

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2081 Bhadra

Exam.	Regular	
Level	BE	Full Marks 80
Programme	BCE	Pass Marks 32
Year / Part	IV / I	Time 3 hrs.

Subject: - Transportation Engineering II (CE 703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

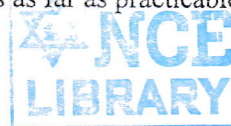


1. Discuss critical characteristics of driver related to vision that affect traffic performance. [8]
2. Define spot speed and explain the methods of conducting spot speed study. Write down the advantages and limitations of rotary intersection. [8]
3. Assuming the linear speed-density relationship, the mean free speed is observed to be 80kmph near zero density and the corresponding jam density is 120veh/hr. [8]
 - a) Write down the speed-density and flow density equation.
 - b) Draw v-k, v-q and q-v diagram indicating the critical values.
 - c) Compute speed and density corresponding to flow of 800 veh/hr.
 - d) Compute the avg headways, spacing when the flow is maximum.
4. At a right-angled intersection of two roads, Road 1 has four lanes with a total width of 14m and Road 2 has two lanes with a total width of 7m. The volume of traffic approaching the intersection during the design hour are 850 and 750 PCU/hr on the two approaches of Road 1 and 200 and 250 PCU/hr on the two approaches of Road 2. Take saturation flow of each direction of road 1 and 2 as 3675PCU/hr and 1890 PCU/hr respectively and amber time 3 sec, lost time 2 sec per phase for both the roads. [8]
5. Explain the various factors affecting the pavement design. [8]
6. Calculate the length and spacing of dowel bars of dia 25mm at an expansion joint of concrete pavement of thickness 25 cm. Design wheel load 5000 kg. Load capacity of the dowel system is 40 percent of design wheel load. Joint width is 2.0 cm and the permissible stress in shear, bending and bearing stress in dowel bars are 1000, 1400 and 100 kg/cm² respectively. Modulus of elasticity of concrete 2.45×10^5 kg/cm², modulus of subgrade reaction = 8 kg/cm³, Poisson ratio = 0.15. [8]
7. Explain the characteristics of Mass Haul Diagram with neat diagram. Define the free haul, the over haul and shrinkage and swelling. [8]
8. Differentiate between rolled concrete and normal concrete used in road construction. Describe the construction steps of cement concrete pavement with material and quality control. [8]
9. Write down the process of overlay design of pavement by Benkelman beam Deflection Method. [8]
10. Explain the major characteristics of Ideal Bridge. How drainage are managed while tunneling? [8]

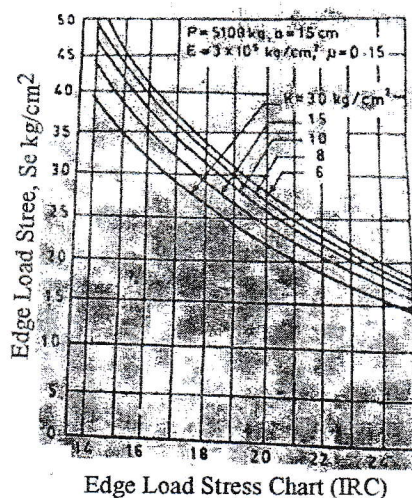
Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering (CE 703)

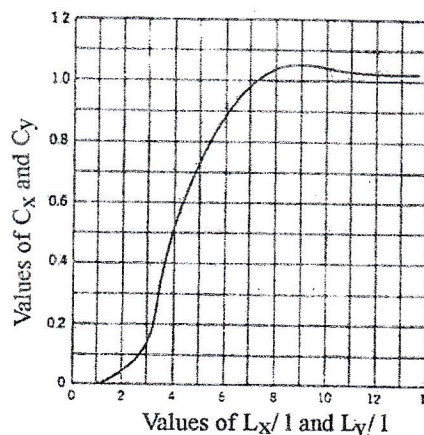
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1. Define parking accumulation, parking turnover, parking load and parking index. Explain speed-density relation and speed-flow relation with required graphs. [4+4]
2. A passenger car of mass 430 kg moving east collides with a truck of mass 1299 kg that is moving south. Initial skid distances of the car and the truck are 15 m and 10 m respectively. After collision they lock together and skid through a distance equal to 8 m in direction 65 degrees south of east before stopping. Compute the initial speeds of the car and the truck. Assume average coefficient of friction as 0.5. [8]
3. What are the advantages of one way traffic movement? Draw a right angle four arm intersection of two roads and show various conflict points, if both roads with two way movements? Classify the type of conflicts. [8]
4. An isolated signal with pedestrian indication is to be installed on a right angled intersection with road A, 18m wide and road B, 12m wide. The heaviest volume per hour for each lane of road A and B are 300 and 250, respectively. The approach speeds are 55 and 40 kmph for road A and B respectively. Design the timing of traffic and pedestrian signals. [8]
5. What are the factors that affect in pavement design? How are they considered in AASHTO method? [1+7]
6. A CC pavement slab of thickness 20cm is constructed over a granular subbase having modular of reaction 15 kg/cm². The maximum temperature difference between the top and bottom of the slab during summer day and night is found to be 18°C. The spacing between the transverse contraction joint is 4.5 m and that between longitudinal joints is 3.5 m. The design wheel load is 5100 kg, radius of contact area is 15 cm, E value of CC is 3×10⁵ kg/cm², Poisson's ratio is 0.15 and coefficient of thermal expansion is 10×10⁻⁶ per °C and friction coefficient is 1.5. Find the worst combination of stresses at the edge. [8]



Bradbury's Warping Stress Coefficients

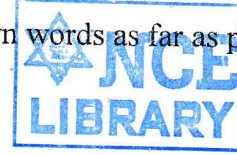


7. Define Mass Haul Diagram with its characteristics. Write down the construction procedure of soil cement stabilized base course. [8]
8. Explain the types of bituminous pavements. How the quality of bituminous pavement can be controlled in the field? [8]
9. Explain the maintenance of bituminous surface. Describe the typical types of rigid pavement failure. [8]
10. List out the characteristics of an ideal bridge site location. Discuss the need of good ventilation system in tunnels and outline methods of providing it. [8]

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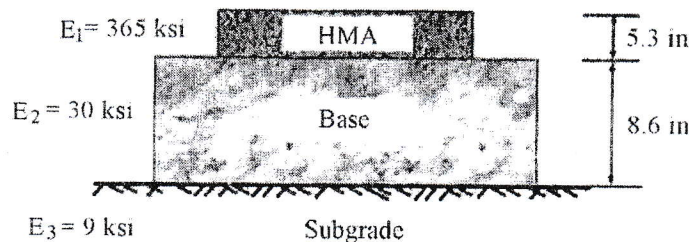
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1. Explain human-vehicle-environment system. Discuss physical characteristics of driver that affect traffic performance. [8]
2. Define the capacity of a road and list out its type. Two veh. A and B approaching at rt. Angle, A from west and B from south, collide with each other. After the collision, vehicle A skids in a direction 45 deg. north of the west and veh. B, 50 deg. east of north. The initial skid distance of veh. A and B are 35 and 25m respectively before collision. The skid distance after collision are 30m and 10m respectively. If the weight of veh. A and B are 3.5 and 6 tonnes respectively, calculate the original speed of vehicles. The avg. skid resistance of the pavement is found to be 0.55 [2+6]
3. Using the data in the table below, come up with cycle length and actual green for all 2 phase signal. Assume lost time per phase = 3 seconds, yellow time of 3 seconds and all red time of 4 sec. [8]

