ESE-2018 PRELIMS TEST SERIES

Date: 30 December, 2017

CE–Test 15(OBJECTIVE SOLUTION)...

ANSWERS

1.	(a)	31.	(c)	61.	(d)	91.	(c)	121.	(b)
2.	(c)	32.	(d)	62.	(b)	92.	(c)	122.	(b)
3.	(b)	33.	(d)	63.	(a)	93.	(c)	123.	(d)
4.	(a)	34.	(b)	64.	(a)	94.	(a)	124.	(c)
5.	(c)	35.	(a)	65.	(b)	95.	(b)	125.	(a)
6.	(b)	36.	(a)	66.	(c)	96.	(b)	126.	(b)
7.	(b)	37.	(d)	67.	(a)	97.	(a)	127.	(a)
8.	(c)	38.	(c)	68.	(c)	98.	(b)	128.	(a)
9.	(d)	39.	(c)	69.	(b)	99.	(d)	129.	(b)
10.	(a)	40.	(d)	70.	(b)	100.	(c)	130.	(a)
11.	(d)	41.	(c)	71.	(b)	101.	(c)	131.	(d)
12.	(a)	42.	(c)	72.	(b)	102.	(b)	132.	(c)
13.	(d)	43.	(d)	73.	(b)	103.	(d)	133.	(b)
14.	(c)	44.	(b)	74.	(b)	104.	(a)	134.	(c)
15.	(b)	45.	(a)	75.	(b)	105.	(c)	135.	(b)
16.	(c)	46.	(c)	76.	(b)	106.	(b)	136.	(d)
17.	(b)	47.	(b)	77.	(a)	107.	(d)	137.	(d)
18.	(d)	48.	(a)	78.	(d)	108.	(b)	138.	(b)
19.	(b)	49.	(a)	79.	(c)	109.	(c)	139.	(a)
20.	(d)	50.	(a)	80.	(c)	110.	(c)	140.	(a)
21.	(d)	51.	(a)	81.	(b)	111.	(b)	141.	(c)
22.	(d)	52.	(a)	82.	(a)	112.	(a)	142.	(a)
23.	(b)	53.	(b)	83.	(b)	113.	(b)	143.	(a)
24.	(b)	54.	(a)	84.	(d)	114.	(a)	144.	(c)
25.	(c)	55.	(d)	85.	(c)	115.	(c)	145.	(d)
26.	(c)	56.	(b)	86.	(b)	116.	(c)	146.	(d)
27.	(d)	57.	(a)	87.	(a)	117.	(b)	147.	(d)
28.	(c)	58.	(a)	88.	(c)	118.	(b)	148.	(a)
29.	(b)	59.	(c)	89.	(a)	119.	(c)	149.	(d)
30.	(b)	60.	(b)	90.	(d)	120.	(d)	150.	(b)

1. (a)

1. In a slow sand filter, impurities are removed by a combination of straining, sedimentation, biochemical and biological processes.
2. Shortly after the start of filtration, a thin slimy layer called the 'schmutzdecke' is formed on the surface of sand bed. It consists of a great variety of biological organisms which feed on the organic matter and convert it into simple, harmless substances.
3. Considerable portion of inert suspended particles is mechanically strained out in this layer.
4. During its passage through 0.4 – 0.6 m of sand bed, the water becomes virtually free from suspended solids, colloids, pathogens and complex salts in solution. The result is a simultaneous improvement in the physical, chemical and bacteriological quality of water.

2. (c)

- In the high value residential area of the city as in a suburban community, per capita consumption is high. Slum areas of large cities have low per capita consumption.
- A person staying in an independent bungalow consumes more water compared to a person staying in a flat.

3. (b)

Items		Design Period in Years
1.	Storage by dams	50
2.	Infiltration Works	30
3.	Pumping :	
	(i) Pump House (Civil Works)	30
	(ii) Electric Motors and Pumps	15
4.	Water Treatment Units	15
5.	Pipe Connection to several treatment units and other small appertenances	15
6.	Raw water and clear water conveying mains	30
7.	Clear water reservoirs at the head works, balancing tanks, and service reservoir coverhead or ground level 1	30
8.	Distribution System	30

4. (a)

CO_2 and other gases consisting of two or more dissimilar atoms absorb infrared (IR) radiation in a characteristics, unique manner. Such gases are detected using IR techniques. H_2O vapour, CH_4, CO_2 and CO can be measured by IR sensor.

