GATE - CIVIL ENGINEERING

MOCK TEST PAPER

- *There are a total of 65 questions carrying 100 marks.*
- *Questions (1-25) will carry 1-mark each and questions (26-55) will carry 2-marks each.*
- *Questions (56-65) belongs to general aptitude (GA). Questions (56-60) will carry 1-mark each, and question (61-65) will carry 2-marks each*
- *For Q.1-25 and Q.56-60 1/3 mark will be deducted for each wrong answer.For Q.26-51 and Q. 61-65 2/3 mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked questions.For Q.52 &54 2/3 mark will be deducted. There is no negative marking for Q.53 &Q.55.*
- *Q.48-51 are common data questions. If first question is attempted wrongly then answer of second question will not be evaluated.*
- *Pattern of questions : MCQs & Numerical*
- *Total marks : 100*
- *Duration of test : 3 Hours*

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1 In the matrix equation Px = q, which of the following is a necessary condition for the existence of at least one solution for the unknown vector x?

(A) Augmented matrix [Pq] must have the same rank as matrix P

(B) Vector q must have only non - zero elements

(C) Matrix P must be singular

(D) Matrix P must be square

2. An arbitrary vector X is an eigen vector of the matrix A = $\begin{bmatrix} 1 & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & b \end{bmatrix}$, if (a, b) =

(A) (0, 0)

(B) (1, 1)

(C) (0, 1)

(D) (1, 2)

3. The integration of $\int \log x . dx$ has the value

(A) (x log x – 1)

(B) log x – x

(C) x (log x – 1)

(D) None of these

4. If f(x) = | x |, then the interval [–1, 1], f(x) is

(A) Satisfied all the conditions of Rolle's Theorem

(B) Satisfied all the conditions of Mean Value Theorem

(C) Does not satisfied the conditions of Mean Value Theorem

(D) None of these

5. Differential equation,

$$\frac{d^2x}{dt^2}+10\frac{dx}{dt}+25x=0$$

will have a solution of the form

(A) $(C_1 + C_2 t)e^{-5t}$

(B) $C1\ e^{-2t}$

(C) $C_1 e^{-5t} + C_2 e^{5t}$

(D) $C1\ e^{-5t} + C_2 e^{2t}$

Where C_1 and C_2 are constants.

6. For the differential equation $\frac{dy}{dt}+5y=0$ with y(0) = 1, then general solution is

(A) e^{5t}

(B) e^{-5t}

(C) $5e^{-5t}$

(D) $e^{\sqrt{-5t}}$

7. For | z | = 1, where C is the circle, f(z) = $\frac{z-3}{z^2+2z+5}$ is

(A) 0

(B) 1

(C) 2

(D) none of these

8. If A and B are independent and P (C)= 0, then A, B and C are independent

(A) True

(B) False

(C) Both (a) and (b)

(D) None of these

9. Following are the value of a function

$y(x)$: $y(-1) = 5$, $y(0)$, $y(1) = 8$

$\frac{dy}{dx}$ at $x = 0$ as per Newton's central difference scheme is ________

10. For any two events A and B

(A) $P(B) = P(A \cap B) + P(\bar{A} \cap B)$

(B) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

(C) $P(A/B) \leq P(A)$.

(D) All of these

11. Which of the following statements is incorrect?

(A) Minimum cross-sectional area of longitudinal reinforcement in a column is 0.8%

(B) Spacing of longitudinal bars measured along the periphery of column should not exceed 300 mm.

(C) Reinforcing bars in a column should not be less than 12 mm in diameter.

D) The number of longitudinal bars provided in a circular column should not be less than four.

12. The following two statements are made with reference to a simply supported under-reinforced RCC beam:

I. Failure takes place by crushing of concrete before the steel has yielded.

II. The neutral axis moves up as the load is increased.

With reference to the above statements, which of the following applies?

(A) Both the statements are false

(B) I is true but II is false

(C) Both the statements are true

(D) I is false but II is true

13 A member of a roof truss consists of two angle iron 80× 50 × 6 mm placed back to back on both side of an 8 mm thick gusset plate. Number of 16 mm power driver field rivet when member carries a 71 kN direct load will be

(A) 3

(B) 4

(C) 2

(D) 5

14 A column has effective length l, when both ends are fixed. What will be the new effective length if one end becomes hinged?

