :** 15th Feb & 26th Feb
- **ME :** 15th Feb & 29th Feb
- **EE, EC & IN :** 15th Feb & 29th Feb
- **CS :** 15th Feb & 5th Mar

www.madeeasy.in 9021300500

LIVE-ONLINE BATCHES

Commencing from

Evening Batches : Hinglish
- **CE :** 20th Feb • **ME :** 20th Feb
- **EE/EC/IN :** 20th Feb
- **CS :** 20th Feb

Evening Batches
English : 20th Feb

Morning Batches
Hinglish : 22nd Feb
Stream : CE

www.madeeasyprime.com 9021300500

Low Cost EMI Facility Available **Admissions open**

Delhi Centre : 44-A/1, Kalu Sarai, Near Hauz Khas Metro Station, New Delhi - 110016 | **Ph :** 9021300500

MADE EASY Centres : Delhi | Bhopal | Hyderabad | Jaipur | Kolkata | Pune www.madeeasy.in

SECTION - B TECHNICAL

STEEL

Q.1 The structural design method that does not take into account the safety factors on the design loads is

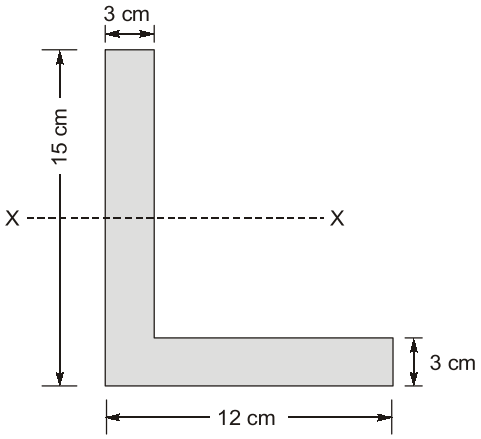
(a) Load factor method
(b) Working stress method
(c) Ultimate load method
(d) Limit load method

Ans. (b)

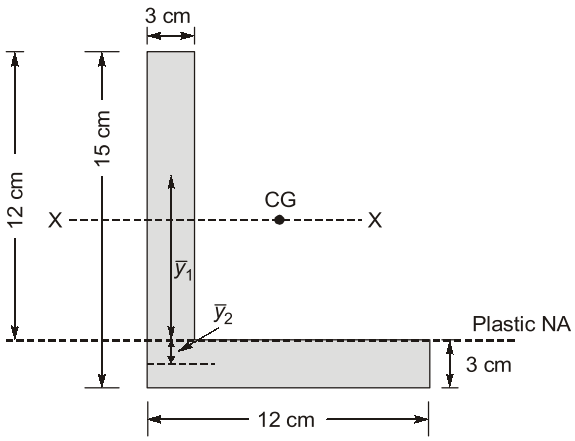
Working stress method.

End of Solution

Q.2 Find the shape factor of section shown below, if elastic section modulus of section is 150.92 cm^3.



Ans. (1.789)



Gross area, Area = $b_e t$
= (15 + 12 – 3) × 3
= 72 cm^2

Location of plastic neutral axis

$$A_1 = A_2 = 36 \text{ cm}^2$$

where A_1 is the area above plastic N.A. and A_2 is the area below plastic N.A.

$$\therefore \quad Z_{Px} = \frac{A}{2}(\bar{y}_1 + \bar{y}_2) = \frac{72}{2}\left(6 + \frac{3}{2}\right)$$

$$= 270 \text{ cm}^3$$

$$\Rightarrow \quad \text{Shape factor, S.F.} = \frac{Z_P}{Z_e} = \frac{270}{150.92} = 1.789$$

End of Solution

TRANSPORTATION

Q.3 In general, the outer edge is raised above the inner edge in horizontal curve for

(a) highway only
(b) high railway and taxiway
(c) railways and taxiways only
(d) highways and railways only

Ans. **(d)**

In highways and railways, the outer edge is raised above the inner edge in horizontal curve.

End of Solution

Q.4 Maximum stress combination for rigid pavement in summer at night

(a) $(\text{Load + Warping})_{\text{corner}}$
(b) $(\text{Load + Warping + Friction})_{\text{edge}}$
(c) $(\text{Load + Warping + Friction})_{\text{corner}}$
(d) $(\text{Load + Warping – Friction})_{\text{edge}}$

Ans. **(a)**

During summer at night, maximum streess combination occur due to load and warping stresses at corner.

End of Solution

Q.5 The consolidated data of a spot speed study for a certain stretch of a highway is given in the table:

Speed range (kmph)	Number of observations
0 - 10	7
10 - 20	31
20 - 30	76
30 - 40	129
40 - 50	104
50 - 60	78
60 - 70	29
70 - 80	24
80 - 90	13
90 - 100	9

The "upper speed limit" (in kmph) for the traffic sign is

(a) 70
(b) 65
(c) 55
(d) 50

Ans. (c)

Speed range (kmph)	Number of observations	Cumulative number of Vehicles	Cumulative %age Passed
0 - 10	7	7	1.4%
10 - 20	31	38	7.6%
20 - 30	76	114	22.8%
30 - 40	129	243	48.6%
40 - 50	104	347	69.4%
50 - 60	78	425	85%
60 - 70	29	454	90.8%
70 - 80	24	478	95.6%
80 - 90	13	491	98.2%
90 - 100	9	500	100%
	$\Sigma N = 500$		

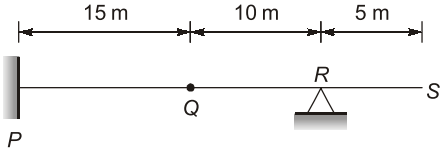
Upper speed limit is corresponding to 85% of cumulative vehicles passed.

$\therefore$ Upper speed limit $= \dfrac{50+60}{2} = 55$ kmph

End of Solution

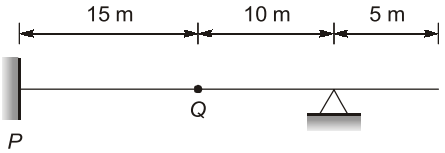
STRUCTURAL ANALYSIS

Q.6 The horizontal beam PQRS shown in the figure has a fixed support at point P, an internal hinge at point Q, and a pin support at point R. A concentrated vertically downward load (V) of 10 kN can act at any point over the entire length of the beam.

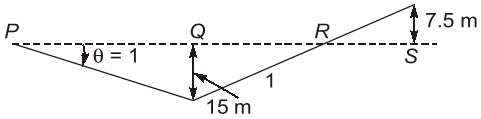


The maximum magnitude of the moment reaction (in kN. m) that can act at the support P due to V is _____ (in integer)

Ans. (150)



ILD for moment at P,



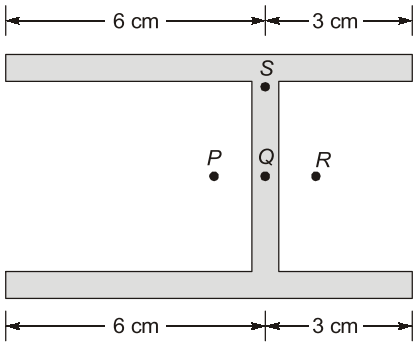
$\therefore$ Maximum moment at P will be when load is at Q,

$\Rightarrow$ $(BM)_{max} = 10 \text{ kN} \times 15 \text{ m} = 150 \text{ kN-m}$

End of Solution

STRENGTH OF MATERIALS

Q.7 What is position of shear centre?



