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B.Tech. DEGREE EXAMINATION, NOVEMBER 2023
Sixth Semester

18CEC303T – HIGHWAY ENGINEERING AND DESIGN
(For the candidates admitted from the academic year 2020-2021 & 2021-2022)
(Use of IRC 37 and IRC 58 to be permitted)

Note:

- (i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.
- (ii) **Part - B & Part - C** should be answered in answer booklet.

Time: 3 hours

Max. Marks: 100

PART – A (20 × 1 = 20 Marks)

| Marks | BL | CO | PO |
|-------|----|----|----|
|-------|----|----|----|

Answer **ALL** Questions

1. The full width of land acquired before finalizing of highway alignment is known as
(A) Right of way width (B) Lane width
(C) Embankment width (D) Carriage way width
2. When a vehicle is negotiating a circular, skidding of vehicle occurs when coefficient of lateral friction is
(A) Less than $\frac{V^2}{gR}$ (B) Greater than $\frac{V^2}{gR}$
(C) Less than $\frac{V}{R}$ (D) Greater than $\frac{V}{R}$
3. Ideal shape of transition curve is
(A) Circular (B) Parabola
(C) Spiral (D) Clothoid
4. A four lane undivided highway has a camber of 1.5% on a straight line. The difference in level between the crown and the edge of the road is
(A) 10.5 cm (B) 10.5 mm
(C) 30.1 cm (D) 30.1 mm
5. The gradient in the vertical alignment of highway is restricted to
(A) Minimum gradient (B) Ruling gradient
(C) Exception at gradient (D) Limiting gradient
6. All vehicles is a highway is travelling at an uniform speed of 40 kmph and with an uniform spacing of 25 m. Its time headway in seconds is
(A) 2.25 (B) 2.5
(C) 2.75 (D) 3.75
7. The fundamental equation of traffic flow is _____, here q represents flow, k represents density and v represents speed
(A) $q = k + v$ (B) $q = k - v$
(C) $q = k \times v$ (D) $q = k / v$

8. Linear relationship between speed and density was assumed in
 (A) Greenshield model (B) Green berg logarithmic model
 (C) Poisson distribution (D) General motor model
9. Conflict point in traffic rotary is due to
 (A) Merging of traffic (B) Diverging of traffic
 (C) Merging and diverging of traffic (D) Crossing of traffic
10. Rectangular shaped sign in highway gives
 (A) Warning to the road user (B) Information to the road user
 (C) Regulation of traffic rules (D) Not used in road signs
11. Grade separator intersections are recommend when the traffic volume is
 (A) More than 15000 vehicles/hr (B) Less than 15000 vehicles/hr
 (C) More than 10000 vehicles/hr (D) Less than 3000 vehicles/hr
12. The average speed of pedestrian crossing in a signal is
 (A) 1.7 m/s (B) 1.2 m/s
 (C) 0.5 m/s (D) 0.7 m/s
13. Fatigue cracking in the bituminous pavement occurs due to
 (A) Tensile strain at the bottom of the asphalt layer
 (B) Tensile strain at the top of the subgrade
 (C) Compressive strain at the bottom of the asphalt layer
 (D) Compressive strain at the top of the subgrade layer
14. The front axle of the vehicle is single axle single wheel type and weighs 64 kN. The rear axle is single axle dual wheel type weighing 80 kN. What is it vehicle damage factor?
 (A) 2.5 (B) 1.0
 (C) 1.5 (D) 2.0
15. Select the specification that suits 16 mm nominal size aggregate
 (A) 100 to 85% passing in 20 mm sieve
 (B) 10 to 85% retained in 16 mm sieve
 (C) 100 to 85% passing in 16 mm sieve
 (D) 70% retained in 16 mm sieve
16. The subgrade property that is used in the design of flexible pavement is
 (A) CBR (B) Resilient modulus
 (C) Modulus of subgrade reaction (D) Shear strength
17. Expansion joints in rigid pavement is provided to relieve
 (A) Temperature stress (B) Wheel load stress
 (C) Frictional stress (D) Temperature stress and wheel load stress
18. During night time, the nature of curling or temperature stress at the top of the concrete pavement is
 (A) Compressive in nature (B) Tensile in nature
 (C) Same as the bottom layer (D) Zero

19. Dowel bars are provided to
 (A) Hold the slab together
 (C) Resist moisture infiltration

- (B) Load transfer
 (D) Transfer load and hold slab in position

1 1 5 1

20. Sealant used in joint filling is a
 (A) Compressible material
 (C) Composite material

- (B) Incompressible material
 (D) Cement

1 1 5 1

PART – B (5 × 4 = 20 Marks)
 Answer ANY FIVE Questions

Marks BL CO PO

21. Define lag distance and brake distance. Also determine the minimum sight distance required on a rolling terrain.

4 2 1 1

22. Determine the length of a valley curve required for a design speed of 85 km/hr where -1.2% grade meets +0.5% grade. Assume all other suitable data.

