Name: **Enrolment No:**	

UPES

End Semester Examination, May 2024

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

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

Instructions: 1. Consider yourself a transportation engineer while answering the questions.
2. Use pencil and scale to draw neat and clean diagrams wherever required.

SECTION A
(5Qx4M=20Marks)

S. No.	List of questions	Marks	CO
Q 1	**Select the right answer in the following questions:** a. Dowel bars in concrete pavement are placed i. Along the direction of traffic ii. Perpendicular to the direction of traffic iii. Along 45° to the direction of traffic iv. Can be placed along any direction b. Road roughness is measured using i. Benkelman beam ii. Bump integrator iii. Dynamic cone penetrometer iv. Falling weight deflectometer c. The maximum number of vehicles can be parked with i. Parallel parking ii. Perpendicular parking iii. 45° angle parking iv. 60° angle parking d. The softening point of bitumen has the same unit as that of i. Distance ii. Temperature iii. Time iv. Viscosity	**4**	**CO1**

Q 2	**Fill in the blanks:** a. For an axle load of 15 tonne on a road, the Vehicle Damage Factor (rounded off to two decimals), in terms of the standard axle load of 8 tonne, is _____. b. During a CBR test, the load sustained by a remolded soil specimen at 5 mm penetration is 50 kg. The CBR value of the soil will be _____. c. ICBP stands for _____. d. The kerb length required to park 15 vehicles in 30° angle parking is _____ meters.	**4**	**CO1**
Q 3	**Define the following terms based on your understanding:** i. Capacity of an intersection ii. Channelization	**2+2**	**CO1**
Q 4	**Differentiate between the following:** i. Alligator cracking and reflection cracking ii. Water Bound Macadam and Wet Mixed Macadam	**2+2**	**CO2**
Q 5	A road has a horizontal curve of 400 m radius on which a superelevation of 0.07 is provided. Find the coefficient of lateral friction mobilized on the curve when a vehicle is travelling at 100 kmph.	**4**	**CO2**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Illustrate the cross-section of a rigid pavement and label the stress regions, different type of joints, along with dowel bars and tie bars used during its construction. Explain the function of each component.	**10**	**CO2**
Q 7	(a) **Column I** **Column II** P. Hardness 1. Water adsorption test Q. Porosity 2. Impact test R. Toughness 3. Soundness test S. Durability 4. Abrasion test Match the correct pair of tests and their corresponding properties along with providing justifications. (b) In how many ways urban roads are classified? Discuss the objective purpose of each classification.	**5 + 5**	**CO2**

<table>
<tr><td>Q 8</td><td>(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, calculate the density of the traffic stream.
(b) Calculate the minimum sight distance required to avoid a head-on collision of two cars approaching from the opposite direction at 90 and 60 kmph. Assume a reaction time of 2.5 seconds, coefficient of friction of 0.7 and a brake efficiency of 50 percent in either case.</td><td>5 + 5</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>Analyze and elaborate the various flexible and rigid pavement failures generally observed in the field? Explain “Mud Pumping” with neat sketches.
OR
Interpret and discuss Westergaard’s concept of temperature stresses in rigid pavements along with its classifications drawing relevant figures.</td><td>10</td><td>CO3</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>a) Using IRC: 37 – 1984 "Guidelines for the Design of Flexible Pavements" and the following data, design the total thickness of the pavement and of individual layers.
No. of CVs when construction is completed = 2723 veh/day
Annual growth rate of the traffic = 5.0%
Design life of the pavement = 10 years
Vehicle damage factor = 2.4
CBR value of the subgrade soil = 5%
Data for 5% CBR value
<table><tr><th>No. of Standard Axles, msa</th><th>Total thickness, mm</th></tr><tr><td>20</td><td>620</td></tr><tr><td>25</td><td>640</td></tr><tr><td>30</td><td>670</td></tr><tr><td>40</td><td>700</td></tr></table>b) Analyze and explain the different types of rollers used in pavement construction. Elaborate their applications.</td><td>15 + 5</td><td>CO4</td></tr>
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Q 11	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. b) Evaluate and assess the step-by-step procedure of constructing a new highway on embankment and in cutting. OR a) Using the given data below, design the wheel load stresses at interior, edge, and corner regions of a CC pavement using Westergaard's stress equations. Wheel load, P = 5200 kg Modulus of elasticity of cement concrete, E = 3 x 10^5 kg/cm^2 Pavement thickness = 18 cm Poisson's ration of concrete = 0.15 K = 6 kg/cm^3 Radius of contact area = 15 cm b) Analyze and compare the working principles of the following laboratory tests: i. CBR Test ii. Los Angeles Abrasion Test iii. Bitumen Penetration Test iv. Aggregate Impact Test v. Plate Load Test	**12 + 8** **10 + 10**	**CO4**