(a) P (b) Q
(c) R (d) S

Ans. (c)
Position of shear centre will be at *R*.

End of Solution

Q.8 A homogenous, prismatic, linearly elastic steel bar fixed at both the ends has a slenderness ratio (l/r) of 105, when L is the length and r is the radius of gyration. The coefficient of thermal expansion of steel is $12 \times 10^{-6}/°C$. Consider the effective length of the steel bar or 0.5 l and neglect the self weight of the bar.
The differential increase in temperature at which the bar buckle is
(a) 85°C (b) 298°C
(c) 400°C (d) 250°C

Ans. (b)

$$\frac{Pe}{A} = \alpha \Delta T E$$

$$\frac{\pi^2 E}{\lambda^2} = \alpha \Delta T E$$

$$\Rightarrow \quad \Delta T = \frac{\pi^2}{\alpha \cdot \lambda^2} = \frac{\pi^2}{\alpha\left[\frac{0.5L}{R}\right]^2} \qquad \left[\because \lambda = \frac{L}{R}\right]$$

$$= \frac{\pi^2}{12\times10^{-6}\times[0.5\times105]^2} = 298°C$$

End of Solution

MADE EASY

TABLET COURSE

MADE EASY Tablet Courses for ESE and GATE provides the flexibility to study anywhere, anytime, as it does not require internet access. Simply turn on the tablet, and you are ready to commence your preparation. This course comes in a 10.5 inch Android OS (Operating System) based Samsung tablet. Utilize this tablet to access the course content. Printed study materials will be sent to your door step. An added advantage of this course is that after completing the program, students can send the tablet to the MADE EASY Corporate Office for a reset, making it available for their further use.

- **GATE Exclusive** • CE, ME, EE : 800 to 900 Hrs. • EC, IN, CS : 650-700 Hrs.
- **GATE + ESE** • CE, ME, EE, EC : 1100 to 1200 Hrs.
- **GATE + SES-GS** • CE, ME, EE : 1150 to 1250 Hrs. • EC, IN, CS : 950-1050 Hrs.
- **GATE + ESE + SES-GS** • CE, ME, EE, EC : 1450 to 1550 Hrs.

Note : SES-GS : General Studies for State Engineering Services Examination.

- The course is offered with a validity of 2 years.

www.madeeasyprime.com

RECORDED COURSE

Our Recorded Video Courses for ESE & GATE, allow you to commence your exam preparation anytime, anywhere. The recorded videos are accessible on devices such as desktops, laptops, and mobiles. Our offerings include a Windows-based application for desktops/laptops, as well as dedicated Android and iOS apps. This flexibility ensures that you can pursue your dream of success while fitting your study schedule into your lifestyle.

- **GATE Exclusive** • CE, ME, EE : 800 to 900 Hrs. • EC, IN, CS, CH : 650-700 Hrs.
- **GATE + ESE** • CE, ME, EE, EC : 1100 to 1200 Hrs.
- **GATE + SES-GS** • CE, ME, EE : 1150 to 1250 Hrs. • EC, IN, CS, CH : 950-1050 Hrs.
- **GATE + ESE + SES-GS** • CE, ME, EE, EC : 1450 to 1550 Hrs.

Note : SES-GS : General Studies for State Engineering Services Examination.

- The course is offered with a validity options of 1 year and 2 years.

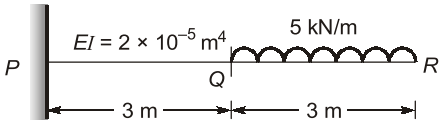
www.madeeasyprime.com

Low Cost EMI Facility Available

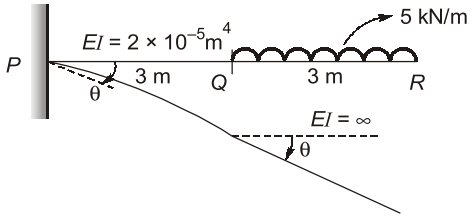
Delhi Centre : 44-A/1, Kalu Sarai, Near Hauz Khas Metro Station, New Delhi - 110016 | **Ph :** 9021300500

MADE EASY Centres : Delhi | Bhopal | Hyderabad | Jaipur | Kolkata | Pune www.madeeasy.in

Q.9 Find deflection at 'Q' for beam shown in figure below if portion QR of the beam is rigid.



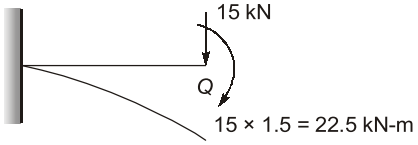
Ans. (1.18)



∴ QR will remain straight

[Transferring UDL to point load and moment at Q]

From principle of superposition,

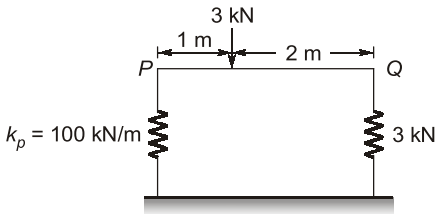


Deflection at Q, $\delta_Q = \frac{PL^3}{3EI} + \frac{ML^2}{2EI}$

$$= \frac{15\times3^3}{3\times2\times10^{-5}} + \frac{22.5\times3^2}{2\times2\times10^{-5}} = 1.18 \text{ m}$$

End of Solution

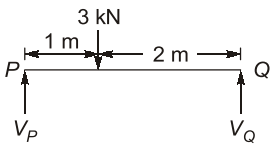
Q.10 Find the value of stiffness in spring at 'Q'.



Ans. (50)

Let V_P and V_Q be forces in spring and stiffness of spring at Q is k_Q.

From equilibrium equations,



$$\Sigma F_y = 0$$

$$V_P + V_Q = 3$$

Also, $\Sigma M_P = 0$

$\Rightarrow$ $V_Q \times 3 - 3 \times 1 = 0$

$\Rightarrow$ $V_Q = 1$ kN and $V_P = 2$ kN

Now, $\delta_P = \delta_Q$

$\Rightarrow$ $\frac{2}{100} = \frac{1}{k_Q}$

$\Rightarrow$ $k_Q = 50$ kN/m

End of Solution

RCC

Q.11 A simply supported uniformly loaded two-way slab is torsionally restrained. The effective span lengths along the short span (X) and long span (Y) directions of the panel are l_x and l_y respectively. The design moments for the reinforcement along the X and Y directions are Mu_x and Mu_y, respectively. By using Rankine Grashoff method the ratio $\frac{Mu_x}{Mu_y}$ is proportional to

(a) $\frac{l_y}{l_x}$ (b) $\frac{l_x}{L_y}$

(c) $\left(\frac{L_x}{L_y}\right)^2$ (d) $\left(\frac{L_y}{L_x}\right)^2$

Ans. **(d)**

By Rankine Grashoff method,

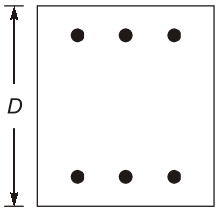
$$Mu_x = \frac{r^4}{1+r^4} w_u \times \frac{L_x^2}{8}$$

$$Mu_y = \frac{1}{1+r^4} w_u \times \frac{L_y^2}{8}$$

Now, $$\frac{Mu_x}{Mu_y} = r^4 \cdot \frac{L_x^2}{L_y^2} = \left(\frac{L_y}{L_x}\right)^4 \times \left(\frac{L_x}{L_y}\right)^2 = \left(\frac{L_y}{L_x}\right)^2$$

End of Solution

Q.12 A rectangular column is loaded such that no tension is developed along the cross-section. If depth of neutral axis is equal to 1.1 times D, then find the maximum compressive strain.