5. (c)

Alum is effective in the pH range of 6.5 to 8.5

6. (b)

$$\text{Applied } Cl_2 = \frac{7.6 \text{ kg/day}}{19\times10^6 \text{ l/day}} = 0.4 \text{ mg/l}$$

Cl_2 demand = Applied CO_2 – residue Cl_2

= 0.4 – 0.2 = 0.2 mg/l

7. (b)

$$\text{Total hardness} = \left(\frac{78}{40/2}+\frac{30}{24/2}\right)\times\frac{100}{2}$$

= 320 mg/l as $CaCO_3$

Carbonate hardness = Min. of (total hardness & alkalinity) = 126 mg/l

Non-carbonate hardness

= Total hardness – Carbonate hardness

= 320 – 126 = 194 mg/l

8. (c)

Maximum upper limit of BOD = THOD (Theoretical Oxygen Demand)

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

180 g 192 g

$C_6H_6 + 7.5O_2 \rightarrow 6CO_2 + 3H_2O$

78 g 240 g

Molecular weight of glucose

= 12 × 6 + 12 × 1 +16 × 6 = 180 g

Molecular weight of C_6H_6

= 12 × 6 + 1 × 6 = 78 g

$$\text{THOD} = \frac{192}{180}\times240+\frac{240}{78}\times39 = 376 \text{ mg/l}$$

9. (d)

Grit chamber is placed either before or after sewage pump and organic matter should not be settled.

Detention time, t_d = 40 – 60 sec only

10. (a)

$$\text{Area} = \frac{40{,}000\ (m^3/d)}{64\ (m^3/m^2/d)}$$

$$= 625\ m^2$$

$$625 = \frac{\pi}{4}d^2$$

$$d = 28.2\ m$$

The diameter of secondary clarifier can be adopted as 30 m.

11. (d)

12. (a)

A structure constructed at the intersection of two large size sewers is known as junction chamber.

Flushing manholes are located mostly at the head of a sewer to flush out deposits in the sewer with water. Stored water is suddenly released for cleaning and it is effective up to a distance of 300 m.

13. (d)

14. (c)

Since engineering stress, σ, is F/A_0, true stress σ_T is

$$\sigma_T = \frac{\sigma}{1-q}$$

where $q = \frac{A_0 - A}{A_0}$ ≡ Fractional reduction in area

$$\sigma_T = \frac{47}{1-0.8} = 235\ N/mm^2$$

15. (b)

Taking bottom as reference, the area is divided into basic shapes of a 1 × 1 square, a 3 × 8 rectangle, and a half circle of radius 1.

$$A_1 = 1 \times 1 = 1\ unit^2$$
$$A_2 = 3 \times 8 = 24\ unit^2$$
$$A_3 = -\frac{1}{2}\pi r^2 = -\frac{1}{2}\pi 1^2 = -1.57\ unit^2$$

Y Components :

$$y_{c1} = 0.5\ units$$
$$y_{c2} = 4\ units$$
$$y_{c3} = 8 - \frac{4\times1}{3\pi} = 7.57\ units\ (given)$$

$$y_c = \frac{\Sigma A_i y_i}{\Sigma A_i}$$

$$= \frac{0.5\times1 + 4\times24 + 7.57\times(-1.57)}{1+24-1.57}$$

$$y_c = 3.61\ units$$

16. (c)

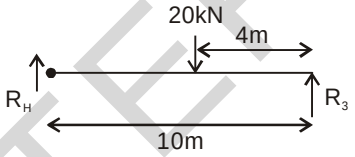
The two couple forces are equal and cancel each other as they come down the stem of the bracket. There are no applied vertical forces.

$$M = rf = 0.2 \times 10$$
$$= 2\ kNm\ [clockwise]$$
$$\Sigma M = 0$$
$$2000 - R_2 \times 5 = 0$$
$$R_2 = 400\ N$$

17. (b)

Moment about hinge is equal to zero, considering right side of hinge.

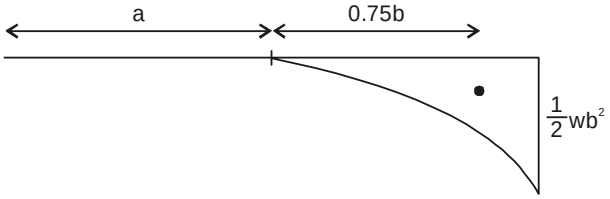
$$\Sigma M_{RH} = 0$$



$$-R_3 \times 10 + 20 \times 6 = 0$$
$$R_3 = 12\ kN$$
& $R_H = 8\ kN$

18. (d)

The deflection from point A (where the deflection is calculated) to the centroid is a + 0.75b. The area of the moment diagram is $Wb^3/6$. Using Moment-Area Theorem II,



$$\text{Area} = \frac{1}{3}b \times \frac{1}{2}wb^2$$
$$= \frac{1}{6}wb^3$$
$$y = \left(\frac{wb^3}{6EI}\right)(a + 0.75b)$$

19. (b)

20. (d)

21. (d)

$$P = Tw$$

$$\Rightarrow \quad T = \frac{P}{w} = \frac{10\times745.7}{1200\times\frac{1}{60}\times2\pi}$$

$$= 59.34\ N\text{-}m \approx 60\ N\text{-}m$$

22. (d)

23. (b)

$$\frac{\phi}{2} = \frac{\varepsilon_x - \varepsilon_y}{2}$$

$$\Rightarrow \quad \phi = 8 \times 10^{-3}$$

24. (b)

25. (c)

$$\text{Maximum hoop stress} = \frac{Pd}{2t}$$

$$= \frac{120 \times 10^3 \times 0.3}{2 \times 3 \times 10^{-3}}$$

$$= 6 \text{ MPa}$$

26. (c)

Heartwood is usually darker than the sapwood, because it is filled with stored sugar, dyes and oils.