Veh/hr	Approach			
	East	North	West	South
Flow	488	338	115	217
Saturation flow	1725	1725	1725	1725

4. Define PIEV theory. Categorize LOS and discuss the factors need to be considered to evaluate LOS. [2+6]
5. The flexible pavement was designed for two lane two way road as shown in figure. The drainage coefficient for base layer is 1, layer coefficient for surface and base layer are $\alpha_1 = 0.323 \log_{10} E_1 - 1.42$, and $\alpha_2 = 0.249 \log_{10} E_2 - 0.977$, Where E_1 and E_2 are in PSi. Determine the initial commercial vehicle per day, the road was designed for. Traffic growth rate = 6%, construction period = 2 yrs, design life = 10 yrs, VDF = 2.5. [8]



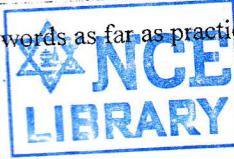
6. Describe four types of rigid pavement with simple sketch. Discuss the importance of standard axle load in flexible pavement design. [5+3]
7. Explain briefly mass haul diagram with neat figure. Define free haul, overhaul and economic haul distance. [5+3]
8. What are the equipment's and plants needed for the various activities of road construction? Write down the material and construction procedure of DBSD. [8]
9. Describe the term maintenance, rehabilitation and reconstruction. Describe the typical types of rigid pavement failure with sketches where possible. [8]
10. Enumerate the factors to be considered for selecting the bridge site. Describe method of providing drainage in tunnel construction. [8]

TRIBHUVAN UNIVERSITY
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Examination Control Division
2080 Baishakh

Exam.	Back		
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Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE 703)

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1. Explain the importance of vision to Road users. The acceleration of a vehicle is given by the equation below:

$$dv/dt = 2 - 0.04 v$$

Compute the time when the acceleration of the vehicle will be 1.0 m/s^2 if the vehicle was initially travelling at 100 kph. [8]

2. a) Table below shows volume counts on an approach of an urban intersection from 8.30 AM to 10:30 AM. [4+4]

Time	Count (PCU)
8:30 - 8:45	500
8:45 - 9:00	390
9:00 - 9:15	300
9:15 - 9:30	300
9:30 - 9:45	260
9:45 - 10:00	350
10:00 - 10:15	400
10:15 - 10:30	490

Determine (i) peak hour (ii) peak hourly volume (iii) peak hour factor, and (iv) the design flow rate for the approach.

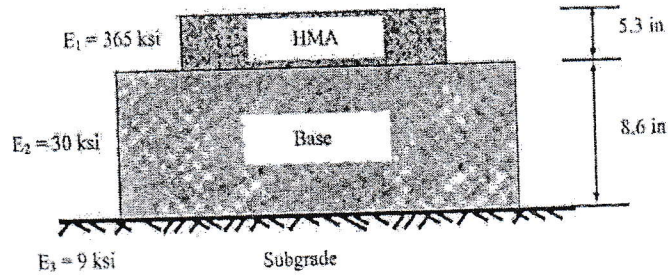
- b) Travel time data (in seconds) of 14 vehicles traversing a two kilometer road segment are:

80, 90, 96, 84.7, 72, 79.1, 120, 97.3, 85.7, 78.3, 80.9, 93.5, 76.6, and 86.7

Estimate (i) the time mean speed and (ii) the space mean speed (iii) What will be the average density of the above traffic stream if the mean headway is 8 sec?

3. Mention the need of crash studies. Discuss the steps to design highway lighting system. [2+6]
4. Road P is 13.5 m wide and road Q is 10.5 m. An isolated signal with pedestrian indications are to be installed at right angled intersection. The peak volumes per hour for road P and road Q are 250 and 200 respectively. The approaching speeds for road P and Q are 60 kmph and 45 kmph. Design the traffic and pedestrian signal timings. [8]
5. List out the differences between flexible and rigid pavement. Explain the terms radius of relative stiffness (I) and modulus of subgrade reaction (k) used in the design of rigid pavements. [4+4]
6. Figure below shows the section of a flexible asphalt pavement designed using AASHTO method. Determine the number of equivalent single-axle loads (ESALs) that the asphalt pavement structure is capable of carrying at a reliability level (R) of 90% [Z-value is equal to -1.282] overall standard deviation (S_0) of 0.5, ΔPSI of 2.0, and $m_2 = 1.0$. Assume material coefficient $a_1 = 0.401$ and coefficient of Layer 2 (the base layer) given by the following formula $a_2 = 0.249 \log(E_2) - 0.977$ [8]

$$\log_{10} W_{18} = z_R s_o + 9.36 \log_{10} (SN+1) - 0.2 + \frac{\log_{10} \left[\frac{\Delta PSI}{4.2-1.5} \right]}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10} M_R - 8.07$$



7. Define soil stabilization and list out the equipments used for road construction. List out the characteristics of Mass haul Diagram. [8]
8. Describe the construction procedure of bituminous premix carpet including the requirements on materials, equipment and the tests for quality control. [8]
9. Differentiate highway maintenance from highway rehabilitation. Discuss about the major causes of flexible pavement failure. [8]
10. List out the component's parts of bridge. Discuss the management of drainage and ventilation in tunneling. [8]

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- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.



1. Describe the critical physical mental and psychological characteristics of driver that affect his/her traffic performance. [8]
2. Assuming the liner speed-density relationship, the mean free speed is observed to be 90 kmph near zero density and the corresponding jam density is 150veh/hr. Average length of vehicle is 6.1 m. [8]
 - a) Write down the speed-density and flow density equation.
 - b) Draw $v=k$, $v-q$ and $q-v$ diagram indicating the critical values.
 - c) Compute speed and density corresponding to flow of 800veh/hr.
 - d) Compute the avg headways, spacing, clearance and gap when the flow is maximum.
3. Discuss traffic capacity of road and its types. Prepare a neat sketch of a rotary intersection with its geometric elements. [8]
4. The design hour traffic and saturation headway at a four-legged intersection are: [8]

Approach	North (N)	South (S)	East (E)	West (W)
Design hour flow	450	430	350	315
Saturation headway (sec)	2.25	2.33	2.5	2.75

Design a two phase signal for the intersection based on Webster method and draw the phase diagram. Use amber time of 2 sec on each phase for clearance and start-up loss time phase per phase of 1.5 sec.