4 2 2 1

23. The speed of 10 vehicles recorded from the spot speed survey conducted at a specific location are 45, 50, 70, 90, 80, 32, 47, 60, 71 and 84 kmph. Calculate time mean speed and space mean speed.

4 2 2 1

24. Explain with neat sketch of all the longitudinal road markings used in highway.

4 3 3 1

25. How will you determine the resilient Modulus of soil using triaxial loading cell. Write the test procedure clearly highlighting the load applied during testing.

4 2 4 1

26. The vertical strain and the horizontal strain at the top of the subgrade is 200 (compression) and 100 (tension) microstrain. The vertical strain and the horizontal strain at the bottom of bituminous layer is 150 (compression) and 120 (tension) micro strain. Check whether the pavement will be able to withstand 100 MSa during its life. Use 90% reliability design equation.

4 4 4 1

27. Design the length and spacing of tie bars for the pavement thickness of 20 cm and the road width of 7 m with one longitudinal joint. The unit weight of concrete is 2400 kg/m³, the coefficient of friction is 1.5, allowable working tensile stress in steel is 1750 kg/cm², and bond stress of deformed bars is 24.6 kg/cm².

4 4 5 1

PART – C (5 × 12 = 60 Marks)
 Answer ALL Questions

Marks BL CO PO

28. a. A National highway in plain terrain has a radius of 360 m. Calculate the length of the transition curve for the speed of 100 kmph. The super elevation is attained by rotating the center line of the highway. It is four land divided highway.

12 3 1 1

(OR)

- b. Determine overtaking sight distance required on highway that has a design speed of 80 kmph. Clearly state all your assumptions you make. Highway is an undivided highway. 12 3 1 1
29. a. Explain in detail about the test procedure for moving observer method and state how flow, density and space mean speed are calculated. 12 2 2 1

(OR)

- b. How are traffic flow measured? Highlight the standard recommendations for the measure of traffic flow. Explain any two intrusive and non-intrusive volume count approach. 12 2 2 1
30. a. What is the purpose of channelization of traffic? Explain in detail on the design principles of channelization. 12 2 3 1

(OR)

- b. Explain the step by step process involved in the design of three phase signal. Sketch sample phase diagram and describe its features. What is signal coordination? Explain how coordination between two signals can be achieved. 12 2 3 1
31. a. The pavement consist of five layers with bituminous concrete layers as a top layer, dense bituminous macadam in second layer, cement treated base as the third layer, water bound macadam as a fourth layer and compacted subgrade as the fifth layer. What are the data you need to collect for the design of this pavement? Explain the design steps in detail. 12 3 4 1

(OR)

- b. Describe in detail on grading of bitumen following the guidelines of Indian standard specification. 12 2 4 1
32. a. Two 50 kN loads are applied at a center to center spacing of 180 cm on a concrete pavement. The first load is applied on the first dowel bar provided at 150 mm from the pavement edge of the slab of 260 mm thickness. The dowel bars are provided at 150 mm from the pavement edge of the slab and at a spacing of 280 mm. Check the adequacy of the dowel system. Use the following information and assume other relevant data required, Modulus of subgrade reaction is 15 MN/m^3 , diameter of dowel bars is 20 mm, lane width is 3.5 m, modulus of dowel support is 400 GN/m^3 , concrete grade is M20. 12 5 5 1

(OR)

- b. Determine the curling stress in a 250 mm slab during day with a temperature gradient of 0.5°C/cm , thickness of slab at interior and at an edge point of an infinite slab. The slab is 7.5 m long and 3.75 m wide, find out the interior stress and edge stresses. Use modulus of subgrade reaction as 15 MN/m^3 , coefficient of thermal expansion as $1 \times 10^{-6}/^\circ\text{C}$. Assume other relevant data as per IRC recommendation. Take stress correct factor along width of the pavement as 0.7 and for the long side of the slab is 1.05. 12 4 5 1

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