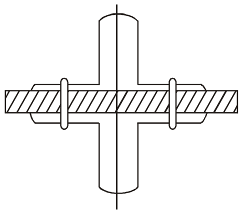
(A) l

(B) 0.5 l

(C) 1.41 l

(D) 2l

15. ________ is the net area of a tension member consisting of 4 ISA 75 × 75 × 8 mm connected by 18 dia rivet as shown in the figure?



16. The liquid of a soil mass is 20% and its plastic limit is 25%, then the plasticity index of this soil is

(A) 5

(B) –5

(C) 0

(D) None of these

17. A soil sample in its natural state has a mass of 2.290 kg and a volume of 1.15×10^{-3} m^3. After being oven dried the mass of the sample is 2.035 kg. G_s for soil is 2.68. The void ratio of the natural soil is

(A) 0.40

(B) 0.45

(C) 0.55

(D) 0.51

18. A horizontal stratified soil deposit consists of three layers each uniform in itself. The permeability of the layers are 8×10^{-4}, 50×10^{-4} and 15×10^{-4} cm/sec; and their thicknesses are 6, 3 and 12 m respectively. Then the average permeability of the deposit in horizontal and vertical directions respectively are

(A) 15×10^{-4} cm / sec and 13.04×10^{-4} cm / sec

(B) 13.04×10^{-4} cm/sec and 18×10^{-4} cm/sec

(C) 18×10^{-4} cm / sec and 13.04×10^{-4} cm / sec

(D) 13.04×10^{-4} cm / sec and 15×10^{-4} cm/ sec

19. The increase in metacentric height

(i) Increases stability

(ii) Decreases stability

(iii) Increases comfort for passengers

(iv) Decreases comfort passengers

The correct answer is

(A) (i) and (iii)

(B) (i) and (iv)

(C) (ii) and (iii)

(D) (ii) and (iv)

20. If the velocity is zero half of the cross - sectional area and is uniform over the remaining half, then the momentum correction factor is __________.

21. The magnitude of the component of velocity at [point (1, 1) for a stream function $y = x^2 - y^2$ is equal to

(A) 2

(B) $2\sqrt{2}$

(C) 4

(D) $4\sqrt{2}$

22 Rain gauge station X did not function for a part of a month during which a storm occurred. The storm produced rainfalls of 84, 70, and 76 mm at three surrounding stations A, B, and C respectively. The normal annual rainfalls at the station X, A, B, and C are respectively 770. 882, 736 and 944 mm. The missing storm rainfall at station X will be

(A) 70 mm

(B) 75 mm

(C) 80 mm

(D) 95 mm

23 The average annual rainfalls in cm at 4 existing raingauges stations in a basin are 105, 79, 70 and 66. If the average depth of rainfall over the basin is to be estimated within 10% error, then the addition number of gauges needed will be

(A) 1

(B) 2

(C) 3

(D) 4

24 A drainage basin has an area of 210 km^2. The average depth of rainfall received by it during a monsoon period is computed as 65 cm, while the runoff measured at its outlet during the same period is estimated to be 5.68×10^7 m^3. What percentage of rainfall has become runoff?

(A) 50.5%

(B) 41.62%

(C) 61.42%

(D) 38%

25. During a daily routine observation, 10.8 litre of water was added to bring the water surface in the evaporation pan to the stipulated level and the nearby rain gauge measured 3.6 mm of rainfall. What was the evaporation recorded for the day if the diameter of the pan is 122 cm?

(A) 10.45 mm

(B) 11.68 mm

(C) 12.84 mm

(D) 13.94 mm

26. The base period for a particular crop is 50 days and the duty of the canal is 500 hectares for per cumec the depth of water will be _____________.