27. (d)

The natural colour of burnt clay brick is determined by raw materials and firing temperature.

28. (c)

Class C lime should be pure white in colour. (Class C lime is fat lime)

29. (b)

30. (b)

31. (c)

Laitance prevents bond formation between the successive layers of concrete and forms a plane of weakness.

32. (d)

33. (d)

Gneiss is a metamorphic rock.

34. (b)

Glass is shaped at high temperature and then allowed to cool.

35. (a)

Let amount of cement required be x kg in 1 m^3 of concrete.

Amount of water required = 0.5x in 1 m^3 of concrete.

$\Rightarrow$ x + 1.5x + 3x + 0.5x = 2400

6x = 2400

x = 400

Weight of water = 0.5 × 400 = 200 kg

Volume of water required = 200 l

36. (a)

37. (d)

$$\text{Area of foundation} = \frac{\pi}{4} \times 100^2$$

Length of side of square foundation of same area

$$= \sqrt{\frac{\pi}{4} \times 100^2}$$

$$= \frac{100}{2} \times \sqrt{\pi} = 88.6 \text{ m}$$

This imaginary square can be divided into four squares of side 44.3 m.

For side 44.3 m & depth 100 m.

$$m = n = \frac{44.3}{100} = 0.443 \approx 0.44$$

For this value of m&n, influence factor K = 0.071

for four squares

$$\Rightarrow \quad k_{eq} = 4 \times K = 4 \times 0.071 = 0.284$$

$$\text{Thus, Pressure} = 0.284 \times 200$$

$$= 2 \times 28.4 \text{ kPa}$$

$$= 56.8 \text{ kPa}$$

38. (c)

$$d = 0.3 \text{ m}$$

$$L = 10 \text{ m}$$

$$L_f = 4 \text{ m Length of fill}$$

$$\text{Cohesion} = \frac{UCS}{2} = \frac{60}{2} = 30 \text{ kN/m}^2$$

$$\alpha = 0.2$$

$$(-) \text{ skin friction} = \alpha C_u (A_{surface})_{fill}$$

$$= 0.2 \times 30 \times \pi \times 0.3 \times 4$$

$$= 22.62 \text{ kN}$$

39. (c)

40. (d)

41. (c)

For dry cohesionless c = 0

$$\text{Then,} \quad \sin\phi = \frac{(\sigma_1 - \sigma_3)/2}{(\sigma_1 + \sigma_3)/2}$$

$$\sin 37^\circ = \frac{\sigma_1 - 100}{\sigma_1 + 100} = \frac{3}{5}$$

$$\Rightarrow \quad 5\sigma_1 - 500 = 3\sigma_1 + 300$$

$$\Rightarrow \quad 2\sigma_1 = 800$$

$$\sigma_1 = 400 \text{ kN/m}^2$$

Deviator stress at failure = 400 – 100
= 300 kN/m²

42. (c)

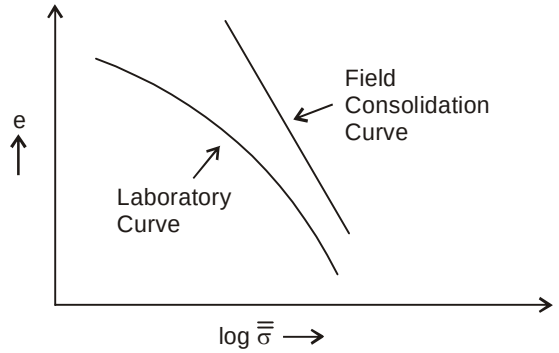
43. (d)

Absolute permeability = $\frac{K\mu}{\gamma}$. Also, ($K_H > K_V$).

Entrapped air and organic matter decreases the permeability.

44. (b)

Field consolidation curve & laboratory consolidation curve are as following :



45. (a)

Sample below water

$S = 100\%$

$G = 2.8$

$$e = \frac{\eta}{1-\eta} = \frac{0.45}{0.55} = \frac{9}{11}$$

$$\gamma = \frac{(G+e)}{1+e}\gamma_w$$

$$= \frac{\left(2.8+\frac{9}{11}\right)}{1+\frac{9}{11}} \times 9.81$$

$$\gamma_{sat} = 19.52\ kN/m^3$$

46. (c)

$$K = Cd_e^{\,2}\frac{\gamma_w}{\mu}\frac{e^3}{1+e}$$

$$K \propto \frac{1}{\mu}$$

$$K = \frac{C}{\mu}$$

$$K_{27} = \frac{K_{30}\mu_{30}}{\mu_{27}}$$

$$= 4.25\times10^{-2}\times\frac{8}{8.5}$$

$$K_{27} = 4 \times 10^{-2}\ mm/s$$

47. (b)