Ans. **(3.27×10^{-3})**

$\varepsilon_{c,\,max} = 0.0035 - 0.75\,\varepsilon_{c,\,min}$

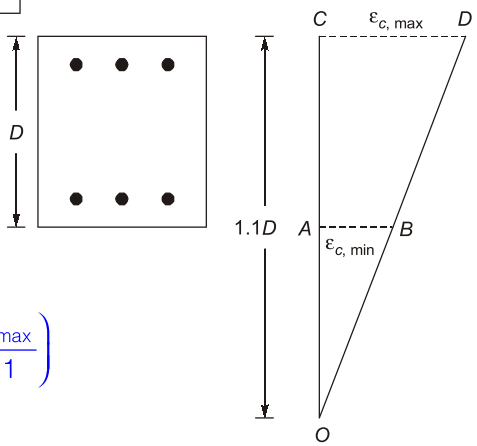
From similar Δ, ΔOAB and ΔOCD,

$$\frac{\varepsilon_{c,min}}{0.1D} = \frac{\varepsilon_{c,max}}{1.1D}$$

$$\Rightarrow \quad \varepsilon_{c,\,min} = \frac{\varepsilon_{c,max}}{11}$$

$$\Rightarrow \quad \varepsilon_{c,\,max} = 0.0035 - 0.75\left(\frac{\varepsilon_{c,max}}{11}\right)$$

$$\Rightarrow \quad \varepsilon_{c,\,max} = 3.27 \times 10^{-3}$$



End of Solution

RAILWAY, AIRPORT, BMC

Q.13 A horizontal curve of radius 1060 m (with transition curves on either side) in a broad gauge railway track is designed and constructed for an equilibrium speed of 70 kmph. However, a few years after construction, the railways authorities decided to run express trains on this track. The maximum allowable cant deficiency is 10 cm.
The maximum restricted speed (in kmph) of the express train running on this track is _____. (Rounded off to nearest integer)

Ans. (112.21)

Radius of curve, $R = 1060$ m
Equilibrium speed, $V_{avg.} = 70$ km/h
Gauge distance, $G = 1.75$ m
Cant deficiency, $C.D = 10$ cm
Now, theoretical cant, $e_{Theor.} = e_{act.} + CD$

$$\Rightarrow e_{Theor.} = \frac{GV_{avg.}^2}{127R} + CD$$

$$\frac{GV_{max}^2}{127\times1060} = \frac{1.75\times70^2}{127\times1060} + 0.10 \text{ where } V_{max} \text{ is maximum speed}$$

$$\Rightarrow \frac{GV_{max}^2}{127R} = 0.16369$$

$$\Rightarrow \frac{1.75V_{max}^2}{127\times1060} = 0.16369$$

$$\Rightarrow V_{max} = 112.21 \text{ km/h}$$

End of Solution

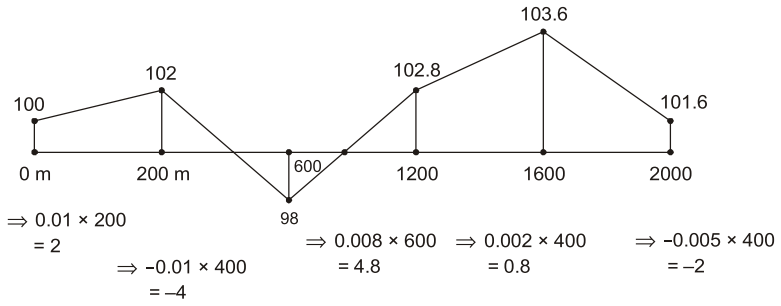
Q.14 The longitudinal section of a runway have gradients as shown in the table:

End to end for section of runway (m)	Gradient (%)
0 to 200	+1.0
200 to 600	–1.0
600 to 1200	+0.8
1200 to 1600	+0.2
1600 to 2000	–0.5

Consider the reduce level (RL) at the starting point of runway as 100 m. The gradient of the runway is

(a) 0.18%
(b) 0.35%
(c) 0.28%
(d) 0.02%

Ans. (c)



$$\text{Gradient} = \frac{\text{Highest elevation} - \text{Lowest elevation}}{\text{Length}}$$

$$= \frac{103.6 - 98}{2000} \times 100 = 0.28\%$$

End of Solution

OPEN CHANNEL FLOW

Q.15 A rectangular channel is 4.0 m wide and carries a discharge of 2.0 m^3/s having a depth of 0.4 m. The channel transitions to a maximum width contraction at a downstream location without influencing the upstream flow condition. The width (in meter) at the maximum contraction is _____.

Ans. (3.533)

Width of channel, $B = 4$ m

Discharge, $Q = 2$ m^3/s

Depth of flow, $y = 0.4$ m

Now, $$E_1 = y_1 + \frac{V^2}{2y} = y_1 + \frac{Q^2}{2gA^2}$$

$$= 0.4 + \frac{(2)^2}{2 \times 9.81 \times (4 \times 0.4)^2} = 0.4796 \text{ m}$$

At maximum contraction

$\Rightarrow$ $E_1 = E_{min} = 1.5y_c$

where y_c is depth at section of critical maximum contraction

$0.4796 = 1.5\ y_c$

$y_c = 0.3197$ m

Now, $$\left(\frac{q^2}{g}\right)^{1/3} = 0.3197$$

$\Rightarrow$ $$\left(\frac{q^2}{9.81}\right)^{1/3} = 0.3197$$

$\Rightarrow$ $q = 0.566$ $m^3/s/m$

Now, $\frac{Q}{B_{min}} = 0.566$

where, B_{min} is width at maximum contraction section.

$\Rightarrow B_{min} = \frac{2}{0.566} = 3.533\ m$

Alternatively,

$$B_{min} = \sqrt{\frac{27Q^2}{8gE_1^3}}$$

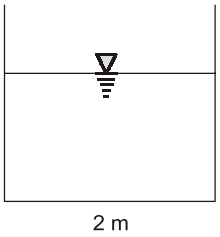
Where, $E_1 = 0.4796\ m$

So, $B_{min} = \sqrt{\frac{27\times 2^2}{8\times 9.81\times 0.4796^3}} = 3.53\ m$

End of Solution

Q.16 A 2 m wide rectangular channel is carrying a distance of 30 m^3/s at a bed slope of 1 in 300. Assuming the energy correction factor as 1.1 and acceleration due to gravity as 10 m/s^2, the critical depth of flow (in metres) is _____. (Rounded off to 2 decimal places)