27. The amount of irrigation water required to melt the evapotranspiration needs of the crop during its full growth is called

(A) Effective rainfall

(B) Consumptive

(C) Consumptive irrigation requirement

(D) Net irrigation requirement

28. Irrigating water having the concentration of Na^{+}, Ca^{++} and Mg^{++} as 20, 3 and 1 milli equivalent per litre respectively will be classified as

(A) Low sodium

(B) Medium sodium water

(C) High sodium water

(D) Very high sodium water

29. If the electrical conductivity of water is in between 250 to 750 mho's/cm at 25°C, then its classified as

(A) Low salinity water

(B) Medium salinity water

(C) High salinity water

(D) Very high salinity water

30. If the average daily consumption of a city is 100,000 m^3, the maximum daily consumption on peak hourly demand will be

(A) 100,000 m^3

(B) 150,000 m^3

(C) 180,000 m^3

(D) 270,000m^3

31. If the total hardness of water is greater than its total alkalinity, the carbonate hardness will be equal to

(A) Total alkalinity

(B) Total hardness

(C) Total hardness - total alkalinity

(D) Non-carbonate hardness

32. If the diameter of the main pipe is taken less than economic diameter, then

1. Head loss will be high

2. Cost of pipe will be less

3. Cost of pumping will be less of these statements.

(A) Only 1 is correct

(B) 1 and 2 are correct

(C) 1 and 3 are correct

(D) 1, 2 and 3 are correct

33. A city supply of 1500 cubic metres of water per day is treated with a chlorine dosage of 0.5 ppm. For this purpose, the requirement of 25% bleaching powder per day would be ________.

34. Large industrial stationary sources may have airborne lead levels of

(A) 1–2 $\mu g/m^3$

(B) 3 to 5 $\mu g/m^3$

(C) 20–30 $\mu g/m^3$

(D) > 300 $\mu g/m^3$

35. In a recuperation test of an open well the specific yield was found to be 0.5. The diameter of the well is 1.0 m and it is under a constant depression head of 4.0 M. Then the discharge form the well is

(A) $\frac{\pi}{2}$

(B) $\frac{\pi}{4}$

(C) 2π

(D) $\frac{3\pi}{4}$

36. Most widespread air pollutants are

(A) So_x

(B) NO_x

(C) CO

(D) Hydrocarbons

37. Two sources generate noise levels of 90 dB and 94 dB respectively. The cumulative effect of these two noise levels on the human ear is

(A) 184 dB

(B) 95.5 dB

(C) 94 dB

(D) 92 dB

38. The sound pressure level for a jet plane on the ground with sound pressure of 2000 μ bar should be

(A) 60 decibel

(B) 100 decibel

(C) 140 decibel

(D) 180 decibel

39. What type of noise can be abated by providing lining on walls and ceiling with sound absorbing materials?

(A) Source noise

(B) Reflection noise

(C) Structural noise

(D) Direct air-borne noise

40. What is the stopping sight distance for design speed of 80 kmph for two way traffic on a single lane road? Assume coefficient of friction as 0.35 and reaction time as 2 sec?

(A) 116.47 m

(B) 122 m

(C) 232.94

(D) 244 m

41. What is the stopping sight distance on a highway at a descending gradient of 2% for a design speed of 80 kmph assuming the data for reaction time as 2.5 sec and co-efficient of friction as 0.35 ?

(A) 132 m

(B) 140 m

(C) 125 m

(D) 120 m

42. What is the minimum length of overtaking zone for a design speed of 96 kmph assuming the data, acceleration as 0.69 m/s^2 and reaction time as 2 sec and traffic road as one way?

(A) 342 m

(B) 684 m

(C) 1026 m

(D) 1710 m

43. The radius of horizontal circular curve is 100 m. The design speed is 50 kmph and the design coefficient of lateral friction is 0.15. Calculate that supper elevation required if full lateral friction is assumed to develop.

(A) 0.037

(B) 0.047

(C) 0.057

(D) 0.067

44. If the staff intercept on a staff located at 100 m from the level for five division deviation of the bubble is 0.050 m and if the length of one division of the bubble tube is 2 mm , then the radius of the curvature of the bubble tube is _________.

45. A sewer is laid from a manhole A to a manhole B, 250 m apart along a downward gradient of 1 in 125. If the reduced level of the invert at A is 205.75 m and the height of the boning rod is 3 m, reduced level of the sight rail at B, is

(A) 202.75 m

(B) 206.75 m

(C) 208.75 m

(D) 211.75 m

46. The deflection angle between the tangents drawn at the ends of a transition curve is 7°. The radius of the curve at the end is 400 m. What is the length of the transition curve?

(A) 60.00 m

(B) 97.74 m

(C) 120.00 m

(D) 150.00 m

47. In the matrix equation Px = q, which of the following is a necessary condition for the existence of at least one solution for the unknown vector x?