48. (a)

$$(N)_{corrected} = N\times\frac{350}{\bar{\sigma}+70}$$

$$\bar{\sigma} = 17.5 \times 12 = 210\ kN/m^2$$

$$(N)_{corrected} = 48\times\frac{350}{280}$$

$$(N)_{corrected} = 60$$

49. (a)

50. (a)

$$d = 1.35\left(\frac{q^2}{f}\right)^{1/3}$$

$$= 1.35\left(\frac{13.5^2}{0.25}\right)^{1/3}$$

$$= 1.35(13.5 \times 13.5 \times 4)^{1/3}$$

$$= 1.35(27 \times 27)^{1/3}$$

$$= 1.35 \times 9 = 12.15\ m$$

51. (a)

$$Q_{required} = \max(Q_{Rabi}, Q_{Kharif})$$

$$= 0.3\ m^3/s$$

$$Q_0 = \frac{Q_{continuous}}{\text{Time Factor}} = \frac{0.3}{0.5}$$

$$= 0.6\ m^3/s$$

$$\text{Max discharge} = Q_{Design} = \frac{0.6}{C.F} = \frac{0.6}{0.6}$$

$$= 1\ m^3/s$$

52. (a)

$$D = \frac{\gamma_d}{\gamma_w}(FC-PWP)\times d$$

$$= \frac{13}{10}(0.3-0.2)\times0.8$$

$$= \frac{13}{10}\times0.1\times0.8 = 0.104\ m$$

$$= 10.4\ cm$$

53. (b)

A divide wall is a long masonary or concrete wall whch is constructed perpendicular to the axis of the weir to separate the undersluices from the rest of the weir. So option (a) is wrong.

54. (a)

In the rocky or hilly stage the river cross-section is made up of rock or very large boulders and hence in this stage river training work are generally not required.

In other three stages as the river flows the deposits are created by the river itself. Hence in these type of stages training works are required.

55. (d)

True length of line

$$= \frac{L'}{L} \times \text{measured length of line}$$

$$= \frac{20.05}{20} \times 634.4$$

$$= 635.99 \text{ m}$$

56. (b)

Magnetic declination

$$= 2°15'44'' + (360° - 348°38'12'')$$

$$= 13°37'32'' \text{ W}$$

Magnetic bearing of AB $= 148°26'10''$

$\therefore$ True bearing of AB

$$= 148°26'10'' - 13°37'32''$$

$$= 134°48'38''$$

57. (a)

Least count $= \frac{1}{n}$ of the primary scale division

$$\therefore \quad \frac{1}{100} \text{ cm} = \frac{1}{n} \times \frac{1}{10} \text{ cm} \quad \text{or} \quad n = 10$$

58. (a)

A contour line must necessarily close upon itself, may be not within the boundary of contour map.

- Closely spaced contour lines indicate steeper slope and widely spaced contour line indicate gentle slope.
- A contour line passing through a point is at right angled to the line of maximum slope at that point.

59. (c)

The minimum thickness of lacing bars.

For simple lacing $= \frac{1}{40} \times$ (Effective length)

For double lacing $= \frac{1}{60} \times$ (Effective length)

60. (b)

(a) Abney Level : For measuring slopes and vertical angles.

(b) Hand Level : Used in reconnaissance operations and preliminary surveys to obtain levels of salient points.

(c) Sextant : Used for measuring horizontal and vertical angle.

(d) Planimeter : Used to measure the area of the given figure.

61. (d)

$$C = 180° - (A + B)$$

$$= 180° - 42°32'40'' - 51°29'20''$$

$$= 85°58'00''$$

Weight of A + B

$$= \text{Reciprocal of } \left(\frac{1}{3} + \frac{1}{2}\right)$$

$$= \frac{6}{5}$$

$\therefore$ Weight of C

$$= \text{Weight of } [180° - (A + B)]$$

$$= \frac{6}{5}.$$

62. (b)

63. (a)

- Sleeper spacing = Width of sleeper + 2 × (depth of ballast) min.

$$d_{min} = \frac{68.4 - 25.4}{2} = 21.5 \text{ cm}$$

- A minimum cusion of 15–20 cm of ballast below the sleeper bed is normally prescribed on IR.

64. (a)

65. (b)

66. (c)

$$R = 80 \text{ m}$$

$$V = 72 \times \frac{5}{18} = 20 \text{ m/s}$$

$$C = \frac{80}{75 + V} = \frac{80}{75 + 72} = 0.544$$

$0.5 < 0.544 < 0.8$

Length by Jerk criteria

$$= \frac{V^3}{CR} = \frac{20^3}{0.544 \times 80}$$

$$= 183.8235 \text{ m}$$

Length by IRC equation for hilly terrain

$$= \frac{V^2}{R} = \frac{72^2}{80} = 64.8 \text{ m}$$

$$\text{Ratio} = \frac{183.8235}{64.8} = 2.84$$

67. (a)

Effective green time

$= 27 + 4 - (2 + 1)$

$= 28$ sec

Green ratio $= \frac{g_i}{C} = \frac{28}{60}$

Saturation flow $= \frac{3600}{2.4} = 1500$ veh/hr

Capacity = Saturation flow × green ratio

$= 1500 \times \frac{28}{60} = 700$ veh/hr/lane

68. (c)

Reciprocating pump are used for high heads and low discharge.