Ans. **(2.914)**



Discharge, $Q = 30\ m^3/s$

$g = 10\ m/s^2$

Width of channel, $B = 2\ m$

Now, Discharge intensity, $q = \frac{Q}{B} = \frac{30}{2} = 15\ m^3/s/m$

Now critical energy, E_c is given as

$$E_c = y_c + \alpha\cdot\frac{v^2}{2g}$$

$$\Rightarrow E_c = y_c + \alpha\cdot\frac{q^2}{2g\cdot y_c^2}$$

$$\Rightarrow 1.5y_c = y_c + \alpha\cdot\frac{q^2}{2g\cdot y_c^2}$$

$$\Rightarrow 0.5y_c = \alpha\cdot\frac{q^2}{2g\cdot y_c^2}$$

$$\Rightarrow y_c^3 = \alpha\cdot\frac{q^2}{g}$$

$$\Rightarrow y_c = \left(\frac{\alpha\cdot q^2}{g}\right)^{1/3}$$

$$\Rightarrow y_c = \left(\frac{1.1\times 15^2}{20}\right)^{1/3} = 2.914\ m$$

Alternatively,

At critical condition,

$$\frac{\alpha Q^2}{g} = \frac{A_c^3}{T_c}$$

Where, A_c = Critical area of flow = (By_c) = $2y_c$

T_c = Critical top width = B = 2 m

$$\Rightarrow \quad \frac{1.1\times 30^2}{10} = \frac{(2y_c)^3}{2}$$

$$\Rightarrow \quad \frac{1.1\times 30^2}{40} = y_c^{\,3}$$

$$\Rightarrow \quad y_c = 2.914 \text{ m}$$

End of Solution

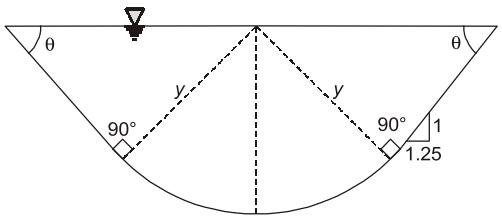
IRRIGATION

Q.17 A round-bottom triangular lined canal is to be laid at a slope of 1 in 1500, to carry a discharge of 25 m^3/s. The side slopes of the canal cross-section are to be kept at 1.25H : 1 V. If Manning's roughness coefficient is 0.013, the flow depth (in meters) will be in the range of

(a) 2.61 to 2.64 (b) 2.24 to 2.27

(c) 1.94 to 1.97 (d) 2.39 to 2.42

Ans. (d)



From the figure, $\tan\theta = \frac{1}{1.25}$

$$\theta = 38.66° = 38.66° \times \frac{\pi}{180°} = 0.675 \text{ radians}$$

Also, $\cot\theta = 1.25$

Cross sectional area, $A = y^2(\theta + \cot\theta)$

$= y^2[0.675 + 1.25] = 1.925\, y^2$

Perimeter, $P = 2y(\theta + \cot\theta)$

Now, Hydraulic radius, $R = \frac{A}{P} = \frac{y^2(\theta+\cot\theta)}{2y(\theta+\cot\theta)} = \frac{y}{2}$

Now, Discharge, $Q = A\times\frac{1}{n}R^{2/3}S^{1/2}$

$$\Rightarrow \quad 25 = (1.925y^2)\times\frac{1}{0.013}\times\left(\frac{y}{2}\right)^{2/3}\times\left(\frac{1}{1500}\right)^{1/2}$$

$$\Rightarrow \quad y = 2.404 \text{ m}$$

End of Solution

MADE EASY

Rank Improvement Course for GATE 2025

Commencing from
3rd June, 2024

Teaching Hours :
300 to 350 hours

Course Validity :
Till GATE 2025 Exam

LIVE-ONLINE COURSE

Streams :
CE, ME, EE, EC, CS

Key Features

- Comprehensive problem-solving sessions by India's top faculties.
- Focus on improving accuracy & speed.
- Practice all types of questions to brush up on your concepts.
- Newly develop workbooks (e-copy) in line with recent trends in GATE.
- Highly useful for repeaters candidates.

Download the App

Android

iOS

9021300500 **www.madeeasyprime.com**

HYDROLOGY

Q.18 A storm with accumulated precipitation of 11.0 cm as shown in the table produced a direct runoff off 6.0 cm

Time from starts (hr)	1	2	3	4	5	6	7	8
Recorded cumulative precipitation (CM)	0.5	1.5	3.1	5.5	7.3	8.9	10.2	11.0

The ϕ-index of the storm in (cm/hr) is _____?

Ans. (0.6428)

Time from start (hr)	1	2	3	4	5	6	7	8
Accumulated precipitation (cm)	0.5	1.5	3.1	5.5	7.3	8.9	10.2	11.0
Incremental precipitation (cm)	0.5	1	1.6	2.4	1.8	1.6	1.3	0.8
Rainfall intensity (cm/hr)	0.5	1	1.6	2.4	1.6	1.6	1.3	0.8

Total infiltration, I = Total rainfall – Total runoff
= 11 – 6 = 5 cm

$$\therefore \quad \text{W–index} = \frac{5}{8} = 0.625 \text{ cm/hr}$$

As the 1 hour rainfall is less than W-index.

So, $$\phi\text{-index} = \frac{5 - 0.5 \times 1}{(8-1)} = 0.6428 \text{ cm/hr}$$

End of Solution

GEOTECHNICAL

Q.19 Which of the following saturated fine grained soils can attain a negative value of skempton pore pressure parameter (A)?

(a) Light consolidated clays (b) Quick clays
(c) Normally consolidated clays (d) Over-consolidated clays

Ans. (d)

End of Solution

Q.20 A reinforced concrete pile of 10 m length and 0.7 m diameter is embedded in a saturated pore clay with unit cohesion of 50 kPa. If the adhesion factor is 0.5, then net ultimate uplift pullout capacity (in kNm) of the pile is _____.

Ans. (549.78)

Length of pile, L = 10 m, Diameter of pile, d = 0.7 m
Cohesion, C = 50 kPa
Adhesion factor, α = 0.5
Net ultimate uplift pullout capacity,

$$T = \alpha C \pi d L = 0.5 \times 50 \times \pi \times 0.7 \times 10 = 549.78 \text{ kN}$$

End of Solution

Q.21 The in situ percentage of voids in a sand deposit is 50%. The maximum and minimum density of sand determine from lab test are 1.8 gm/cm^3 and 1.3 gm/cm^3. Assume G of sand as 2.7. Its relative density is

Ans. **(13.33)**

Minimum dry density, $\gamma_{dmin} = 1.3$ g/cm^3

Maximum dry density, $\gamma_{dmax} = 1.8$ g/cm^3

Specific gravity of soil solids, $G = 2.7$

Porosity of soil, $n = 0.5$

$$\text{Void ratio, } e = \frac{n}{1-n} = \frac{0.5}{0.5} = 1$$

$$\text{In situ dry density, } \gamma_d = \frac{G\rho_w}{1+e} = \frac{2.7\times 1}{1+1} = 1.35 \text{ g/cm}^3$$

$$\text{Now, Relative density, RD} = \frac{\frac{1}{\gamma_{dmin}} - \frac{1}{\gamma_d}}{\frac{1}{\gamma_{dmin}} - \frac{1}{\gamma_{dmax}}} = \frac{\frac{1}{1.3} - \frac{1}{1.35}}{\frac{1}{1.3} - \frac{1}{1.8}} = 0.1333 = 13.33\%$$

End of Solution

Q.22 A homogeneous earthen dam has maximum water head difference of 15 m between the upstream and downstream sides. A flownet was drawn with the number of potential drops as 10 and the length of square at exit as 3 m, specific gravity of the soil is 2.65. For a factor of safety of 2.0 against piping failure, void ratio of the soil is _____. (Rounded off to 2 decimal place)

Ans. **(0.65)**

Total head loss, $h_L = 15$ m

Number of equipotential drops, $N_d = 10$

Average length, $L = 3$ m

Specific gravity, $G = 2.65$

Factor of safety, FOS = 2

$$\text{Hydraulic gradient, } i = \frac{h_L}{L} = \frac{\frac{15}{10}}{3} = 0.5$$

Now, $\text{FOS} = \frac{i_C}{i}$, where i_C is critical hydraulic gradient

$$\Rightarrow 2 = \frac{i_C}{0.5}$$

$$\Rightarrow i_C = 1$$

$$\Rightarrow i_C = \frac{G-1}{1+e}$$

$$\Rightarrow 1 = \frac{2.65-1}{1+e}$$

$$\Rightarrow e = 0.65$$

End of Solution

Q.23 A drained triaxial test was conducted on a saturated sand specimen using a triaxial testing system. The specimen failed when the axial stress reached a value of 100 kN/m^2 from an initial confining pressure of 300 kN/m^2,.