5. Discuss the step by step procedure for the determining of rigid pavement thickness based on IRC guidelines. [8]
6. Design a flexible pavement for a two lane highway using provided tables and catalogues. Subgrade CBR values obtained from tests conducted at eight locations are: 11%, 7%, 6%, 7%, 4%, 4%, 8%, and 5%. Total both directional traffic as per last count is 340 CV/day with 60% vehicles of 10000 kg axle load and 40% vehicles of 9000 axle load. Use design life of 10 years, expected completion period of 2.5 years from the date of last count and a traffic growth rate of 7%. State your assumption for estimating the design traffic. [8]
7. List out different soil stabilization methods. Write down construction procedure of soil cement stabilized road including details of equipment and material requirement. [2+6]
8. Describe the construction procedure of Asphalt Concrete including the requirements on material, construction steps, plants and equipments and the tests for quality control. [8]
9. What are the most common failures of flexible pavement? Describe the deflection approach for the design of overlay for flexible pavement. [8]
10. Describe the importance and methods of lighting and ventilation in road tunnels. [8]

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2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
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Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE 703)

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1. Explain Vehicle Damage Factor (VDF) used in design of flexible pavements. An existing two-lane single carriageway highway is proposed to be widened to a 4-lane divided highway. Design a new flexible pavement for the proposed highway for the following information using provided design catalogues:

[2+6]

- (i) 4-lane divided carriageway
- (ii) The expected traffic in the year of completion of construction is 4000 commercial vehicles per day in both direction with 30% heavy trucks of 100kN axle load, 50% light trucks of 80kN axle load, and 20% tractors of 70kN axle load.
- (iii) Design life = 15 years
- (iv) Percentage CBR values obtained from seven different locations along the stretch of the highway are 9, 7, 8, 5, 4, 5, 6.5 respectively.
- (v) Traffic growth rate = 8%

CBR 4%				
Cumulative traffic (msa)	Total Payment thickness (mm)	Pavement Composition		
		bituminous surfacing		Granular base and sub base (mm)
		BC(mm)	DBM(mm)	
10	700	40	80	base = 250 subbase = 330
20	730	40	110	
30	750	40	130	
50	780	40	160	
100	800	50	170	
150	820	50	190	

CBR 5%				
Cumulative traffic (msa)	Total Payment thickness (mm)	Pavement Composition		
		bituminous surfacing		Granular base and sub base (mm)
		BC(mm)	DBM(mm)	
10	660	40	70	base = 250 subbase = 300
20	690	40	100	
30	710	40	120	
50	730	40	140	
100	750	50	150	
150	770	50	170	

2. Discuss tools, equipment and plants used in road construction. List out the characteristics of Mass haul Diagram.

[4+4]

3. Describe the construction procedure of bituminous concrete road and check needed for quality control. [8]
4. Describe pavement maintenance and its types with examples. [8]
5. What are the methods of providing tunnel ventilation? Explain the factors controlling the selection of bridge sites. [8]
6. Describe driver's characteristics and their influence in traffic performance. [8]
7. Two vehicles approaching at right angles, A from West and B from South, collide with each other. After the collision, vehicle A skids in a direction 51° North of West and vehicle B, 61° East of North. The initial skid distances of the vehicles A and B are 39m and 21m respectively before collision. The skid distances of vehicles A and B after collision are 15m and 36m respectively. If the weights of vehicles B and A are 6 and 4.4 tonnes respectively, calculate the original speeds of the vehicles. Take average skid resistance as 0.55. [8]
8. At right angled crossing of road A and road B isolated signal with pedestrian indicators is to be installed. The road is 14.4m wide and road B is 12m wide and the peak hour volumes are 280 and 230 PCU per hour and the approach speeds are 50 and 35 kmph respectively. Design the vehicular and pedestrian signal timing. [8]
9. Explain the design factors to be considered in rotary intersection design. [8]
10. Explain the temperature stresses in rigid pavement. Write down the design procedure of dowel bar in expansion joints. [8]

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2076 Chaitra

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Year / Part	IV / I	Time	3 hrs.

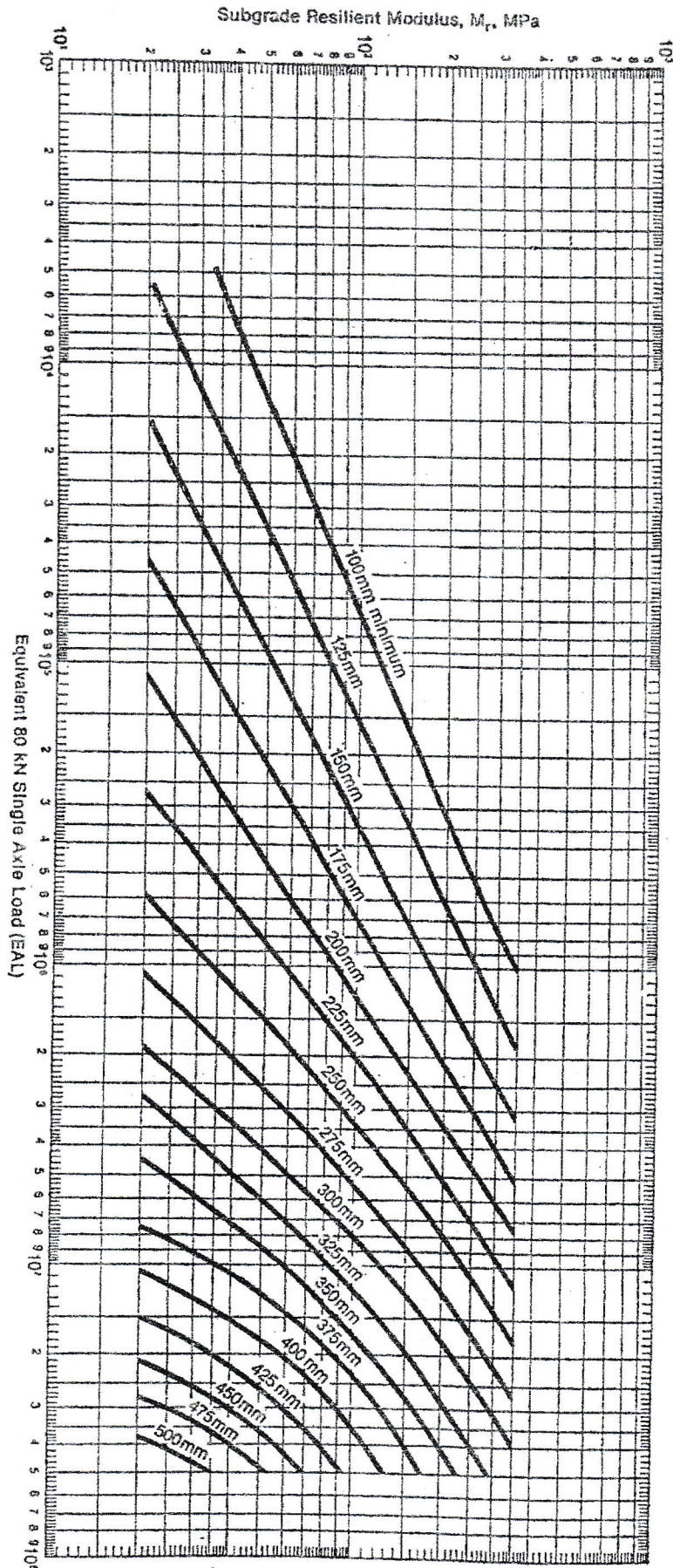
Subject: - Transportation Engineering II (CE 703)

