Full Marks: 100   **Time: 3 hrs**

Answer **ANY FIVE** questions

1. [a] Define 'Time Mean Speed' and 'Space Mean Speed'.

    [b] Derive the relation between 'Time Mean Speed' and 'Space Mean Speed'.

    [c] In a vehicular stream the observed spot speeds of four vehicles were 30, 40, 50 and 60 kilometer/hour respectively. Compute the 'Time Mean Speed' and 'Space Mean Speed'.

    [(4+4)+6+(3+3)]=20

2. [a] Derive the fundamental equation of vehicular stream i.e. $q=uk$, where, q, u, k indicate flow(volume), speed and concentration respectively.

    [b] The u-k relationship of a particular freeway lane was found to be as follows:
    $u + 2.6 = 0.001(k-240)^2$. Given that the speed is in miles per hour and concentration is in vehicles per mile, find (a) the free-flow speed, (b) the jam-concentration, [c] the lane-capacity and [d] the speed at capacity   [8+(3x4)]=20

3. [a] Derive the equation for capacity of a single platform railway station capable of allowing only one train to occupy the platform at any given time.

    [b] A trans-river ferry-service operates between two ferry-stations on the two banks of a river. It is expected to carry 2000 passengers in one direction during the 2-hour morning peak period. Given a round-trip time of 15 minutes and average vehicle occupancy of 75 passengers, calculate the required frequency of service during the peak-hour. Also estimate the fleet size to provide the service.   [10+10]=20

4. [a] Construct a flow-diagram to explain the 4-step sequential travel demand forecasting method. Also indicate the commonly used models, data inputs and expected outputs at each step.

    [b] A calibration study for a given area resulted in the following utility function:

$U_k = a_k - 0.003 X_1 - 0.04X_2$, where X_1 indicates travel cost (in rupees) and X_2 indicates travel-time (in minutes). Estimate the probable market share (in percentage) of the travel modes, indicated in Table I, with their attributes.

[15+5]=20

Table I

Mode k	a_k	X_1	X_2
Suburban rail	- 0. 30	50	50
Express Bus	- 0. 40	55	45
Regular Bus	- 0. 60	45	55

5. [a] Briefly discuss the concept of Level of Service(LoS) in context of highway capacity analysis.

[b] A free way that is being designed is expected to carry a traffic-volume of 3750 vehicles/hour during the peak hour. Trucks and buses are estimated to constitute 12% and 5% of the traffic respectively, and the rest are passenger cars. Determine the minimum number of lanes required to provide LoS-C, given

[i] a rolling terrain,

[ii] a design speed of 70 miles /hour.

[iii] Maximum Service Flow (at LoS-C and design speed of 70 miles/hour): 1550 PCU/hour/lane

[iv] adequate lane width and lateral clearance in compliance with the 'ideal conditions'

[v] PCU value for trucks and buses: 4.0 and 3.0 respectively in rolling terrain.

[10+10]=20

6. [a] What is meant by highway alignment? Explain the guiding principles to be applied for planning a highway alignment.

[b] Discuss in brief the important factors, which affect highway alignment.   [8+12]=20

7. [a] Classify urban roads indicating the norms for right of way, intersection frequency and design speed.

[b] The existing road of 200 km length is further to be extended in stages of 40 km lengths. With the details given in Table II, find out at what km the saturation limit will be reached. Assume one unit of utility for a population size of 1000 and also one unit for 1000 tonnes of freight quantity served.   [15+5]=20

Table II

Length (km.)	Number of towns and villages expected to be served with population range			Freight quantity expected to serve (in 1000 tonnes)
	<500	501 - 1000	1001-2000	
Existing 200	100	80	60	. 500
Extension 40	100	30	20	90
80	80	24	15	80
120	60	10	10	38

8. Write short notes on:

[a] PCU

[b] Benefit-Cost Analysis

[c] Traffic Calming

[d] Gravity Model

[5x4]=20