The angle of shearing plane (in degrees) with respect to horizontal is _____ nearest integer)

Ans. (49.10)

Given: $\sigma_d = 100\ kN/m^2$, $\sigma_3 = 300\ kN/m^2$

Now, $\sigma_1 = \sigma_3 \tan^2\alpha + 2c^{o} \tan\alpha$

$\Rightarrow (\sigma_d + \sigma_3) = \sigma_3 \times \tan^2\alpha$ $\left[\therefore \alpha = 45° + \frac{\phi}{2}\right]$

$\Rightarrow (100 + 300) = 300 \tan^2\alpha$

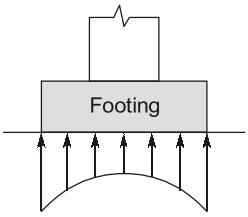
$\Rightarrow 400 = 300 \tan^2\alpha$

$\tan^2\alpha = \frac{4}{3}$,

$\tan\alpha = 1.1547 = \tan^{-1}(1.1547) = 49.10°$

End of Solution

Q.24 The pressure distribution shown in the figure belong to a



(a) Rigid footing resting on a cohesive soil.
(b) Rigid footing resting on a cohesionless soil.
(c) Flexible footing resting on a cohesionless soil.
(d) Flexible footing resting on a cohesive soil.

Ans. (a)

End of Solution

Q.25 Consider the statements P, Q and R.

P: Compacted fine-grained soils with flocculated structure have isotropic permeability.

Q: Phreatic surface / line is the line along which the pore water pressure is always maximum.

R: The piping phenomenon occurring below the dam foundation is typically known as blowout piping.

Which of the following option(s) is / are correct?

(a) Both P and R are TRUE
(b) Both Q and R are FALSE
(c) P is FALSE and Q is TRUE
(d) P is TRUE and R is FALSE

Ans. (b)

End of Solution

GEOMETICS ENGG.

Q.26 What is the correct match between the survey instruments/parts of instruments shown in the table and the operation carried out with them?

Instruments/Parts of instruments	Operations
(P) Bubble tube	(i) Tacheometry
(Q) Plumb bob	(ii) Minor movements
(R) Tangent screw	(iii) Centering
(S) Stadia cross-wire	(iv) Levelling

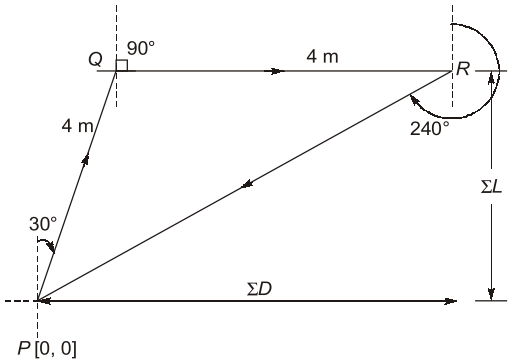
(a) P-iii, Q-iv, R-i, S-ii (b) P-i, Q-iii, R-ii, S-iv
(c) P-ii, Q-iii, R-iv, S-i (d) P-iv, Q-iii, R-ii, S-i

Ans. (d)

End of Solution

Q.27 A child walks on a level surface from point P to point Q along a line of bearing of 30°, from point Q to point R along aline of a bearing of 90° and then directly returns to the starting point P along a line of bearing of 240°. The straight-line paths PQ and QR are 4 m each. Assuming that all the bearings are measured from magnetic north, the straight line path length RP (in meter) is _____ (rounded off to the nearest integer).

Ans. (6.928)



Horizontal distance of traverse from P to $R = \Sigma D$

$= PQ \sin 30° + QR \sin 90°$

$= 4 \times \frac{1}{2} + 4 \times 1$

$= 6$ m

Vertical distance of traverse from P to R $= \Sigma L$

$= PQ \cos 30° + QR \cos 90°$

$= 4 \times \frac{\sqrt{3}}{2} = 2\sqrt{3}$

$\Rightarrow \quad PR = \sqrt{(\Sigma L)^2 + (\Sigma D)^2} = \sqrt{(6)^2 + (2\sqrt{3})^2} = \sqrt{48} = 6.928$ m

End of Solution

Conventional Questions Practice Programme for ESE & State Exams

Commencing from
1st /2nd week of March, 2024

Teaching Hours :
300 to 350 hours

Course Duration :
100 days

OFFLINE & ONLINE COURSE
Streams :
CE, ME, EE, EC

Key Features

- In-depth discussion on conventional questions.
- Beneficial to develop numerical question solving techniques.
- Helps to improve answer writing and presentation skills.
- Discussion on probable questions.
- Updated Mains workbook with wide range of practice questions.
- ESE Mains test series will be conducted on every Sunday in synchronization with the subjects.

Note : Offline classes will be conducted at Delhi Centre.

Delhi Centre : 44-A/1, Kalu Sarai, Near Hauz Khas Metro Station, New Delhi - 110016 | **Ph :** 9021300500
MADE EASY Centres : Delhi | Bhopal | Hyderabad | Jaipur | Kolkata | Pune www.madeeasy.in

Q.28 To finalize the direction of a survey line, surveyors set up a theodolite at a station P and made all the temporary adjustment. Then from the station P, each of the surveyors observed the bearing to a tower located at station Q with the same instrument without shifting it. The bearings observed by the surveyors are 30° 30′ 00″, 30° 29′ 40″, 30° 30′ 20″ and 30° 31′ 20″. Assuming that each measurement is taken with equal precision, the most probable value of the bearing is

(a) 30° 30′, 20″ (b) 30° 31′, 20″
(c) 30° 30′, 00″ (d) 30° 24′, 40″

Ans. **(a)**

$$\text{Most probable value} = \frac{30°30'00'' + 30°2940'' + 30°30'20'' + 30°3120''}{4}$$
$$= 30°\ 30'\ 20''$$

End of Solution

Q.29 Differential levelling is carried out from point P (BM: = 200.000m) to point R. The readings taken are given in the table,

Points	Staff readings(m)		Remarks
	Back sight	Fore sight	
P	(–) 2.050		BM: + 200.000 m
Q	1.050	0.950	Q is a change point
R		(–) 1.655	

Reduced Level (in meters) of the point R is _____ (rounded off to 3 decimal places).

