Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

Course: Transportation Engineering
Program: B.Tech Civil Engineering
Course Code: CIVL 3022

Semester: Sixth
Time : 03 hrs
Max. Marks: 100

Instructions: Use a pencil and scale to draw neat and clean diagrams wherever required. Assume suitable data wherever required.

SECTION A
(5Qx4M=20Marks)

S. No.	List of questions	Marks	CO
Q 1	**Select the correct answer in the following questions:** a. The shape of the STOP sign according to IRC:67-2001 is i. Circular iii. Triangular ii. Octagonal iv. Rectangular b. The rebound deflection of a flexible pavement is measured using i. Bump Integrator iii. Falling Weight Deflectometer ii. Benkelman Beam iv. Dynamic Cone Penetrator c. Which of the following parking statistics gives an aggregate measure of how effectively the parking space is utilized? i. Parking index iii. Parking accumulation ii. Parking load iv. Parking turnover d. In case of governing equation for calculating wheel load stresses using Westergaard's approach, the following statements are made: I. Load stresses are inversely proportional to wheel load. II. Modulus of subgrade reaction is useful for load stress calculation. The correct option evaluating the above statements is i. I: True, II: False iii. I: False, II: True ii. I: True, II: True iv. I: False, II: False	**4 x 1 = 4**	**CO1**
Q 2	**State 'True' or 'False' for the following statements:** a. The third twenty-year road development plan is also known as Nagpur road plan. b. Radius of relative stiffness is directly related to modulus of elasticity of concrete and inversely related to Poisson's ratio. c. Comfort to passengers is an important consideration in the design of summit curves. d. The softening point of bitumen has the same unit as that of viscosity.	**4 x 1 = 4**	**CO1**

<table>
<tr><td>Q 3</td><td>Differentiate between the following:
a. Pneumatic rollers and sheep-foot rollers
b. Alligator cracking and sheer failure cracking</td><td>2 + 2</td><td>CO1</td></tr>
<tr><td>Q 4</td><td>Fill in the blanks:
a. The VDF of an HCV with rear axle load of 19.5 t in terms of the standard axle load of 8.16 t is _____.
b. _____ parking can accommodate maximum number of vehicles for a given kerb length.
c. In cement concrete pavements, tie bars are installed in _____ joints.
d. _____course acts as a drainage layer in flexible pavements.</td><td>4 x 1 = 4</td><td>CO1</td></tr>
<tr><td>Q 5</td><td>On a two-way highway, a horizontal curve of radius 300 m is provided. The design speed is 80 km/h. If the longest wheel-base of vehicle expected on the highway is 7 m, determine the extra widening required.</td><td>4</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION B
(4Qx10M= 40 Marks)</td></tr>
<tr><td>Q 6</td><td>(a) For designing a 2-phase fixed type signal at an intersection having North-South and East-West Road where only straight-ahead traffic is permitted, the following data is available.
<table>
<tr><th></th><th>North</th><th>South</th><th>East</th><th>West</th></tr>
<tr><td>Flow (PCU/hr)</td><td>1000</td><td>700</td><td>900</td><td>550</td></tr>
<tr><td>Saturation flow</td><td>2500</td><td>2500</td><td>3000</td><td>3000</td></tr>
</table>
Total time lost per cycle is 12 seconds. Estimate the cycle length (seconds) as per Webster's approach.

(b) In the Marshall method of mix design, the coarse aggregates, fine aggregates, filler and bitumen, having respective specific gravities of 2.62, 2.72, 2.70 and 1.02 are mixed in the ratio of 55, 34.6, 4.8 and 5.6 percent, respectively. Evaluate the theoretical specific gravity of the mix.</td><td>6 + 4</td><td>CO3</td></tr>
<tr><td>Q 7</td><td>a) Discuss the significant factors influencing the flexible and rigid pavement design.
b) As a transportation engineer, how will you construct a new highway on an embankment? Explain step-by-step procedures.
c) Examine the differences between Water Bound Macadam and Wet Mix Macadam in a flexible pavement.</td><td>3 + 4 + 3</td><td>CO2</td></tr>
</table>