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1. Explain different vehicular characteristics that influence traffic performance. [8]
2. Discuss different types of intersection. Write the advantages and limitations of grade separated intersection. [8]
3. a) The vehicle arrivals at the section of road are assumed to be Poission distributed with an average arrival rate of 1 vehicle every 5 minutes. What is the probability of
 - (i) Exactly 3 vehicles arrive in a 15 minute interval
 - (ii) less than 3 vehicles arrive in a 15 minute interval?
 - (iii) More than 3 vehicles arrive in a 15 minute intervals? [4]
- b) Calculate the capacity of rotary with entry and exit width of 8m, the width of non-weaving section is 9m. width of rotary is 12m, length of weaving section is 60m. The ratio of weaving to total traffic in weaving section is 0.7. [4]
4. The average normal flow of traffic on the cross roads 1 and 2 during design period are 450 and 350 PCU/hr. The saturation headway on these roads are estimates as 2.5sec and 3.75 sec respectively. The all red time required for pedestrian crossing is 15sec. Design two phase signal by Webster's method with neat phase diagram. Take amber time of 2 sec on each phase for clearance and start-up loss time of 2 sec and 3 sec for roads 1 & 2 respectively. [8]
5. What are the various factors to be considered in design of flexible pavement and indicate their significance? [8]
6. A proposed flexible pavement design of single lane carriageway consists of 75mm of Asphalt concrete, 120 mm of emulsified stabilized base course and 145mm of granular subbase. The expected commercial traffic volume is 140 cvpd. The expected traffic composition is 30% truck, 30% of mini truck and 40% of bus, whose truck factors are 5.6, 0.6 and 0.1 respectively. The expected annual traffic growth rate is 8% for all vehicles, and 18month required for construction to be completed. The CBR test conducted at 7 locations strating from Ch.0+100 at the interval of 200m distance gave the value of 11,9,7,10,8,6,4. $E_{sub\ base}=275\ MPa$, $L_{base}=500MPa$ and $E_{surface}=2400\ MPa$. How many years can this pavement last? [8]
7. Define mass haul diagram. Write down the construction procedure of WBM road. [2+6]
8. Describe the construction procedure of Asphalt Concrete including the requirements on materials, plants and equipment and the tests for quality control. [8]
9. Define pavement evaluation. Explain the types of failure & its causes in flexible pavement. [8]
10. Discuss the factors which affect the bridge site selection. List the essential components of bridge with sketches. [8]

Full-Depth Asphalt Concrete

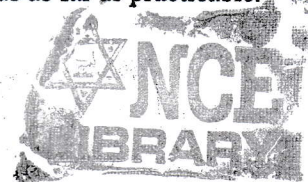


TRIBHUVAN UNIVERSITY
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2076 Ashwin

Exam.	Back		
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1. A bicycle racer practices everyday in the morning. Her route includes a ride along 800 m bikeway and back. Since she is traffic engineer, she has made it a habit to count the numbers of cars in lane A that she meets while riding southward, the number of cars in lane A that overtake her while riding northward and the number of cars in lane A that she overtakes while riding northward as shown in table below. Find average traffic flow and time of lane A.

[8]

Average Travel speed (km/hr)	Nos. of Vehicle met	Nos. of Overtaken Vehicle	Nos. of Overtaking Vehicle
32	117	10	74
34	93	25	41
32	30	15	5
33	70	18	9

2. Explain in detail about different physical characteristics of Driver that affect design of traffic facilities. [8]
3. List out the importance of parking and ill effect of illegal parking. Explain about different types of On-Street and Off-street parking facilities with their pros and cons. [8]
4. What are the factors affecting Night Visibility? What are the different types of road marking and traffic island used to regulate and control traffic flow? Explain. [2+3+3]
5. A 4-lane divided highway is to be constructed on a new alignment Traffic volume forecasts indicate that the AADT in both directions during the first year of operation will be 12,000 with 50% Passenger cars (5 kN/axle), 33% of two axle single unit trucks (25 kN/axle) and 17% of three axle single unit trucks (30 kN/axle) = 17%. The vehicle mix is expected to remain the same throughout the design life of the pavement. If the expected annual traffic growth rate is 4% for all vehicles, design pavement with AC of thickness 7.5 cm, base and sub base. CBR of subgrade = 6.5%, $E_{\text{sub base}} = 275 \text{ MPa}$, $E_{\text{base}} = 500 \text{ MPa}$ and $E_{\text{surface}} = 2400 \text{ MPa}$. [8]
6. Write down the assumption and analysis of Westergaard Theory. How the warping stress and friction stress are developed in the Rigid pavement? [8]
7. What are the factors affecting soil stabilization? What do you mean by mechanical method of soil stabilization? Write down the procedure of constructing cement soil stabilized road base. [8]

8. Write down material selection and construction procedure of double surface treatment pavement. [8]
9. Differentiate between Repair and Rehabilitation of highways. Explain about different types of typical rigid pavement failures. Draw a sketches wherever applicable. [8]
10. What are the importance of tunnel? With neat sketch, describe different components of tunnel and tunnel cross sections? [8]



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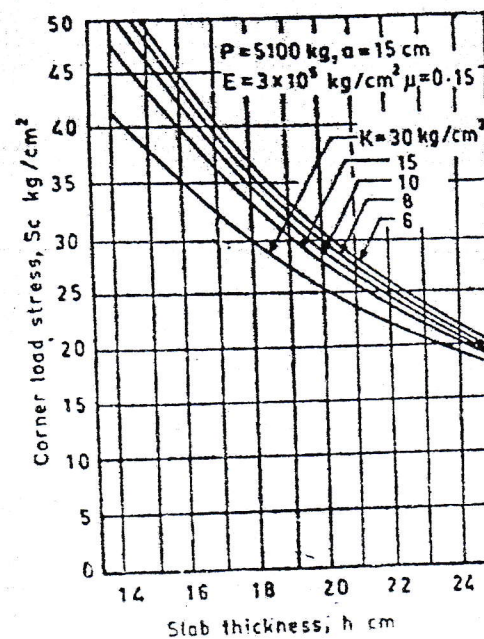
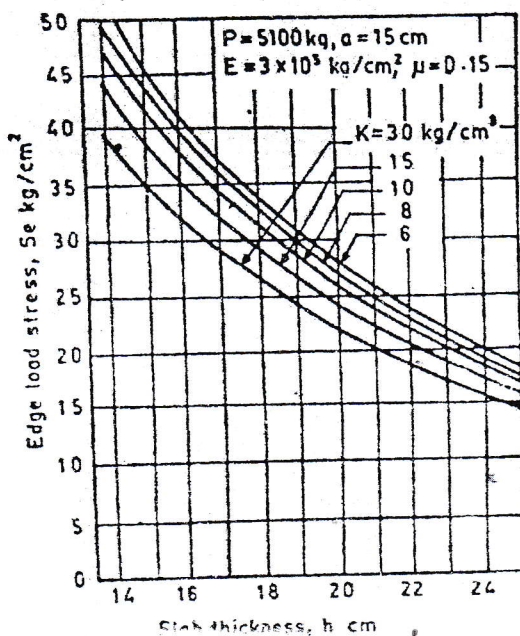
Subject: - Transportation Engineering II (CE 703)

