No. of Pages : 5

Code : ESM-5
Subject : CIVIL ENGINEERING – 3
Question Paper

Time : 3 Hours Max. Marks : 200

Q. 1. If the expected time along the critical path of a project is 27 weeks and the standard deviation along it is 5 weeks, determine the probability of completing the project within 21 weeks and 33 weeks. Consider the following necessary data for calculation. **5**

Z	Probability (%)	Z	Probability (%)
–3.0	0.01	0.0	50
–2.5	0.60	0.5	69.15
–2.0	2.28	1.0	84.13
–1.5	6.67	1.5	93.32
–1.0	15.87	2.0	97.72
–0.5	30.85	2.5	99.38
0.0	50	3.0	99.87

Q. 2. Consider the network diagram, as shown in Fig. 1, and prove that the interfering float for any activity is equal to its slack value of the head event. Given that T_E is the Earliest Occurrence Time, T_L is the Latest Allowable Time, t_{ij} is the duration of the activity i-j. **5**

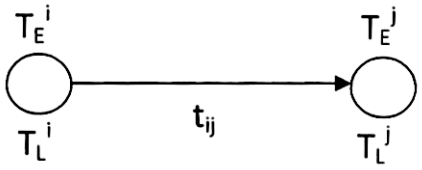

Fig. 1

Q. 3. Calculate the safe Stopping Sight Distance for design speed of 50 km/hr for

a) Two way traffic on a two lane road

b) Two way traffic on a single lane road

Give that brake reaction time is 2.5 seconds and coefficient of friction is 0.37. **5**

Q. 4. Define Ruling Gradient and Grade Compensation. If the ruling gradient is 1 in 20, then what will be the grade compensation and compensated gradient for a curve of radius 120 m. **5**

P.T.O.

Q. 5. What are faults in geology? Considering the 'faults', what precautions should be taken while designing
(i) Dams
(ii) Tunnels. **5**

Q. 6. Write short notes on expansion and contraction joints in rigid pavements. **5**

Q. 7. Calculate the maximum dry density for a soil sample having specific gravity of 2.65 and Optimum Moisture Content of 18%. **5**

Q. 8. 8 m thick layer of stiff saturated clay, having density of 19 kN/m^3, is lying over a layer of sand. The sand is under an artesian pressure of 5 m. Calculate the maximum depth of cut that can be made without causing a heave. **5**

Q. 9. The following results were obtained from a consolidated undrained test on a normally consolidated clay : **5**

Sample No.	Cell Pressure (kN / m^2)	Deviator Stress (kN / m^2)	Pore Water Pressure (kN / m^2)
1	250	152	120
2	500	300	250
3	750	455	350

Plot the strength envelope in terms of effective stresses and determine the strength parameter.

Q. 10. A precast concrete pile of size 60 cm × 60 cm is to be driven into clay strata whose unconfined comprehensive strength is 120 kN/m^2. Compute the length of the pile required to carry safe working load of 500 kN. Consider the factor of safety to be 2.5 and the adhesion factor as 0.7. **5**

Q. 11. The following staff readings were observed along a continuously sloping ground at a constant interval of 15 m on a vertically held staff with a level. Prepare a field book page and calculate the reduced level of the various points using any method if the reduced level of the point is 1997. **5**

Staff readings (in m): 1.360, 2.225, 3.785, 1.235, 2.705, 3.665, 0.385, 1.945, 3.275

Q. 12. A 30-m long tape was standardized at 20°C and under a pull of 100 N. The tape was used to measure a distance AB when the temperature was 45°C and the pull was 150 N. The tape was supported at the ends only. Find the corrections per tape length. Given that c/s of the tape is 4 mm^2, unit weight of the tape material is 0.0786 N/mm^3, coefficient of thermal expansion of the tape material is 11.5×10^{-6} / °C, E = 2000000 kN / m^2 . **5**

Q. 13. A sand deposit consists of two layers. The top layer is 2.5 m thick (density = 1709.67 kg / m^3) and bottom layer is 3.5 m thick (saturation density = 2064.52 kg / m^3). The water table is at a depth of 3.5 m from the surface and the zone of capillary saturation is 1 m above the water table. Draw the diagram showing the variation of total stress, neutral stress and effective stress. **10**

Q. 14. Two stations P and Q have a true difference in elevation of 0.5 m (fall from P to Q). The theodolite was kept in line with PQ and close to Q. The reading taken on P and Q, 200 m apart, were 1.865 and 1.305 m respectively. Find the angular error in collimation. At what length of sight will the error due to collimation be the same as that due to curvature and refraction ? **10**

Q. 15. For the network diagram of a project, as shown in Fig. 2, the data for the duration and costs of each activity are given in Table 1. Taking the indirect cost of the project is Rs. 4,000 per week, determine the optimum duration of the project and the corresponding minimum cost. **10**