69. (b)

70. (b)

71. (b)

72. (b)

Above the broad crested weir, flow is critical, so specific energy above hump will be E_c.

$E_1 = E_2 + \Delta z$

$\Delta z = E_1 - E_2$

For flow to be critical,

$E_2 = E_c$

= minimum specific energy

$\Delta z \geq (E_1 - E_c)$

73. (b)

74. (b)

75. (b)

As per IS 456-2000, for a continuous beam having span less than 10m, the limiting ratio of span to effective depth is 26.

But for span more than 10m,

$\frac{\text{Span}}{\text{Effective depth}} = 26 \times \frac{10}{\text{Span}}$

$= 26 \times \frac{10}{13} = 20$

$\Rightarrow \frac{\text{Span}}{\text{Effective depth}} = 20$

76. (b)

Slope of beam due to prestressing moment, θ_1

$= 5 \times 10^{-4}$ radian

Slope of beam due to loading, θ_2

$= 2.5 \times 10^{-3}$ radian

If $\theta_2 > \theta_1$, there will be net elongation of steel reinforcement.

Net elongation $= 2e(\theta_2 - \theta_1)$

$= 2 \times 45 \times (2 \times 10^{-3})$

$= 0.180$ mm

Gain of stress in steel due to elongation

$= \frac{2e\theta}{\ell} \times E_S$

$= \frac{0.18}{5000} \times 200 \times 10^3$

$= 7.2$ N/mm^2

% increase

$= \frac{7.2}{1200} \times 100\% = 0.60\%$

77. (a)

The permissible shear stress in Punching, when shear reinforcement is not provided, shall not exceed $K_S \tau_C$.

$K_S = (0.5 + \beta_C) \not> 1$

$\beta_C = \frac{\text{Short side of column}}{\text{Long side of column}}$

$\tau_C = 0.25(f_{ck})^{1/2}$

So, $\tau_C = 0.25(25)^{1/2} = 1.25$ N/mm^2

$\beta_C = 1$, $K_S = 0.5 + 1 \not> 1$

$= 1$

$\tau_V \leq K_S \tau_C = 1 \times 1.25$ N/mm^2

$= 1.25$ N/mm^2

78. (d)

L = unsupported length

= Clear distance between the floor

= 4000 mm

$e_{x_{min}} \equiv \max\left(\frac{L}{500} + \frac{D}{30}, 20 \text{ mm}\right)$

$\equiv \max\left(\frac{4000}{500} + \frac{600}{30}, 20 \text{ mm}\right)$

$= 28$ mm

$e_{y_{min}} \equiv \max\left(\frac{L}{500} + \frac{D}{30}, 20 \text{ mm}\right)$

$\equiv \max\left(\frac{4000}{500} + \frac{450}{30}, 20 \text{ mm}\right)$

$= 23$ mm

79. (c)

(i) In warm clouds, ambient temperature is above freezing point. Coalescence is the process by which two or more droplets, bubbles merge during contact to form a single droplet or bubble.

(ii) As the saturation vapour pressure over ice is lower than over liquid water.

80. (c)

High infiltration capacity leads to more infiltration of rainfall resulting lesser surface runoff.

Vegetation cover provide resistance to flow giving more time for infiltration, leading to lesser surface runoff.

81. (b)

82. (a)

83. (b)

84. (d)

85. (c)

$$\text{Economical depth} = \left[\frac{MK\gamma_{m_0}}{f_y}\right]^{1/3}$$

$$= \left[\frac{1234\times10^6\times60\times1.1}{250}\right]^{1/3}$$

$$= [325776000]^{1/3}$$

$$= 688 \text{ mm}$$

86. (b)

$$\frac{b}{t_f} = \frac{100}{10} = 10$$

$$\text{As } 9.4\in < 10 < 10.5\in \left(\text{where } \varepsilon = \sqrt{\frac{250}{f_y}}\right)$$

The section is compact.