(A) Augmented matrix [Pq] must have the same rank as matrix P

(B) Vector q must have only non - zero elements

(C) Matrix P must be singular

(D) Matrix P must be square

Statement for common data Questions 48 and 49

A city has to treat 24 MLD of turbid water using rapid sand filters with a filtration rate of $5m^3/h/m^2$.

48. The required area of filter bed if L : B = 2 : 1 (only one unit of filter is to provided) will be

(A) 110 m^2

(B) 210 m^2

(C) 310 m^2

(D) 510 m^2

49. What is the percentage of filtered water that is required to backwash the filter, if rate of back wash is 6 times the rate of filtration and duration of backwash is 10 minutes ? Backwashing is done one a day.

(A) 2.2

(B) 3.2

(C) 4.2

(D) 6.2

Statement for common data Q. 50 and 51.

An average operating data for conventional activated sludge treatment plant is as follows.

Waste water flow = 3500m^3/day

Volume of aeration tank = 10900 m^3

Influent BOD = 250 mg/1

Effluent BOD = 20 mg/1

Mixed liquor suspended solids (MLSS) = 2500 mgl

Effluent suspended solids = 30 mg/ 1

Waste suspended solids = 9700 mg/1

Quantity of waste sludge = 220 m^3/d

50. Aeration period (hrs) will be _________.

51. Efficiency of BOD removal will be ___________.

Statement for Linked Answer Q. (52-53)

A doubly reinforced rectangular concrete beam has a width of 300 mm and an effective depth of 500 mm. The beam is reinforced with 2200 mm^2 of steel in tension and 628 mm^2 of steel in compression. The effective cover for compression steel is 50 mm. Assume that both tension and compression steel yield. The grades of concrete and steel used are M20 and Fe250, respectively. The stress block parameters (rounded off to first two decimal places) for concrete shall be as per IS 456 : 2000.

52. The depth of neutral axis is ___________.

53. The moment of resistance of the section is _________.

Statement for linked Answer Q. 54-55

A certain crop is grown in an area of 3000 hectare, which is fed by a system. The data pertaining to irrigation are

Field capacity of soil = 26%

Optimum moisture = 12%

Permanent wilting point = 10%

Effective depth of root zone = 80cm

Apparent relative density of soil = 1.4

The frequency of irrigation is 10 days and overall irritgation efficiency is 22%,

54. The daily consumptive use will be

(A) 0.568 cm

(B) 2.068 cm

(C) 1.568 cm

(D) 2.068 cm

55. The water discharge (in m3/s) in the canal feeding the area approximately will be

(A) 20

(B) 25

(C) 30

(D) 40

56. No doubt, it was our own government but it was being run on borrowed ideas, using _________solutions.

(A) Worn out

(B) Second hand

(C) Impractical

(D) Appropriate

The question below consists of pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair:

57. Ratify: Approval:

(A) Mutate: change

(B) Pacify: conquest

(C) Duel: combat

(D) Appeal: authority

58. Speed of a railway engine is 42 km per hour when no compartment is attached and the reduction in speed is directly proportional to the square root of the number of compartments attached. If speed of the train carries by this engine is 24 km per hour when 9 compartments are attached, then maximum number of compartments that can be carried by the engine is

(A) 49

(B) 48

(C) 46

(D) 47

59. Some critics believe that Satyajit Ray never quite came back to the great beginning he made in this path breaking film Pather Panchali. ______have endured decades of well-travelled bad prints to become a signpost in cinematic history.

(A) The bizarre history of its misty origins

(B) Its haunting images

(C) Its compelling munificence

(D) The breathtaking awe it inspires

Choose the most appropriate word from the options given below that is most nearly opposite in meaning to the given word:

60. Valedictory

(A) Sad

(B) Collegiate

(C) Derivative

(D) Generosity

Each of the 11 letters A, H, I, M, O,T, U, V, W, X and Z appears same when looked at in mirror. They are called symmetric letters. Other letters in the alphabet are asymmetric letters.