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 - ✓ All questions carry equal marks.
 - ✓ Necessary charts and tables are attached herewith.
 - ✓ Assume suitable data if necessary.
1. What are the basic requirements of intersection at grade? Write down the design steps of rotary intersection.
 2. In a field survey of spot speed measurement, the following twenty observations were taken. Find time mean speed, and space mean speed.
50, 40, 60, 54, 45, 31, 72, 58, 43, 52, 46, 56, 43, 65, 33, 69, 34, 51, 47, 41.
Also, assuming these vehicle speeds are fixed over a half km segment, calculate the corresponding travel times and show that the space mean speed calculated using travel times is equal to the point estimate.
 3. What are the causes of accident and how accident can be prevented? Describe briefly the factors influencing street light design.
 4. The average normal flow of traffic on cross roads A and B, of width 7m both, during design period are 400 and 250 PCU per hour; the saturation flow values on these roads are estimated as 1250 and 1000 PCU per hour respectively. The all-red time is provided for pedestrian crossing with speed 1 m/sec and initial walk time 6 sec. Design two phase traffic signal.
 5. Explain the followings:
 - a) Traffic and loading factors controlling pavement design
 - b) Lane distribution factors and Vehicle damage factors
 6. Estimate the thickness of a plain cement concrete pavement for a 7m wide highway following the design procedure recommended by Indian Roads Congress (IRC) wherever applicable. Use given data, IRC load stress charts for edge and corner regions.
Design wheel load = 5100 kg
Traffic growth rate = 7.5%
Present traffic intensity = 1050 cvpd
Design life = 20 years
Construction period = 3 years
Radius of contact area = 15 cm
Modulus of elasticity of concrete = $3.0 \times 10^5 \text{ kg/cm}^2$
Poisson's ratio of concrete = 0.15
Modulus of rupture of concrete = 40 kg/cm^2
Thermal expansion of concrete = $10 \times 10^{-6}/^\circ\text{C}$
Modulus of subgrade reaction = 6 kg/cm^3
Maximum temperature in summer = 50°
Maximum temperature in winter = 15°C
The temperature differential in slab in the region is 17.3, 19.0 and 20.3 degree Celsius for thickness of 15, 20 and 25 cm respectively.

7. What are the various activities involved in road construction? Write the plants and equipment required for bituminous and cement concrete road constructions.
8. Explain construction procedure of water bound macadam road.
9. Explain the maintenance of bituminous surfaces. Describe the typical types of rigid pavement failures.
10. Enumerate the factors to be considered for selecting the bridge site. Why is ventilation important in tunnel?

Traffic Classification	Design Traffic Intensity at the End of Design Life (CVPD)	Adjustment in Design Thickness of CC Pavement, (cm)
A	0 - 15	-5
B	15 - 45	-5
C	45 - 150	-2
D	150 - 450	-2
E	450 - 1500	0
F	1500 - 4500	0
G	> 4500	+2

Table for Determination of Coefficient, C				
$\frac{L}{l}$ or $\frac{B}{l}$	C	$\frac{L}{l}$ or $\frac{B}{l}$	C	
1	0.000	7	1.030	
2	0.040	8	1.077	
3	0.175	9	1.080	
4	0.440	10	1.075	
5	0.720	11	1.050	
6	0.920	12	1.000	



Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the basic requirements of intersection at grade? Mention the importance of street lighting.
2. Explain different types of traffic islands? How accident study is carried out?
3. Two vehicles A and B approaching at right angle. Vehicle A from West and vehicle B from south collides each other. After the collision, vehicle A skids in 49° N of W and vehicle B skids 27° E of N. The initial skid distance of vehicle A and B are 37 m and 19 m respectively before collision. If weight of vehicle A is 4 tonne and weight of vehicle B is 6 tonne. The skid distances after collision for vehicle A is 15 m and for vehicle B is 36 m. calculate the initial speeds of vehicles if the average skid resistance of the pavement is found to be 0.55.
4. A four-legged right angled intersection is to be signalized with a fixed time 2-phase signal. The design hour flow and saturation flow are as under:

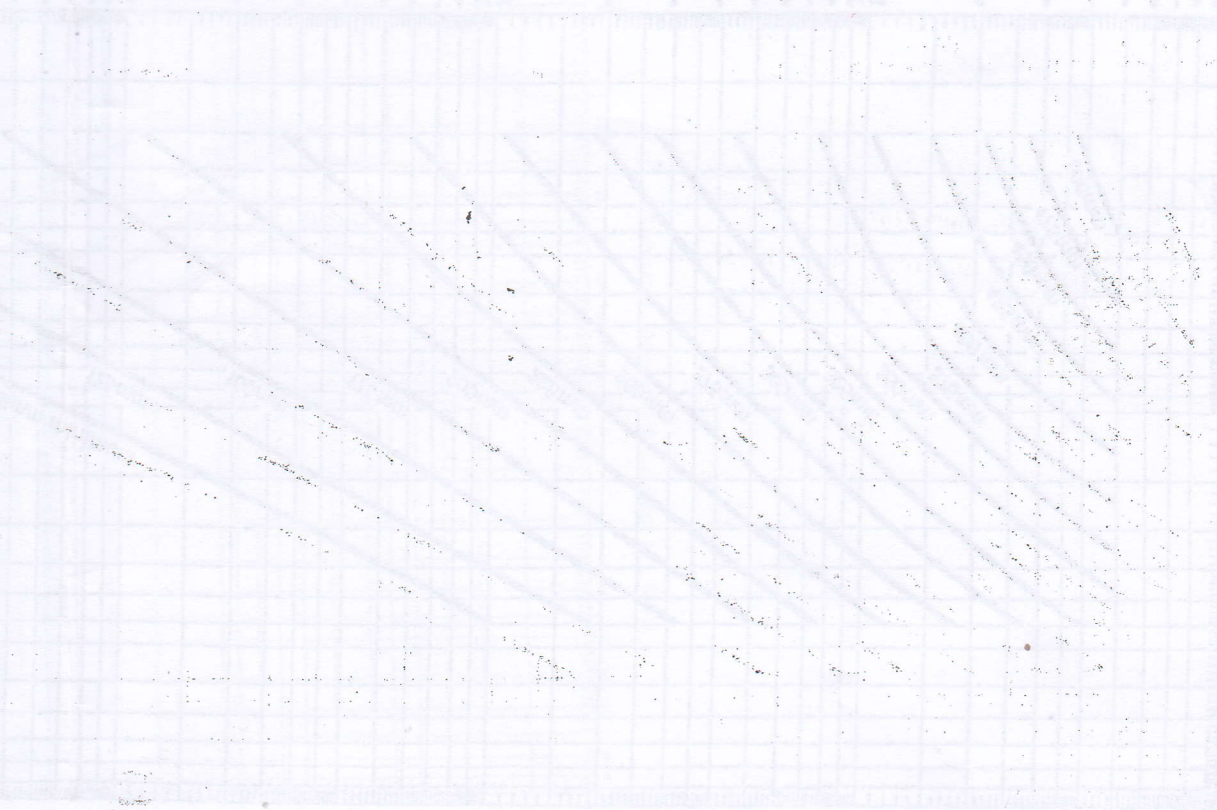
	North (N)	South (S)	East (E)	West (W)
Design hour flow	900	500	800	700
Saturation flow	2500	2000	3200	3000

The lost time is 2 seconds per phase due to starting delays and amber time for north-south and east-west are 3 seconds and 4 seconds respectively. Determine the optimum cycle time. Allocated the green times to the two phases.