Ans. **(199.705)**

$$\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$$
$$(1.05 - 2.05) - (0.95 - 1.655) = (RL)_R - 200$$
$$RL_R = 199.705 \text{ m}$$

End of Solution

Q.30 For a reconnaissance survey, it is necessary to obtain vertical aerial photographs of a terrain at an average scale of 1: 13000 using a camera. If the permissible flying height is assumed as 300 m above a datum and the average terrain elevation is 1050 m above the datum, then required focal length (in mm) of the camera is

(a) 100 (b) 150
(c) 200 (d) 125

Ans. **(b)**

$$\text{Scale} = \frac{1}{13000} = \frac{f}{H - h_{avg}} \quad \text{where } f \text{ is focal length}$$

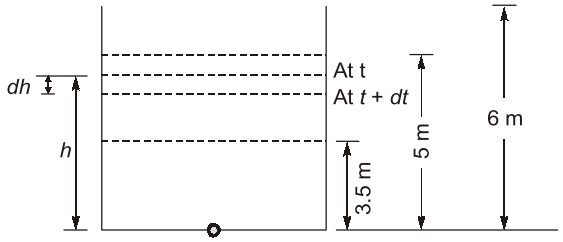
$$\Rightarrow \quad \frac{1}{13000} = \frac{f}{3000 - 1050}$$
$$f = 0.15 \text{ m} = 150 \text{ mm}$$

End of Solution

FLUID MECHANICS

Q.31 A 2 m × 1.5 m tank of 6 m height is provided with a 100 mm diameter orifice at the centre of its base. The orifice is plugged and the tank is filled upto 5 m height. Consider the average discharge coefficient as 0.6 and acceleration due to gravity (g) as 10 m/s^2. After unplugging the orifice, the time (in seconds) taken for the water level to drop from 5 m to 3.5 m under the discharge condition?

Ans. (103.98)



Coefficient of discharge, $C_d = 0.6$

Acceleration due to gravity, $g = 10\ m/s^2$

$$\text{Area, } A = (2 \times 1.5)\ m^2 = 3\ m^2$$

Let, in dt time, the water level decreases by 'dh'.

$$-Adh = C_d \times a \times \sqrt{2gh} \cdot dt$$

$$\frac{-A}{aC_d\sqrt{2g}} \cdot \frac{dh}{\sqrt{h}} = dt$$

Integrating it,

$$\frac{-A}{aC_d\sqrt{2g}} \int_{H_1}^{H_2} \frac{dh}{\sqrt{h}} = \int_0^T dt$$

$$\frac{A}{aC_d\sqrt{2g}} \int_{H_2}^{H_1} \frac{dh}{\sqrt{h}} = T$$

$$\frac{A}{C_d a\sqrt{2g}} \times \left[2\sqrt{H}\right]_{H_2}^{H_1} = T$$

$$T = \frac{2A}{C_d a\sqrt{2g}}\left(\sqrt{H_1} - \sqrt{H_2}\right)$$

$$= \frac{2 \times (2 \times 1.5)}{0.6 \times \frac{\pi}{4} \times 0.1^2 \times \sqrt{2(10)}} \times \left(\sqrt{5} - \sqrt{3.5}\right)$$

$$= 103.98 \text{ sec}$$

End of Solution

Q.32 A 500 m long water distribution pipeline P with diameter 1.0 m, is used to convey 0.1 m^3/s of flow. A new pipeline Q, with the same length and flow rate, is to replace P. The friction factors for P and Q are 0.04 and 0.01, respectively. The diameter of the pipeline Q (in meter) is _____.

Ans. **(0.75)**

Here, $h_{fP} = h_{fQ}$

$$\frac{8q^2}{\pi^2 g} \times \frac{0.04 \times L}{(1)^5} = \frac{8q^2}{\pi^2 g} \times \frac{0.01 \times L}{D^5}$$

where q is discharge and L is length of pipeline.

$$D = \left(\frac{1}{4}\right)^{1/5} = 0.75 \text{ m}$$

End of Solution

ENVIRONMENTAL

Q.33 A circular settling tank is to be designed for primary treatment of sewage at a flow rate of 10 million litre/day. Assume a detention period of 2.0 hours and surface loading rate, SLR of 40000 litres/m^2/day. The height (in meter) of the water column in the tank is ____.

Ans. **(3.08)**

Discharge, $Q = 10$ MLD

Detencion tine, $t_d = 2$ hrs.

$\text{SLR} = 40{,}000 \text{ L/m}^2\text{/day}$

$\text{Volume} = Q \times t_d$

$$= \frac{10 \times 10^3 \text{m}^3 \times 2}{24}$$

$$= 833.33 \text{ m}^3$$

Now, $\text{Surface area} = \frac{Q}{SLR} = \frac{10 \times 10^6 \text{ L/d}}{40{,}000 \text{ L/m}^2\text{/d}} = 250 \text{ m}^2$

Now, $\frac{\pi}{4} \cdot D^2 = 250$

$D = 17.841$ m

Now, $\text{Volume} = 833.33 \text{ m}^3$

$D^2[0.785H + 0.011D] = 833.33$

$(17.841)^2[0.785H + 0.011 \times 17.841] = 833.33$

$H = 3.08$ m

End of Solution

Q.34 Which of the following is not obtained after anaerobic decomposition of glucose?

(a) H_2S (b) CO_2

(c) H_2O (d) CO

Ans. **(a)**

End of Solution

Q.35 An organic waste is represented as $C_{240}O_{200}H_{180}N_5S$.
(Atomic weights: S - 32, H - 1, C- 12, O - 16, N- 14)
Assume complete conversion of S to SO_2 while burning.
SO_2 generated (in grams per kg) of this waste is _____ (rounded off to 1 decimal place.)

Ans. **(10.059)**
Molecular weight of $C_{240}O_{200}H_{180}N_5$ S is given as :
$12 \times 240 + 16 \times 200 + 1 \times 180 + 14 \times 5 + 32 = 6362$ gm

$$SO_2 \text{ generated} \Rightarrow \frac{64}{6362} \times 1000 \text{ gm/kg}$$
$$= 10.059 \text{ gm/kg}$$

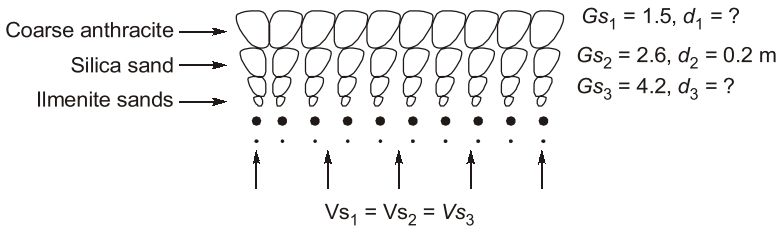
End of Solution

Q.36 A hypothetical multimedia filter, consisting of anthracite particles (specific gravity: 1.50), silica sand (specific gravity: 2.60) and ilmenite sand (specific gravity: 4.20), is to be designed for treating water/ wastewater. After backwashing, the particles should settle forming three layers: coarse anthracite particles at the top of the bed, silica sand in the middle, and small ilmenite sand particles at the bottom of the bed.

Assume:
(i) Slow discrete settling (Stoke's law is applicable)
(ii) All particles are spherical.
(iii) Diameter of silica sand particles is 0.20 mm.