61. How many four-letter computer passwords can be formed using the symmetric letters (no repetition allowed)?

(A) 7920

(B) 330

(C) 14640

(D) 419430

62. Look at this series: 58, 52, 46, 40, 34, ... What number should come next?

(A)26

(B)28

(C) 30

(D) 32

63. John has 8 friends. In how many ways can he invite one or more of them to dinner?

(A) 256

(B) 254

(C) 255

(D) 253

64. Consider the sets T_n = {n, n+1,n + 2,n + 3, n + 4}, where n = 1, 2, 3, ..., 96. How many of these sets contain 6 or any integral multiple there of (i.e., any one of the numbers 6, 12, 18...)?

(A) 80

(B) 81

(C) 82

(D) 83

Profit to sale-Table for three companies A, B and C for 1996-97

	Companies	1996	1997
Total units		**300000**	**400000**
Shares	A	5%	25%
	B	60%	40%
	C	35%	35%
Price (per unit) (in rupees)	A	10%	8%
	B	7%	14%
	C	9%	10%
Profit (per unit) (in rupees)	A	3%	1%
	B	0.5	5%
	C	2%	2.5

65. What is the increase in the total profits of company B in 1997?

(A) 800%

(B) 900%

(C) 750%

(D) 789%

ANSWER KEY

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Answer	A	B	B	C	A	B	A	A	1.5	D	D	A	C	C	32.04
Question	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Answer	C	D	C	B	2	B	B	A	B	C	86.4 cm	C	A	B	D
Question	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Answer	A	B	30 kg	D	A	A	B	C	B	C	A	C	B	20 m	B
Question	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Answer	B	A	B	C	7.5 h	92%	160 mm	210.29 kN-m	C	C	B	B	A	B	D
Question	**61**	**62**	**63**	**64**	**65**										
Answer	B	B	C	D	D										

HINTS AND SOLUTIONS

1.(A) According to Rouche's theorem, the system is consistent if and only if the coefficient matrix and the augmented matrix K are of the same rank, otherwise the system is inconsistent.

2.(B) since the matrix is triangular, the eigen values are α, a, b.

If (X_1, X_2, X_3) is an arbitrary eigen vector, say corresponding to 1, then

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & b \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 1\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

X_2, X_3 being not zero, we have, $X_1 = X_1$; a $X_2 = X_2$ which gives

$a = 1$

and $bX = X_3$ which gives $b = 1$

$\therefore$ $(a, b) = (1, 1)$.

3.(B) $\int \log x.dx = \log x.x - \int x.\frac{d}{dx}(\log x)dx$

$= x \log x - \int 1.\, dx$

$= x \log x - x$

$= x (\log x - 1)$

4.(C) Since $f(x) = |x|$ is continuous is $[-1, 1]$ be it is not differentiable at $x = 0 \in (-1, 1)$

5.(A) $\frac{d^2x}{dt^2} + 10\frac{dx}{dt} + 25x =]0$

$\Rightarrow$ $(D^2 + 10D + 25)\, X = 0$

$\Rightarrow$ $(D + 5)^2 = 0$

$\Rightarrow$ $D = -5, -5$

Hence solution is, $(C_1 + C_2 t)e^{-5t}$

6.(B) Given: $\frac{dy}{dt} + 5y = 0$

$\Rightarrow$ $\frac{dy}{y} = -5\, dt$

Integrating, we get

$\log_e y = c - 5t$

When $t = 0$, $y = 1$.

$\therefore$ $\log_e 1 = c - 5 \times 0$

$\Rightarrow \quad c = 0$

$\therefore \quad \log_e y = -5t$

$\Rightarrow \quad y = e^{-5t}$

7.(A) Poles of $f(z) = \dfrac{z-3}{z^2+2z+5}$ are given by

$z^2 + 2z + 5 = 0$

$\therefore \quad z = \dfrac{-2 \pm 4i}{2} = -1 \pm 2i$

Since, both poles lie outside the circle | z | = 1, therefore f(z) is analytic inside the circle

$\therefore \quad \oint \dfrac{z-3}{z^2+2z+5}\,dz = 0$

8. (A) $P(C) = 0$

$\Rightarrow \quad C = \phi$

$P(A \cap B \cap C) = P(A \cap B \cap \phi)$

$= P(\phi) = 0$

$P(A) \times P(B) \times P(C) = 0$ .....Since $P(C) = 0$

$\therefore P(A \cap B \cap C) = P(A) - P(B) - P(C)$

Hence A, B, C are independent.