87. (a)

$$t \geq \sqrt{\frac{2.5w(a^2-\mu b^2)}{f_y/\gamma_{mo}}}$$

$$t \geq \sqrt{\frac{1.1\times2.5\times64000\times10^3\times(50^2-0.3\times25^2)}{250\times10^6}}$$

$$t \geq 40.35 \text{ mm}$$

88. (c)

Minimum width = 3 (nominal dia of rivet)

$$= 3\times16$$

$$= 48 \text{ mm}$$

89. (a)

l_j = 1000 > 150 × 0.7 × 8 (150 × Throat thickness)

= 1000 > 840 mm

β_{lw} (design capacity reduction factor)

$$= 1.2-\frac{0.2l_j}{150t_t}\leq1.0$$

$$= 1.2-\frac{0.2\times1000}{150\times8\times0.7}$$

$$= 0.96\leq1.0$$

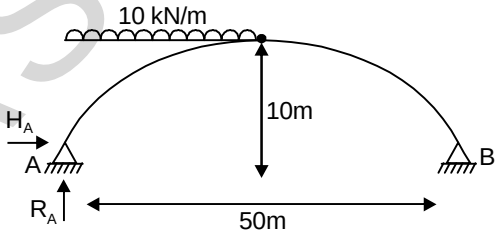
90. (d)

The maximum cover which will ensure reduced crack width should not be more than 75 mm.

91. (c)

92. (c)

93. (c)



$$H_A = H_B = \frac{w\ell^2}{16h}$$

$$= \frac{10\times50^2}{16\times10} = 156.25\text{kN}$$

$$M_B = 0$$

$$R_A\times50-10\times25\times37.5 = 0$$

$$R_A = 187.5 \text{ kN}$$

$$V_{x_{10}} = 187.5-10\times10 = 87.5 \text{ kN}$$

$$H_{x_{10}} = 156.25 \text{ kN}$$

Normal Thrust

$$= V_{x_{10}}\sin\theta+H_{x_{10}}\cos\theta$$

$$\left[\because \tan\theta = \frac{4h}{l^2}(l-2x)\right.$$

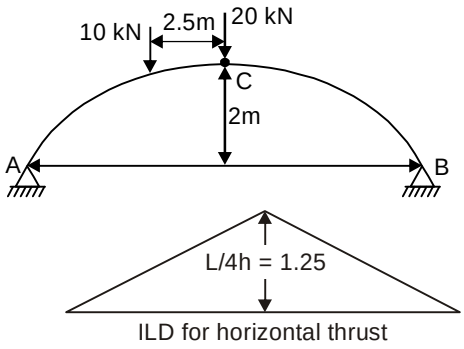
$$= \frac{4\times10}{50^2}(50-2\times10)$$

$$= 0.48]$$

$\therefore$ Normal thrust = 87.5 × 0.4 + 0.9 × 156.25 = 175 kN

94. (a)

The influence line diagram for horizontal thrust is linear. Maximum thrust will be induced when 20 KN is at the crown.



ILD for horizontal thrust

Ordinate of ILD at 2.5 m from A

$$= \frac{1.25}{2} = 0.625$$

Max. Horizontal thrust

$$= 20 \times 1.25 + 10 \times 0.625$$

$$= 31.25 \text{ kN}$$

95. (b)

All three reactions (external) are not parallel but concurrent, therefore the given structure (truss) is externally unstable.

No. of Joints = 9

No. of member = 11

No. of member needed = $2j - 3$

$$= 2 \times 9 - 3$$

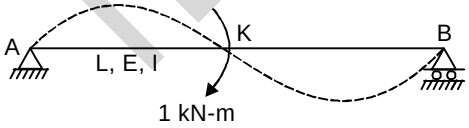
$$= 15$$

Since 11 < 15

It is internally unstable.

96. (b)

97. (a)

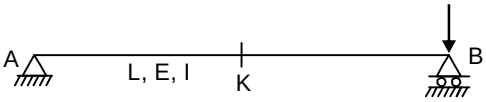


Applying unit moment at K

$$f_{11} = \frac{L}{12EI}$$

$$f_{21} = 0$$

$$f_{31} = -\frac{L}{24EI}$$

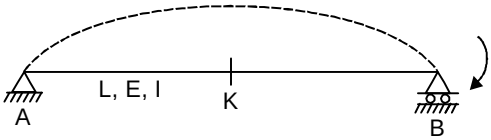


Applying unit load at point B

$$f_{22} = 0$$

$$f_{12} = 0$$

$$f_{32} = 0$$



Applying unit moment at B

$$f_{13} = -\frac{L}{24EI}$$

$$f_{23} = 0$$

$$f_{33} = \frac{L}{3EI}$$

$$[f] = \begin{bmatrix} \frac{L}{12EI} & 0 & -\frac{L}{24EI} \\ 0 & 0 & 0 \\ -\frac{L}{24EI} & 0 & \frac{L}{3EI} \end{bmatrix}$$

98. (b)

At joint A

Stiffness of AB = $\frac{4EI}{L}$

Stiffness of AC = $\frac{3EI}{L}$

Distribution Factor,

$$D_{AB} = \frac{K_{AB}}{K_{AB} + K_{AC}} = \frac{4}{7}$$

Similarly,

$$D_{AC} = \frac{3}{7}$$

Fixed end moments,

$$F_{AB} = -\frac{PL}{8}$$

$$F_{BA} = \frac{PL}{8}$$

$$M_{AC} = \frac{3}{7}\left(\frac{PL}{8}\right)$$

$$M_{AB} = \frac{4}{7}\left(\frac{PL}{8}\right) - \frac{PL}{8} = PL\left(\frac{1}{14} - \frac{1}{8}\right)$$

$$= PL\left(\frac{4-7}{56}\right) = \frac{-3PL}{56}$$

$$|M_{AB}| = \frac{3PL}{56}$$

99. (d)

100. (c)

Sway will occur along the lesser stiff column. Sway can occur with eccentric loading having symmetric stiffness.