The **correct** option fulfilling the diameter requirements for this filter media is
(a) diameter of anthracite particles is slightly greater than 0.35 mm and diameter of ilmenite particles is slightly less than 0.141 mm.
(b) diameter of anthracite particles is slightly less than 0.64 mm and diameter of ilmenite particles is slightly less than 0.10 mm
(c) diameter of anthracite particles is slightly less than 0.35 mm and diameter of ilmenite particles is slightly less than 0.141 mm.
(d) diameter of anthracite particles is slightly greater than 0.64 mm and diameter of ilmenite particles is slightly less than 0.10 mm.

Ans. **(a)**



$$\frac{1}{18\mu}(G_{s1}-1)\rho g d_1^2 = \frac{\rho g}{18\mu}(G_{S_2}-1)d_2^2 = \frac{\rho g}{18\mu}(G_{S_3}-1)d_3^2$$

$$\frac{\rho g}{18\mu}(G_S-1)d_1^2 = \frac{\rho g}{18\mu}(G_{S_2}-1)d_2^2 = \frac{\rho g}{18\mu}(G_{S_3}-1)d_3^2$$

$$(G_{S-1})d_1^2 = (G_{S2} - 1).d_2^2$$
$$(1.5 - 1)d_1^2 = (2.6 - 1) \times (0.2)^2$$
$$d_1 = 0.357 \text{ m}$$
$$(G_{S2-1})d_2^2 = (G_{S3} - 1).d_3^2$$
$$(2.6 - 1) \times (0.2)^2 = (4.2 - 1)d_3^2$$
$$d_3 = 0.141 \text{ mm}$$

End of Solution

Q.37 What is the correct match between the air pollutants and treatment techniques given in the table

Air pollutants	Treatment techniques
P. NO_2	i. Flaring
Q. SO_2	ii. Cyclonic separator
R. CO	iii. Lime scrubbing
S. Particles	iv. NH_3 injection

(a) P - i, Q - ii, R - iii, S - iv
(b) P - iv, Q - iii, R - i, S - ii
(c) P - ii, Q - iii, R - iv, S - i
(d) P - ii, Q - i, R - iv, S - iii

Ans. (b)

End of Solution

CONSTRUCTION MANAGEMENT

Q.38 P : In a pure project organisation, the project manager maintains complete authority and has maximum control over the project.

Q : A matrix organisation structure facilitates quick response to changes, conflicts and project needs.

Which one of the following option is correct?

(a) Both P and Q are false
(b) Both P and Q are true
(c) P is false and Q is true
(d) P is true and Q is false.

Ans. (b)

P: In a pure project organisation, the project manager has the complete authority and control over the project.

Q: In a matrix organisation, employees have more than one boss and work on multiple teams. This leads to quick response to changes, conflicts and project needs.

End of Solution

Q.39 A critical activity in a project is estimated to take 15 days to complete at a cost of Rs. 30,000. The activity can be expedited to complete in 12 days by spending a total amount of Rs. 54,000. Consider the statements P and Q.

P : It is economically advisable to complete the activity early by crashing, if the indirect cost of the project is Rs. 8,500 per day.

Q : It is economically advisable to complete the activity early by crashing, if the indirect cost of the project is Rs. 10,000 per day.

Which one of the following options is correct?

(a) Both P and Q are FALSE
(b) P is FALSE and Q is TRUE
(c) P is TRUE and Q is FALSE
(d) Both P and Q are TRUE

Ans. (d)

$$\text{Cost slope} = \frac{54000 - 30000}{15 - 12}$$

$$= \text{Rs. } 8000/\text{day}$$

Case-1

Increase in direct cost by crashing of 3 days = 8000 × 3 = Rs. 24000

Decrease in indirect cost by crashing of 3 days = 8500 × 3 = Rs. 25500

As the decrease in indirect cost is more than increase and direct cost, so crashing is advantageous.

Case-2

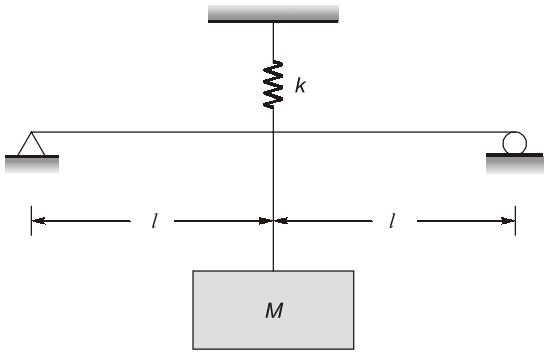
Decrease in indirect cost by crashing of 3 days

= 10000 × 3 = Rs. 30000

As the decrease in indirect cost is more than increase and direct cost, so crashing is advantageous.

End of Solution

Q.40 Find out the natural frequency of oscillation of system.



(a) $\sqrt{\frac{48EIk}{(kl^3 + 48EI)m}}$
(b) $\sqrt{\frac{kl^3 + 48EI}{ml^3}}$
(c) $\sqrt{\frac{kl^3 + 6EI}{ml^3}}$
(d) $\sqrt{\frac{6EIk}{(kl^3 + 6EI)m}}$

Ans. (?)

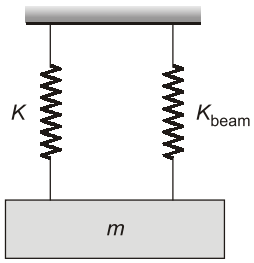
Here, weight (mg) is shared by the beam and top spring and the deflection in beam and top spring will be same.

∴ Beam and top spring will be in parallel.

Beam stiffness:

$$K_{beam} = \frac{48EI}{(2l)^3} = \frac{6EI}{l^3}$$

Equivalent stiffness:



$$K_{eq} = K + K_{beam}$$
$$= K + \frac{6EI}{l^3}$$

$\therefore$ Natural frequency,

$$w_n = \sqrt{\frac{K_{eq}}{m}} = \sqrt{\frac{K + \frac{6EI}{l^3}}{m}}$$
$$= \sqrt{\frac{Kl^3 + 6EI}{ml^3}} \text{ rad/s}$$

End of Solution

ENGG. MATHEMATICS

Q.41 Consider two matrices $A = \begin{bmatrix} 2 & 1 & 4 \\ 1 & 0 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & 0 \\ 2 & 3 \\ 2 & 4 \end{bmatrix}$. The determinants of the matrix AB is _____.

Ans. (10)

$$A = \begin{bmatrix} 2 & 1 & 4 \\ 1 & 0 & 3 \end{bmatrix}_{2\times3}, \quad B = \begin{bmatrix} -1 & 0 \\ 2 & 3 \\ 2 & 4 \end{bmatrix}_{3\times2}$$

Then, $AB = \begin{bmatrix} 4 & 19 \\ 2 & 12 \end{bmatrix}$

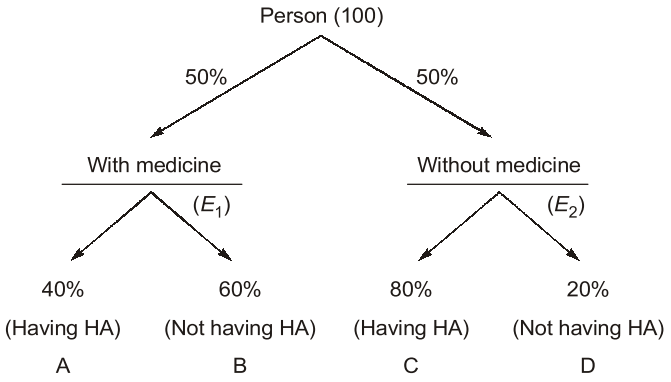
So, $|AB| = (4)(12) - (2)(19)$
$= 48 - 38 = 10$

End of Solution

Q.42 In a sample of 100 heart patients, each patients has 80% chance of having a heart attack without medicine X. It is clinically known that medicine X reduces the probability of having a heart attack by 50% medicine X is taken by 50 of there 100 patients. The probability that a randomly selected patient out of the 100 patients takes medicine X and has a heart attack is

(a) 20%
(b) 40%
(c) 30%
(d) 60%

Ans. (a)



$$P\left(\frac{A}{E_1}\right) = 50\% \times 40\% = \frac{50}{100}\times\frac{40}{100} = \frac{20}{100} = 20\%$$

End of Solution

Q.43 P : $\dfrac{dy}{dx} = \dfrac{x^2+3x^2y^2+2y^4}{x^3y}$

Q : $\dfrac{dy}{dx} = \dfrac{-y^2}{x^2}$

Which one of the following option is correct?