9. **1.5**

$$\left(\frac{dy}{dx}\right)_{\text{at } x=0} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{y(1) - y(-1)}{1-(-1)} = \frac{8-5}{2} = 1.5$$

10.(D) (a) $B = (A \cap B) \cup (\bar{A} \cap B)$

$\Rightarrow \quad P(B) = P(A \cap B) + P(\bar{A} \cap B)$

$A \cap B$ and $\bar{A} \cap B$ are mutually exclusive.

$\Rightarrow \quad P(\bar{A} \cap B) = P(B) - P(A \cap B).$

(B) $\quad P(A \cup B) = P[A \cup (\bar{A} \cap B)]$

$= P(A) + P(\bar{A} \cap B)$

$= P(A) + P(B) - P(A \cap B)$

(C) $\quad P(A/B) = P(A)\, P(B/A)$

$\leq P(A)$ as $P(B/A) \leq 1$.

11.(D) Minimum number of longitudinal bars is

= 4 in rectangular column

= 6 in circular column

12.(A) Failure is taken place when steel has yielded.

Natural Axis depth is independent of loading.

13.(C) Strength of rivet in bearing on 8 mm gusset

$= \sigma_{pf}\, dt$

$= \frac{270 \times 17.5 \times 8}{1000} = 37.8$ kN

Strength of rivet in double shear

$= 2 \times \frac{\pi}{4} \times d^2 \times \tau_{\upsilon f}$

$= 2 \times \frac{\pi}{4} \times 17.5^2 \times \frac{90}{1000} = 43.3$ kN

$\therefore$ Rivet value pf 37.8 kN

Number of rivets $= \frac{71}{37.8} \approx 2$

14.(C) When both ends fixed,

$L_e = 0.6\ L$

$\therefore \quad L = \frac{L_{e1}}{0.6}$

When one end hinged, $L_e = 0.85\ L$

$\therefore \quad L = \frac{L_{e2}}{0.85}$

$\frac{L_{e1}}{0.6} = \frac{L_{e2}}{0.85}$

$\Rightarrow \quad L_{e2} = \frac{0.85}{0.6} L_{e1} = 1.41\ell$

15. **32.04 cm²**

$A_{net} = 4\ (A_1 + K\ A_2)$

$A_1 = 0.8\left[7.5 - \frac{0.8}{2} - 1.95\right] = 4.12\ cm^2$

$A_2 = 0.8\left[7.5 - \frac{0.8}{2}\right] = 5.68\ cm^2$

$A_{net} = 4\left[4.12 + 5.68 \times \frac{3 \times 4.12}{3 \times 4.12 + 5.68}\right]$

$= 32.04\ cm^2$

16.(C) PI = LL – PL

= 20 – 25 = – 5 < 0

17.(D) $\gamma = \frac{G\gamma_\omega(1+\omega)}{1+e}$

$$\omega = \frac{2.290 - 2.035}{2.035}$$

$$\gamma = \frac{2.290}{1.15 \times 10^{-3}} = 0.51$$

18. (C) $k_h = \frac{k_1H_1 + k_2H_2 + ... + k_nH_n}{H}$

$$k_u = \frac{H}{\frac{H_1}{k_1} + \frac{H_2}{k_2} + ... + \frac{H_n}{k_n}}$$

19.(B) Increase in metacentric height reduces the time period of rolling of the body which is quite uncomfortable for passengers.

20. **2**

$$\beta = \frac{1}{A}\int_{A/2}^{A}\left(\frac{v}{V}\right)^2 dA$$

$$\Rightarrow \quad \beta = 2$$

21. (B) $\because \quad u = \frac{\partial \psi}{\partial x} = 2x = 2$

$$v = \frac{\partial \psi}{\partial x} = -2y = -2$$

$$\therefore \quad |V| = \sqrt{v^2 + v^2} = 2\sqrt{2}$$

22.(B) $\frac{P_x}{N_x} = \frac{1}{3}\left[\frac{P_a}{N_a} + \frac{P_b}{N_b} + \frac{P_c}{N_c}\right]$

23.(A) Additional rain gauge = N – 4 = $\left(\frac{C_\upsilon}{\in}\right)^2 - 4$

Where, $\in$ = 10 %

$$C_\upsilon = \frac{\sigma_{n-1}}{\overline{x}} \times 100$$

24.(B) % of rainfall that become runoff

$$= \frac{5.68 \times 10^7 \times 100 \times 100}{210 \times 10^6 \times 65} = 41.62\%$$

25.(C) Evaporation = Depth of water added + Rainfall

$$= \frac{\text{Volume}(108000)}{\text{Area}\left[\frac{\pi}{4} \times (1220)^2\right]} + 3.6$$

26. 86.4 cm

$\Delta = 8.64\ \frac{B}{D}$

$= 8.64 \times \frac{50}{500} = 0.864$ m

= 86.4 cm

27.(C) It is equal to consumptive use -effective rainfall.