Q 8	(a) The data given below pertains to the design of a flexible pavement. Initial traffic = 1250 cvpd Traffic growth rate = 8 percent per annum Design life = 12 years Vehicle damage factor = 2.5 Lane Distribution factor = 0.75 Evaluate the design traffic in terms of million standard axles (msa) to be catered by the pavement. (b) In signal design as per Indian Roads Congress specifications, if the sum of the ratios of normal flows to saturation flow of two directional traffic is 0.50 and the total lost time per cycle is 10 seconds, determine the optimum cycle length.	**6 + 4**	**CO3**
Q 9	(a) A two-lane urban road with one-way traffic has a maximum capacity of 1800 vehicles/hour. Under the jam condition, the average length occupied by the vehicles is 5.0 m. The speed versus density relationship is linear. For a traffic volume of 1000 vehicles/hour, determine the density of the traffic stream. (b) Estimate the radius of relative stiffness for a 20 cm thick slab with E = 3×10^5 kg/cm^2 and Poisson's ratio = 0.15, resting on a subgrade having modulus of 5 kg/cm^2. OR (a) Calculate the perception-reaction time for a vehicle travelling at 90 km/h, given the coefficient of longitudinal friction of 0.35 and the stopping sight distance of 170 m. (b) A valley curve has a descending gradient of 1 in 40 followed by an ascending gradient of 1 in 50. Determine the length of the valley curve required for a design speed of 80 km/hour for comfort condition. (c) During a CBR test, the load sustained by a remolded soil specimen at 5.00 mm penetration is 50 kg. Determine the CBR value of the soil.	**6 + 4** **4 + 4 + 2**	**CO3**

SECTION-C (2Qx20M=40 Marks)			
Q 10	Design the wheel load stresses at interior, edge, and corner for the given data. Also, determine the probable location where the crack is likely to develop due to corner loading. Wheel load, P = 5100 kg Pavement thickness = 20 cm Poisson's ration of concrete = 0.15 E = 3 x 10^5 kg/cm^2 K = 6 kg/cm^3 Radius of contact area = 15 cm	**20**	**CO4**
Q 11	(a) A cement concrete pavement has a thickness of 26 cm and lane width of 3.5m. Design the tie bars along the longitudinal joints using the data given below: Allowable working stress in steel tie bars = 1250 kg/cm^2 Unit weight of CC = 2400 kg/m^3 Max. Value of coefficient friction = 1.2 Allowable tensile stress in deformed tie bars = 2000 kg/cm^2 Allowable bond stress in deformed bars = 24.6 kg/cm^2	**10 + 10**	**CO4**
	(b) What are Interlocking Concrete Block Pavements? Where are they generally used? Analyze and discuss their advantages and limitations in field application.		**CO3**
	OR		
	(a) The design thickness of a CC pavement is 26 cm considering a design axle load of 12,000 kg on single axle and M-40 concrete with characteristic compressive strength of 400 kg/cm^2. The radius of relative stiffness is 62.2 cm. If the elastic modulus of dowel bar steel is 2 x 10^6 kg/cm^2, modulus of dowel-concrete interaction is 41,500 kg/cm^3 and joint width is 1.8 cm, design the dowel bars for 40% load transfer considering edge loading.		**CO4**
	(b) The design speed of a highway is 80 kmph. There is a horizontal curve of radius 200 m in a certain locality. What should be the superelevation required to maintain this design speed? If the maximum superelevation of 0.07 is not to be exceeded, what should be the maximum allowable speed on this curve? Also determine the extra widening required and length of transition curve using the following data: Length of wheel base of the largest vehicle = 6.1 m Pavement width = 7.2 m Number of lanes = 2 Type of terrain = Plain, Safe limit of coefficient of friction = 0.15	**10 + 10**	**CO3**