(a) P is homogeneous O.D.E. and Q is an exact O.D.E.

(b) P is non-homogeneous O.D.E. and Q is an exact O.D.E.

(c) P is homogeneous O.D.E. and Q is not an exact O.D.E.

(d) P is non-homogeneous O.D.E. and q is not an exact O.D.E.

Ans. (d)

P $\Rightarrow$ non-homogeneous

Q: $\dfrac{dy}{dx} = \dfrac{-y^2}{x^2}$

$$x^2dy + y^2\,dx = 0$$

$$\left.\begin{aligned} y^2dx + x^2dy = 0 \\ Mdx + Ndy = 0 \end{aligned}\right\} \text{Compare it}$$

$$M = y^2, \quad M = x^2$$

$$\frac{\partial M}{\partial y} = 2y, \quad \frac{\partial N}{\partial x} = 2x$$

$$\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$$

$\Rightarrow$ So, Q is non-exact option (d).

End of Solution

Q.44 The function $f(x) = x^3 - 27x + 4,\ 1 \le x \le 6$ has

(a) Saddle point
(b) Point of minima
(c) Point of maxima
(d) Inflection point

Ans. (c)

$$f'(x) = 3x^2 - 27$$
$$f'(x) = 0$$
$$\Rightarrow \quad 3x^2 - 27 = 0$$
$$3x^2 = 27$$
$$x^2 = 9$$
$$x = \pm 3$$
$$f''(x) = 6x$$
$$f''(x)\big|_{x=3} = 6 \times 3 = 18 > 0$$
$$f''(x) > 0$$

At $x = 3$, there will point of minima.
Hence option (c) is answer.

End of Solution

Q.45 If $\vec{p} = \hat{i} + \hat{j} + \hat{k},\ \vec{q} = \hat{i} + 2\hat{j} + 3\hat{k},\ \vec{r} = 2\hat{i} + 3\hat{j} + 4\hat{k}$, then which of the following is/are correct.

(a) $\vec{p} \times (\vec{q} \times \vec{r}) + \vec{q} \times (\vec{r} \times \vec{p}) + \vec{r} \times (\vec{p} \times \vec{q}) = \vec{0}$
(b) $\vec{p} \times (\vec{q} \times \vec{r}) = (\vec{p} \cdot \vec{r})\vec{q} - (\vec{p} \cdot \vec{q})\vec{r}$
(c) $\vec{r} \cdot (\vec{p} \times \vec{q}) = 0 = (\vec{q} \times \vec{p}) \times \vec{r}$
(d) $\vec{p} \times (\vec{q} \times \vec{r}) \neq (\vec{p} \times \vec{q}) \times \vec{r}$

Ans. (a, b, c, d)

By observation $\vec{p} + \vec{q} - \vec{r} = \vec{0}$ (or $\vec{r} = \vec{p} + \vec{q}$) i.e. $\vec{p}, \vec{q}$ and $\vec{r}$ are L.D. $\Rightarrow$ $\vec{p}, \vec{q}, \vec{r}$ lies on same plane i.e. $\vec{p}, \vec{q}, \vec{r}$ are coplanar $\Rightarrow$ S.T.P = 0.

Hence option (c) is correct.
Option (b) is also correct as it is the standard result.

Now checking option (a); $\vec{p} \times (\vec{q} \times \vec{r}) + \vec{q} \times (\vec{r} \times \vec{p}) + \vec{r} \times (\vec{p} \times \vec{q})$

$$= \vec{p} \times [\vec{q} \times (\vec{p} + \vec{q})] + \vec{q} \times [(\vec{p} + \vec{q}) \times \vec{p}] + \vec{r} \times (\vec{p} \times \vec{q})$$
$$= \vec{p} \times (\vec{q} \times \vec{p}) + 0 + 0 + \vec{q} \times (\vec{q} + \vec{p}) - \vec{r} \times (\vec{q} \times \vec{p})$$
$$= (\vec{q} \times \vec{p})[\vec{p} + \vec{q} - \vec{r}] = (\vec{q} \times \vec{p})(\vec{0}) = \vec{0}$$

Hence (a) is also correct.

End of Solution

Q.46 The value of $\lim_{m\to\infty}\left(1+\frac{0.05}{m}\right)^{m}-1$ is _____.

Ans. (0.05127)

$$\lim_{m\to\infty}\left(1+\frac{0.05}{m}\right)^{m}-1$$

$$y = e^{\lim\limits_{x\to\infty} mx\left[1+\frac{0.05}{m}-1\right]^{m}};\ 1^{\infty}\text{ form}$$

$$y = e^{\lim\limits_{x\to\infty} mx\left[1+\frac{0.05}{m}-1\right]}$$

$$y = e^{\lim\limits_{x\to\infty} mx\left[1+\frac{0.005}{m}-1\right]}$$

$$y = e^{\lim\limits_{x\to\infty} 0.05}$$

Finally, $y = e^{0.05} - 1$

$y = 0.05127$

End of Solution

■■■■

MADE EASY Group

LAUNCHES

MENIIT

NEET | IIT-JEE

With a legacy of 23 years, the **MADE EASY Group** is a pioneer in the fields of ESE and GATE. The group offers courses for the Civil Services Examination under the NEXT IAS brand name. Under the guiding light of **Mr. B. Singh (Ex. IES;** founder of MADE EASY Group and an **alumnus of IIT BHU**) we are focused to provide best quality teaching to our students with experienced and renowned faculty members. We have been constantly producing toppers and large number of rank holders continuously since last many years.

MENIIT is a new addition to the MADE EASY Group, which provides coaching for the prestigious NEET and IIT-JEE. As a part of the esteemed MADE EASY Group, MENIIT upholds the same values of academic excellence, integrity and student centricity.

MADE EASY Group Statistics

95% Selections from MADE EASY in UPSC ESE 2023	**250+** Faculty Members	**67%** Selections from NEXT IAS in UPSC CSE 2022	**1000+** Employees

Inaugural Offer

50% DISCOUNT

on tuition fee to first 100 students

Admissions Open

Corporate Office : 44-A/1, Kalu Sarai,
Near Hauz Khas Metro Station
New Delhi - 110016

8448815580
www.meniit.com

Our Initiatives

NEXT IAS — UPSC CSE

MADE EASY SCHOOL — CBSE K-12 School (Delhi & Gurugram)

MADE EASY — ESE & GATE