28. (A) Sodium absorption ratio = $\left[\frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}\right]$

$$= \left[\frac{20}{\sqrt{\left(\frac{3+1}{2}\right)}}\right] = 14.14$$

Which lies between 10 and 18?

S_2 – (10 – 18) which is medium salinity

29.(B) C_1 (100 – 250) mhos/cm – all crops low salinity

C_2 (250 – 750) mhos– ca be used when moderate amount of leaching occurs.

C_3 – 750 –2250 – only high salt tolerant soil

c_4 – 2250 and above mhos /cm – unsuitable for irrigation

30.(D) The maximum daily consumption on peak hourly day or maximum day

= 2.7 × (Average demand)

= 2.7 × 100,000

= **2.70,000 m^3**

31.(A) the carbonate hardness is equal to total hardness if total harness is equal to or less than total alkalinity.

The non carbonate harness = Total hardness – total alkanity.

32.(B) If diameter is less than economic diameter, the cost of pipe will be less but head loss will be high. Hence cost of pumping will be more.

33. **30 kg**

Amount of chlorine required daily

$$= \left[\frac{0.5 \times 15000 \times 10^3}{10^6}\right] = 7.5\text{kg}$$

Amount of bleaching powder required daily

$$= \frac{7.5 \times 1500}{25} = 30 \text{ kg}$$

34.(D) Large industrial stationary sources may have airborne lead levels of greater than 300 $\mu g/m^3$

35.(A) $q = \left(\frac{k}{A}\right) AH$

$$= 0.5 \times \frac{\pi}{4} \times 1^2 \times 4 = \frac{\pi}{4} m^3 / hr$$

36.(A) Most widespread air pollutants are So_x

37.(B) Two sources generate noise levels of 90 dB and 94 dB respectively. The cumulative effect of these two noise levels on the human ear is 95.5 dB

38.(C) The sound pressure level for a jet plane on the ground with sound pressure of 2000 μ bar should be 140 decibel

39.(B) Reflection noise can be abated by providing lining on walls and ceiling with sound absorbing materials

40.(C) SSD = 2[SD]

41.(A) SSD = $0.278 \times 2.5 + \frac{80^2}{254(0.350-0.02)}$

42.(C) Minimum length of overtaking zone

$$= 3(d_1 + d_2) = 3\,(V_b t + V_b T + 2\,S)$$

Where, V_b = (96 – 16)= 80 kmph,

$$t = 2 \text{ sec}, T = \sqrt{\frac{4\,S}{a}}$$

$$a = 0.69 \text{ m/s}^2$$

43.(B) $e = \frac{V^2}{127\,R} - 0.15$

where V is in kmph.

44. **20 m**

The radius of curvature of bubble tube is given by

$$\frac{\ln D}{S} = \frac{2/1000 \times 5 \times 100}{0.05} = 20.0 \text{ m}$$

45.(B) Reduce level of the invert at B

$$= 205.75 - \frac{250}{125} = 203.75 \text{ m}$$

$\therefore$ Reduced level of the sight rail at B

$$= 203.75 + 3.0 = 206.75 \text{ m}$$

46.(B) $V^2 = \frac{0.15}{1.5} \times 9.81 \times 200$

$\therefore$ V = 14m/sec

$$l = \frac{14^3}{0.3 \times 200} = 45.73 \text{ m} \approx 46 \text{ m}$$

47.(A) According to Rouche's theorem, the system is consistent if and only if the coefficient matrix and the augmented matrix K are of the same rank, otherwise the system is inconsistent.

48.(B) Filtration rate = 5m3/ h/m2 = 5' 103 lit/h/m^2.