101. (c)

The Froude number for a given Q at any depth y will be :

$$F = \frac{Q}{\sqrt{g(A^3/T)}}$$

$$F = \frac{Q\sqrt{T}}{\sqrt{g}\sqrt{A^3}}$$

$$= \frac{19.8\sqrt{2}}{\sqrt{10}\sqrt{\left(\frac{\pi}{2}\right)^3}}$$

$$= \frac{19.8\times 2\sqrt{2}}{\sqrt{5}\,\pi\sqrt{\pi}} = \frac{25}{\pi\sqrt{\pi}}$$

102. (b)

For a hydraulic jump,

$$\frac{Y_2}{Y_1} = \frac{1}{2}\left[-1+\sqrt{1+8F_1^2}\right]$$

$$\frac{8.0}{Y_1} = \frac{1}{2}\left[-1+\sqrt{1+8\times 11.67^2}\right]$$

$$Y_1 = 0.50 \text{ m}$$

103. (d)

Area of pan = $\frac{\pi}{4}\times 1.5^2 = 1.767\ m^2$

Evaporation in a day

$$= \frac{\text{Evaporation} + \text{Rainfall}}{\text{Area}}$$

Rate of Evaporation

$$= \frac{10+15}{1.767\times 24} = 0.59\,mm/h/m^2$$

104. (a)

The direct runoff

$$A = 280 \text{ ha}$$

$$C = \frac{C_1A_1 + C_2A_2}{A}$$

$$C = 0.35\times 0.6 + 0.65\times 0.8$$

$$C = 0.736$$

$$Q = CiA$$

$$Q = 0.73\times\frac{80\times 10^{-3}}{24\times 60\times 60}\times 280\times 10^4$$

$$Q = 1.89\ m^3/s$$

105. (c)

Porosity of aquifer can be written as

η = Specific Yield + Specific Retention

$$0.30 = \frac{1890}{\text{Volume of Aquifer}} + \frac{\text{Retention}}{\text{Volume of Aquifer}}$$

Retention = $10^6 \times 0.3 \times 24.5 \times 325 - 1890 \times 10^6$

= 498.7 million m^3.

106. (b)

To calculate the discharge Q_2

$$D = \frac{I_1+I_2}{2}\Delta t - \frac{(Q_1+Q_2)}{2}\Delta t$$

$$-120 = \frac{50+150}{2}\times 6 - \frac{(100+Q_2)}{2}\times 6$$

$$Q_2 = 140\ m^3/h$$

107. (d)

Choice of Network Type

(i) Precedence networks (A-O-N) are more widely used where repetitive task are involved and where overlapping and interdependencies of activities are major feature of project.

(ii) Activity over arrows are considered better for the representation of complex projects where there is not a high degree of repetitive work.

108. (b)

When there is salvage value of the equipment, the average value of the equipment is calculated as

$$P_{av} = \frac{P(n+1)+S(n-1)}{2n}$$

$$P_{av} = \frac{75000(6+1)+20000(6-1)}{2\times 6}$$

$$P_{av} = 52083$$

109. (c)

If the depth of the face from which a shovel is excavating material is too shallow, cycle time increases, hence the output is reduced.

110. (c)

Work done to split into smaller droplet.

As volume will remain same

$$\frac{4}{3}\pi R^3 = \frac{4}{3}\pi r^3 n$$

$$R = (216)^{1/3} r$$

$$R = 6r$$

Work done = Change in surface energy

$$= 72\times10^{-3}[4\pi r^2\times216-4\pi R^2]$$

$$= 72\times10^{-3}[4\pi R^2]\left[\frac{1}{36}\times216-1\right]$$

$$= 0.724 \text{ Joule}$$

111. (b)

The Hydrostatic Force (F)

$$F = \gamma A\bar{x}$$

$$F = 9.81\times10^3\times\frac{2}{3}\times0.4\times \times0.6\times\left[0.2+\frac{3\times0.6}{5}\right]$$

$$F = 0.88 \text{ kN}$$

112. (a)

For possible flow, steady and incompressible, continuity equation should be satisfied.