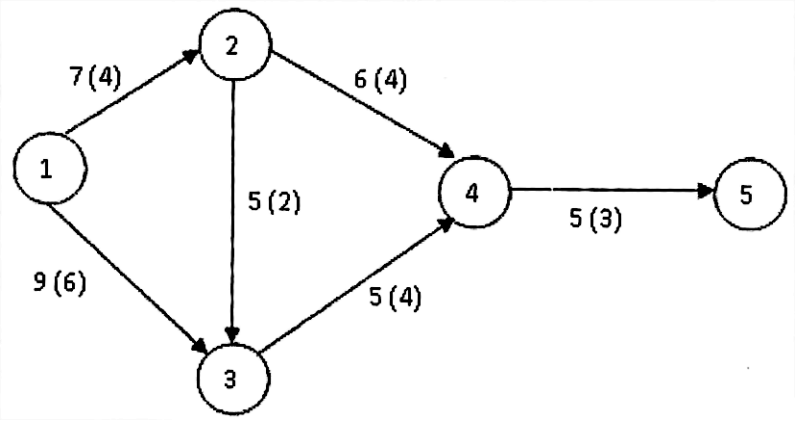

Fig. 2

Activity	Normal Duration (weeks)	Normal Cost (Rs.)	Crash Duration (weeks)	Crash Cost (Rs.)
1-2	7	7,000	4	14,500
1-3	9	4,000	6	8,500
2-3	5	6,000	2	9,000
2-4	6	8,000	4	15,000
3-4	5	5,000	4	11,000
4-5	5	9,000	3	13,000

Table 1

Q. 16. An express way of four-lane passing through a flat terrain has a horizontal curve of radius equal to ruling minimum radius. If the design speed is 120 kmph, calculate the following elements of the curve : **10**

i) Ruling Minimum radius

ii) Super elevation

iii) Extra widening

iv) Length of the transition Curve

v) Suggest the best suitable shape of the transition curve.

Q. 17. 2 m wide strip footing is located at a depth of 2 m in a stiff clay of unsaturated unit weight of 20 kN/m^3 having $\phi_u = 0$ and $c_u = 120$ kN / m^2. Using Terzaghi's bearing capacity equation, compute the safe load carried by footing per metre length with factor of safety with respect to shear failure as 3. Given that $N_c = 5.7$. **10**

Q. 18. Spot speed studies are carried out at a certain stretch of highway and the consolidated data is given below : **10**

Speed range, kmph	No. of vehicles observed	Speed range, kmph	No. of vehicles observed
0 to 10	12	50 to 60	255
10 to 20	18	60 to 70	119
20 to 30	68	70 to 80	43
30 to 40	89	80 to 90	33
40 to 50	204	90 to 100	9

Prepare a frequency distribution table. Determine

(i) the upper and lower values of speed limits for regulation of mixed traffic flow and

(ii) the design speed for checking the geometric design elements of highway.

Q. 19. In order to determine the elevation of top Q of a signal on a hill, observations were made from two stations P and R. The stations P, R and signal Q were on the same plane. If the angles of elevation of the top Q of the signal measured at P and R were 25°35′ and 15°5′ respectively, determine the elevation of the foot of the signal if the height of the signal above its base was 4 m. The staff readings upon the benchmark (RL 105.42 m) were respectively 2.755 and 3.855 m when the instrument was at P and R. The distance between P and R was 120 m. **10**

Q. 20. Enlist five types of major traffic studies. Mention the objectives and importance of each study. **10**

Q. 21. In running a closed traverse ABCDE, the following bearing were observed with a prismatic compass **15**

Station	Fore Bearing	Back Bearing
A	80°	140°
B	90°	260°
C	120°	269°
D	200°	301°
E	318°	18°

At which stations do you suspect local attraction? Calculate the corrected included angles. Also calculate the true bearings if the magnetic declination is 2°30′ E.

Q. 22. A road curve of 180 m radius is to be setup to connect two tangents. The maximum speed on this part of road will be 13.2m/s. Transition curves are to be introduced at each end of the curve. Find a suitable length of the transition curve and calculate **15**

i) The necessary shift of the circular curve,

ii) The chainage at the beginning and at the end of the combined curve and

iii) The value of the first two deflection angles of the transition curve assuming a peg interval of 10 m

Give that : Angle of intersection 62°30′; rate of change of radial acceleration = 0.3m/sec^3 and chainage of intersection point =1092.18 m.

Q. 23. A truck with center of gravity at x =1.4 m and y =1.7 m is travelling on curved road of radius 200 m and super elevation 0.05. Determine the minimum safe speed to avoid both slipping and overturning assuming coefficient of side friction = 0.15. Derive the expression for condition when overturning is critical and correspondingly calculate the speed. **15**

Q. 24. A retaining wall of 2 m height has a smooth vertical surface. The backfill has a horizontal levelled surface with the top of retaining wall. The density of the backfill is 1.8 t/m^3, shearing resistance angle is 30° and cohesion is zero. A uniformly distributed surcharge load of 3 t/m^2. **15**

i) Calculate the magnitude and point of application of active earth pressure per meter length of the retaining wall.

ii) If during rainy season, water table rises behind the wall to a height of 1 m above the base of the retaining wall, workout the effect on the active earth pressure if there is no change in the angle of shearing resistance. Assume the submerged unit weight of the backfill to be 1.25 t/m^3.

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