Assume 4% as allowance for washeater

Since $\frac{235}{6}$ hours is actual duration of filtration, thus,

Filter area required = $\dfrac{\frac{24.96 \times 10^6}{23.83} \ell / h}{5 \times 10^3 \ell / h / m^2} = 209.48 m^2$

49.(C) Rate of backwash = 6 × 5

$$= 30c^3/h/m^2$$

Duration of backwashing = 10 minutes

$$= 1/6 \text{ hours.}$$

Backwash quantity required/m^2 = $\frac{30 \times 10^3}{6}$

$$= 5 \times 10^3 \text{ liters}$$

Area of filter = 210.125m2

Back wash quantity required = $5 \times 10^3 \times 210.25$

$= 1050.625 \times 10^3$

Percent of filtered water required for backwashing

$$= \frac{1050.625 \times 10^3}{24.96 \times 10^6} \times 100 = 4.2$$

50. 7.5 h

Given Q = 35000 m^3/d, V = 10900m^3,

Y_0 = 250 mg/1, Y_E = 20mg/l

X_t = 2500 mg/1, X_B = 30mg/l

X_R = 9700 mg/ 1, Q_W = 220m^3/d

Aeration period,

$$t = \frac{V}{Q}.24 = \frac{10,900}{35,000} \times 24 = 7.47h, say 7.5h$$

51. 92%

Efficiency of BOD removal

$$= \frac{\text{Incoming BOD} - \text{Outgoing BOD}}{\text{Incoming BOD}}$$

$$= \frac{250 - 20}{250} \times 100\% = 92\%$$

52. 160 mm

Given: b =300 mm, d = 500 mm,

A_{st} = 2200 mm²,

Depth of neutral axis in doubly reinforced beam,

$$x_u = \frac{f_{st}A_{st} - (f_{sc} - 0.44\, f_{ck})A_{sc}}{0.362\ f_{ck}b}$$

Here, $f_{st} = f_{sc} = 0.87 \times 250 = 217.5$

$$\therefore \qquad x_u = \frac{217.5 \times 2200 - (217.5 - 0.447 \times 20)628}{0.362 \times 20 \times 300}$$

= 160 mm

53. **210.29 kN -m**

Moment of resistance (under reinforced section), $M_u = 0.362\ f_{ck}\ b\ x_u\ (d - 0.416\ x_u) + (f_{sc} - 0.447\ f_{ck})\ A_{sc}\ (d - d')$

$= 0.362 \times 20 \times 300 \times 160.91\ (500 - 0.416 \times 160.91)$

= 210.29 kN -m

54.(C) Depth of water used by plants for growth, which is supplemented by irrigation after every 10 days.

$= \frac{\gamma d}{\omega}$ (Field capacity moisture content

– Optimum moisture content)

$$= \frac{1.4 \times 0.8}{10}(0.26 - 0.12)$$

= 0.1568m = 15.68 cm

Daily water consumption by plants

$$= \frac{15.68}{10} = 1.568$$

55.(C) Total irrigation water required i.e., losses in field and conveyance

$$= \frac{\text{NIR}}{\eta\ \text{irrigation}} = \frac{1.56}{0.22} = 7.127\text{cumec/day}$$

56.(B) No doubt, it was our own government but it was being run on borrowed ideas, using second hand solutions.

57.(B) Ratify: Approval:: duel: combat

58.(A) Total distance covered

$= 35 + 270 + 80 = 385$ km.

$= 1 + 3 + 2\frac{1}{2}$ hrs.

$= 13/2$ hrs

Average speed $= \frac{D}{T} = \frac{385 \times 2}{13}$

$= 59.23$ km/hr.

59.(B) some critics believe that Satyajit Ray never quite came back to the great beginning he made in this path breaking film Pather Panchali. Its haunting images have endured decades of well-travelled bad prints to become a signpost in cinematic history.

60(D) Generosity is nearly opposite to Valedictory.

61.(B) Count the number of squares in the figure and multiply it by 3.

62.(B) This is a simple subtraction series. Each number is 6 less than the previous number.

63.(C) 4 = good 7 = picture and 2 and 9 = are and faint respectively

64.(D) $\frac{X}{1} + \frac{X}{2} + \frac{X}{4} = 35$ or $\frac{7X}{4}$

$= 35$ or $7X$

$= 35 \times 4$ or $X = 20$

65.(D) The increase in the total profits of company B in 1997 is 789%

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