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z} = 0$$

$$2xy^2-3\lambda x^2y+\frac{4}{5}\times2x^2y-\frac{2}{3}\times x\times3y^2=0$$

$$\frac{8}{5}x^2y = 3\lambda x^2y$$

$$\lambda = \frac{8}{15}$$

113. (b)

For a turbulent layer if

$$\frac{V}{V_0} = \left(\frac{Y}{\delta}\right)^{1/3}$$

$$\frac{\theta}{\delta} = \frac{m}{(m+1)(m+2)}$$

$$\theta = 60\times\frac{3}{4\times5}$$

$$\theta = 9 \text{ mm}$$

114. (a)

$$\text{Power Ratio} = F_rV_r$$

$$= \rho_rL_r^3\sqrt{L_r}$$

$$= \rho_rL_R^{7/2} \quad [\rho_r=1]$$

$$= \left[\frac{1}{100}\right]^{7/2}$$

$$= 1\times10^{-7}$$

115. (c)

The total pressure head acting at the bottom of the column is an algebraic sum of the pressure due to centrifugal action and the weight of the liquid column.

Total pressure head

$$= \left(1+\frac{1}{g}\frac{V^2}{r}\right)h$$

$$= 0.75\left(1+\frac{1}{9.81}\times\frac{3^2}{25}\right)$$

$$= 0.778 \text{ m}$$

116. (c)

The path durations are ;

$1\to2\to6\to7 = 15$

$1\to3\to4\to6\to7 = 20$

$1\to3\to5\to7 = 23$

The critical path is $1\to3\to5\to7$ and duration of the project is 23 unit.

117. (b)

118. (b)

EPC stands for engineering procurement and construction.

119. (c)

A GPS receiver uses trilateration (a more complex version of triangulation) to determine its position on the surface of the earth.

120. (d)

121. (b)

122. (b)

123. (d)

Autotrophs derive 'C' for their growth from CO_2. Hence, they have to spend energy in reducing 'CO_2' to 'C' thus energy available for their reproduction is less, thereby growth rate is less whereas heterotropes derive 'C' from organic matter directly. Hence, energy is not spent in getting 'C', thereby, their reproduction rate is more.

124. (c)

The septic tank effluent has a BOD_5 of about 180 mg/l without an effluent filler and about 130 mg/l if an effluent filter is used in the system. Usually, the BOD_5 limit to allow wastewater to be discharged to surface waters is 20 mg/l or less, so the BOD_5 of a septic effluent is too high to allow for surface water discharge. However, as further treatment occurs in the soil absorption fields can be used to safely dispose off the partially treated septic tank effluent.

125. (a)

Due to diffused aeration organic solids remains in suspension while grit settles out.

126. (b)

In turbulent flow, both turbulent shear and viscous shear is present.

127. (a)

128. (a)

129. (b)

130. (a)

131. (d)

Shotcrete is frequently more economical than conventional concrete because of less formwork requirement, requiring only a small portable plant for manufacture and placement.

132. (c)

The term dry pressing is not strictly correct because in many cases, the materials being pressed contain from 3 to 15% water.

133. (b)

134. (c)

Flow net is independent of permeability of soil.

135. (b)

136. (d)

Grain size of montmorillonite is minimum.

137. (d)

Piping failures can be prevented by providing sufficient length of the impervious floor so that path of percolation is increased and the exit gradient is decreased.

138. (b)

Here both assertion and reason are correct but reason is not correctly explaining assertion because clay soils have better water holding capacity means that they are having more number of capillary pores not vice-versa.

139. (a)

The plain alidade is not very much suitable on hilly area since the inclination of the line of sight is limited in hilly areas.

- A string is used to join the tips of the two vanes when sights of considerable inclination have to be taken.
- The telescopic alidade is used when it is required to take inclined sights.

140. (a)

To obtain overlaps, the aircrafts flies in a straight line to the extent possible. However, there can be problems in controlling the flight path of the aircraft. The aircraft may not fly in a straight line, it may be thrown off track due to atmospheric conditions such as air currents.

141. (c)

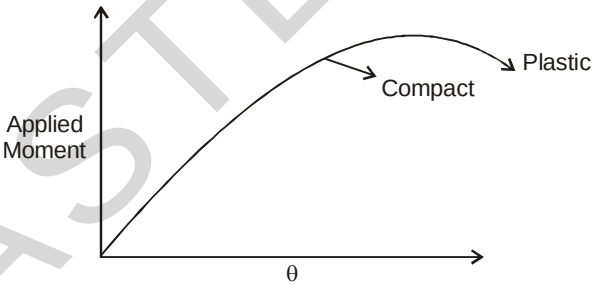
Total energy line always falls down but sudden rise or fall in TEL occurs due to pump and turbine respectively.

142. (a)

143. (a)

144. (c)

Plastic section have more reserve strength than compact sections.



145. (d)

For irrotational flow, Bernoulli's equation can be applied to all non-viscous region of fluid field.

146. (d)

147. (d)

The horizontal vibrations are the most damaging to masonry building.

148. (a)

149. (d)

For break in grade in an open channel, Y_C does not depend upon the slope (if Q = constant), the CDL is at a constant height above the channel bed in both slopes.

150. (b)

When water infiltrates, it starts moving laterally towards a stream and appears on the surface. This is known as interflow, It is above the ground water table. The velocity of flow is very low as compared to the surface flow. It is also known as subsurface storm flow, subsurface runoff, storm seepage and secondary base flow.