5. Explain the factors that controlled the pavement design?
6. Design the flexible pavement for 4-lane single carriage way road with the following parameters:
 - i) Initial traffic in each direction = 2000 CVPD
 - ii) Design life = 15 years
 - iii) Construction period = 3 years
 - iv) Traffic growth rate = 8%
 - v) Design CBR value = 6%
 - vi) Modulus of elasticity of asphalt concrete surface course = 2500 MPa
 - vii) Modulus of elasticity of bituminous treated base = 1200 MPa
 - viii) Modulus of elasticity of granular subbase course = 125 MPa
 - ix) Axle load distribution of commercial vehicles on the road is as follows:

Axle Load (kN)	No. of Axles (%)
10	15
30	15
50	20
70	30
90	10
110	10

7. Describe the materials required and construction procedure of water Bound Macadam road.
8. Describe the construction steps of cement concrete pavement.
9. Describe briefly maintenance, rehabilitation and reconstruction. Describe the methods of pavement evaluation.
10. Draw a neat sketch of bridge with its components. Explain the methods of river bank protection?



Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.
- ✓ Normal graph paper should be provided.

1. What are the basic requirements of intersection at grade? Describe grade separated intersection with its advantages and disadvantages.
2. Spot speed observation at a particular link provides the following data, calculate maximum speed limit, minimum speed limit, design speed and modal speed for regulation of traffic.

Speed range (kmph)	Frequency
6-10	1
10-14	4
14-18	7
18-22	20
22-26	44
26-30	80
30-34	82
34-38	79
38-42	49
42-46	36
46-50	26
50-54	9
54-58	10
58-62	3

3. Describe highway capacity. Explain the factors which affect capacity and level of service.
4. Assuming linear Speed-density relationship of $V = 60 - 0.43K$
 - a) Draw V-K, V-Q and Q-K diagram showing critical value
 - b) Find the saturation flow?
 - c) Find speed and density at flow of 1000veh/hr
5. What are factors affecting pavement design? Write down the steps of IRC design guidelines for rigid pavement.

6. Design a flexible pavement by using asphalt institute method from the following data of a stretch of existing two lane road.

- a) Current traffic of 80KN equivalent single axle load = 0.95×10^3 EAL/day
- b) Traffic growth rate = 7.5%
- c) Design period = 15 yrs
- d) construction period = 16 months
- e) CBR of sub-grade to be taken = 5%
- f) Elastic modulus of asphalt concrete surface course = 2500 MPa
- g) Elastic modulus of bituminous treated base = 1200 MPa
- h) Elastic modulus of granular sub base course = 125 MPa

Also draw the neat sketches of the pavement layers.

- 7. What is Mass Haul Diagram? What are the equipment and plants needed for the accomplishment of various activities of road construction?
- 8. What are various types of bituminous pavements? Explain the construction procedure of Asphalt Concrete pavement.
- 9. What is highway maintenance? Explain the general causes of pavement failures.
- 10. What are the factors affecting the choice of location of bridge site? Discuss the river bank protection structures.

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

1. Define traffic engineering. Explain road user characteristics and human-vehicle-environment system.
2. The average normal flow of traffic on cross roads H and F during design period are 400 and 250 PCU per hour, the saturated headway on these roads are estimated as 3 secs and 4 secs respectively. The all red time required for pedestrian crossing is 15 secs. Design two phase traffic signal by Webster's method.
3. What is the importance of parking studies? Describe different types of parking.
4. A vehicle hits a bridge abutment at a speed estimated by investigations as 20kmph. Skid marks of 30 m on the pavement ($f=0.35$) followed by skid marks of 60 m on the gravel shoulder approaching the abutment ($f=0.50$). What was the initial speed of vehicle?
5. Explain the concept of cumulative standard axle load. What are the advantages of rigid pavement over flexible pavement?
6. Design a flexible pavement by using Asphalt Institute Method for a two lane two way pavement carrying traffic of 1500pcu/day with growth rate of traffic 5% per annum. The design life is 15 years. The vehicle damage factor is 2.5 and CBR value of sub grade soil is 5%. The modulus of asphalt concrete surface course, bituminous treated base course and granular sub-base course are 2500MPa, 1200MPa and 125 MPa respectively. Assume construction period of 18 months. Draw a neat sketch of pavement layers.
7. What is surface dressing? Write down the construction procedure of DBSD?
8. What are the equipment and plants needed for the various activities of road construction? Describe prime coat, tack coat and seal coat with their usefulness.
9. Explain the typical failures of flexible pavement with neat sketches?
10. Show the various component parts of bridge with a neat sketch. How drainage and ventilation problems are managed while tunneling?

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

- Describe various types of traffic control devices. Write down the advantages and disadvantages of traffic signal.
- What are the importances of street lighting? Describe the factors affecting street light design.
- Assuming a linear speed-density relationship, the mean free speed is observed to be 80 km/h near zero density and the corresponding jam density is 130 veh/km. Assume that the average length of vehicles is 6 m.
 - Write down the speed-density and flow-density equations
 - Compute speed and density corresponding to flow of 1000 veh/hr.
 - Compute the average headways, spacing, clearance and gaps when the flow is maximum
- The following data collected for a section of road 25.5 km long during the floating car method study. Assuming the equivalency factor of 1, 2 and 3 for each car bus and truck respectively, Calculate the flow in per/hr journey speed and running speed in both direction of flow.

Direction	Journey time		Stopped delay		No. of vehicles from opposite direction			Vehicles in the same direction	
	Min	Sec	Min	Sec	Car	Bus	truck	Overtaking	Overtaken
N-S	4	25	1	2	40	2	4	3	1
S-N	4	21	1	5	21	2	3	2	3
N-S	4	10	1	3	15	1	2	4	2
S-N	4	14	1	5	20	5	1	6	1
N-S	4	30	1	45	21	3	2	3	3
S-N	4	16	1	15	25	2	1	2	2
N-S	4	12	1	18	27	4	2	5	2
S-N	4	10	1	55	28	1	3	1	1
N-S	4	10	1	13	20	3	2	2	3
S-N	4	20	1	50	29	2	1	4	3
N-S	4	50	1	42	26	1	3	2	2
S-N	4	40	1	35	25	3	3	1	1

5. Differentiate between flexible pavement design and rigid pavement design. Describe Weatergaad's concept for temperature stresses.
6. A road pavement is to be designed for a stretch of road with the following pavement layers:

(i) Minimum thickness of asphalt concrete on the surface course = 50 mm.

(ii) Well graded crushed stone aggregate for base course, CBR value = 90%

(iii) Fairly graded gravel for sub-base course, CBR Value = 20%

(iv) Compacted Soil, CBR value = 10%

(v) 90th percentile sub grade CBR Value = 4%

The road has single lane carriage way & caters present ADT of 1200 commercial vehicle per day with annual growth of 6%. The pavement is to be designed for 10 years period. Design the pavement section using IRC recommendation for CBR method. The road is to be compacted with 6 months from initial traffic count

7. What are the various activities involved in road construction? Explain the construction procedure of otta seal.
8. Describe the materials required and construction procedure of Water Bound Macadam (WBM) road.
9. Describe the causes of failures in flexible pavement.
10. Explain the methods of river bank protection? Explain the methods of tunneling in hard soil.

05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Normal graph paper should be provided.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

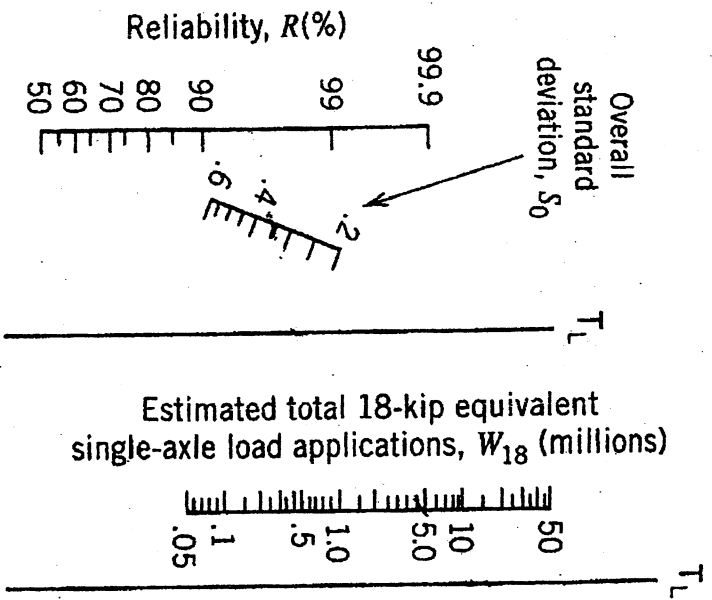
- Define traffic engineering. Describe road users and vehicular characteristics.
- What are the uses of origin and destination study? Briefly explain the methods of conducting this study.
- Average trip time for office is 30 minutes with standard deviation of 5 min. Assuming normal distribution of trip time, calculate the followings:
 - Probability of trip time being at least 35 minutes
 - If the working hour starts at 10:00 AM and trip starts at 9:40 AM what is the probability of being late?
- An isolated signal with pedestrians indication is to be installed on a right angled intersection with road A 15 m wide and road B 12 m wide. The heaviest volume per hour for each lane of road A and road B are 300 and 250 respectively. The amber times for roads A and B are 3 and 2 seconds respectively. Design the timings of traffic and pedestrian signal.
- What do you understand by legal axle load and standard axle load? Describe the stresses induced in the rigid pavement slab. How spacing between contraction joints is calculated in jointed plain concrete pavement?
- In the figure below, a pavement system with the resilient moduli, layer coefficient of surface course and drainage coefficients are shown. If predicted ESAL = 15×10^6 , $R = 90\%$, $S_o = 0.4$ present serviceability index = 4.2 and terminal serviceability index = 2.7, select the thickness of D_1 , D_2 and D_3 .

$E_1 = 450,000 \text{ psi}$	$a_1 = 0.44$	D_1
$E_2 = 25,000 \text{ psi}$	$m_2 = 1.2$	D_2
$E_3 = 15,000 \text{ psi}$	$m_3 = 1.2$	D_3

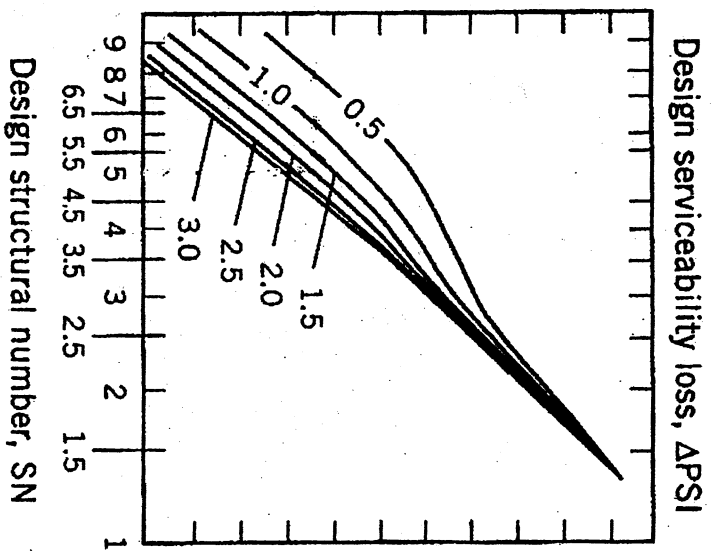
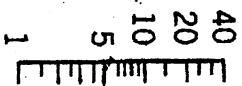
$M_R = 5000 \text{ psi}$

- Draw a neat sketch of typical pavement structures. Explain in detail the construction methodology of Otta Seal.
- Explain with a neat diagram the characteristics of mass haul diagram, including free haul, over haul, economic haul, shrinkage and swelling factor.
- Define road maintenance. Describe the failures of the flexible pavement.
- What are the methods of providing tunnel ventilation? Explain the major factors controlling the selection of bridge sites.

AAHSTO Flexible Pavement Nomograph



Effective roadbed soil
Resilient modulus, M_R (ksi)



Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

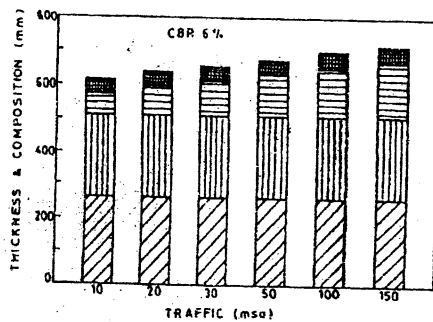
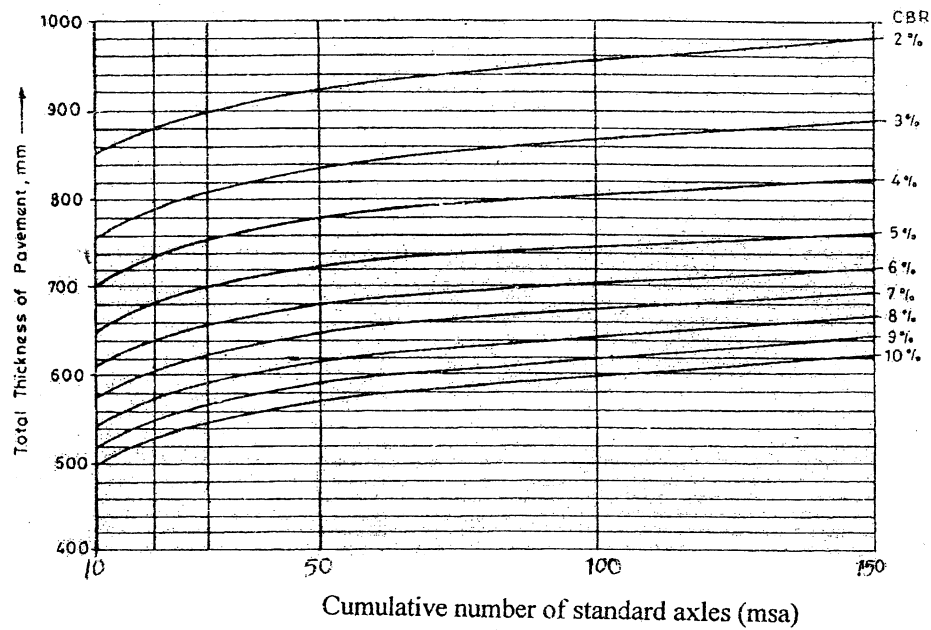
Subject: - Transportation Engineering II (CE703)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
 - ✓ Attempt All questions.
 - ✓ All questions carry equal marks.
 - ✓ Necessary figures are attached herewith.
 - ✓ Assume suitable data if necessary.
- List the objectives of accident study. Explain briefly causes and preventive measures of accident.
 - Describe channelized intersections with their advantages and disadvantages.
 - The data collected after speed and delay studies by floating car method on a stretch of road 3.2 km long are given below. Determine the average values of volume, journey speed and running speed of the traffic stream along either direction.

Trip	Direction of trip	Journey time (min)	Total stopped delay (min)	No. of vehicles		
				Overtaking	Overtaken	From opposite direction
1	C - D	6.50	1.58	4	7	270
2	D - C	7.48	1.72	5	4	250
3	C - D	6.92	1.62	5	4	300
4	D - C	7.82	1.82	3	3	275
5	C - D	6.33	1.40	3	2	295
6	D - C	8.13	2.10	2	1	280
7	C - D	6.71	1.73	4	4	300
8	D - C	7.40	1.85	3	3	230
9	C - D	6.23	1.60	4	2	275
10	D - C	6.98	1.78	2	1	242

- An isolated signal with pedestrians indication is to be installed on a right angled intersection with road H of 12 m wide and road F of 9.6 m wide. The heaviest volume per hour for each lane of H and F are 475 and 325 respectively. The approach speeds are 60 and 45 kmph for road H and road F respectively. Design the timings of traffic and pedestrian signals. Assume amber times for road H and road F as 5 and 4 secs respectively.
- Explain how design traffic is calculated from the data obtained from traffic surveys. Give at least three different examples in various design methods.
- Design the pavement for an existing two lane single carriageway road with the following details.
 - Initial traffic in both direction in the year of completion of construction = 5640 CVPD
 - Design life = 10 years
 - Design CBR value = 6%
 - Axle load using the road (CV) = 118 KN
- Define road construction technology. Describe the various activities to be performed for the road construction.
- Describe the construction procedure of bituminous concrete road and check needed for quality control.
- Define road maintenance. Explain different measure to be taken for gully control works.
- What are the factors to be considered in tunnel lighting? What are the different methods of river bank protection work?

Chart for question no. 6



cumulative traffic (msa)	Total pavement thickness (mm)	pavement composition		
		bituminous surfacing		Granular base and sub base (mm)
		BC (mm)	DBM (mm)	
10	615	40	65	base = 250 subbase = 260
20	640	40	90	
30	655	40	105	
50	675	40	125	
100	700	50	140	
150	720	50	160	

GSB GB DBM BC

Exam.	Old Back (2065 & Earlier Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

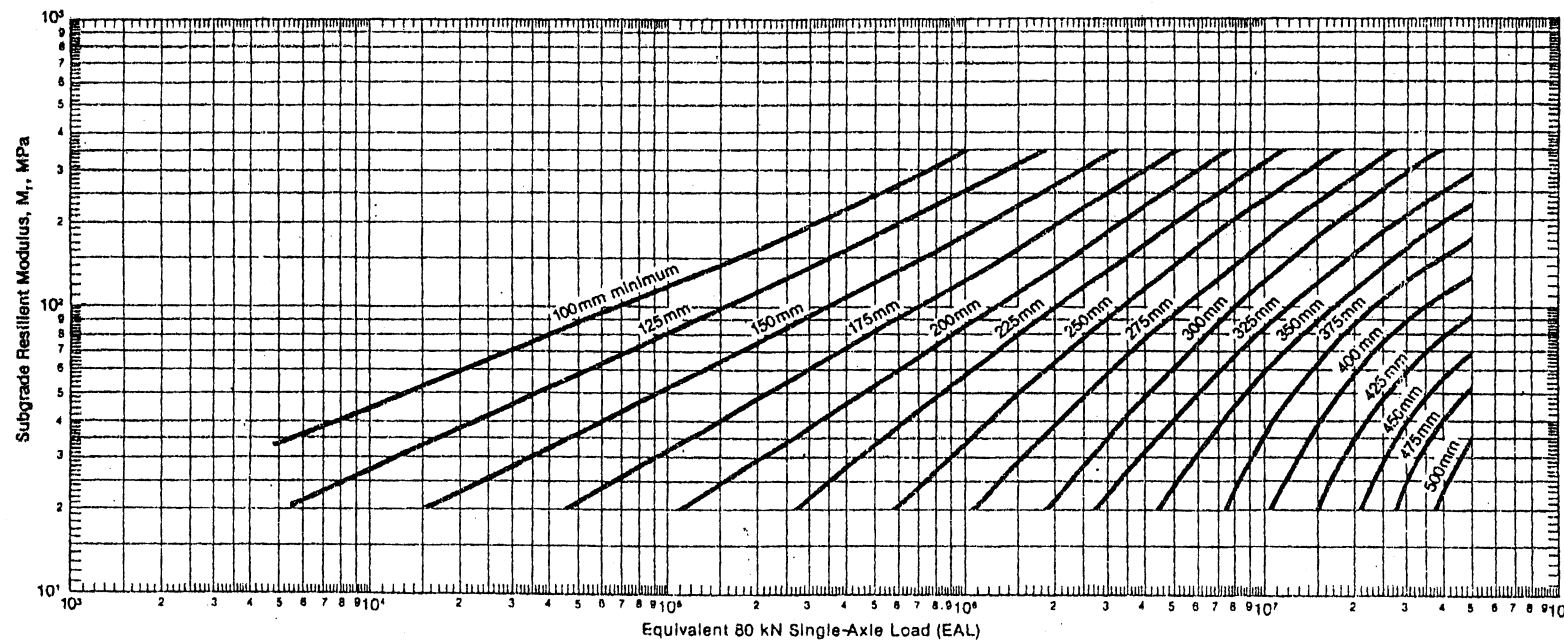
Subject: - Transportation Engineering II (EG723CE)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

1. a) What do you mean by Origin and Destination Study? Explain the various applications of Origin and Destination studies. (8)
- b) What do you mean by Traffic Control Device? Explain in short about the types of Traffic Signs. (8)
2. a) Compare on-street and off-street parking. Draw neat sketches showing parallel and angle kerb (on-street) parking geometry. (6)
- b) An isolated signal with pedestrian indicators to be installed on a right angled intersection with road A of 15 m and road B of 7 m respectively. The heaviest volume per hour for each lane of road A and road B are 350 and 250 respectively. The approaching speeds for road A and road B are 60 kmph and 45 kmph. Design the traffic and pedestrian signal timings. (Take amber period for yellow light signal as 2 to 4 secs and pedestrian walking speed of 1.0 m/sec) (10)
3. a) Explain the various types of stresses needed to be considered in the design of rigid pavement. (8)
- b) An existing single lane road has to be upgraded by bituminous pavement for a certain length by the following considerations. (8)
 - i) Base traffic of 80 kN equivalent single axle load (ESAL) = 5.11×10^4 ESAL per year
 - ii) Design period = 12 years
 - iii) Construction period = 1 year
 - iv) Traffic growth rate = 6%
 - v) 87.5th percentile CBR value of sub-grade soil from 7 sample locations = 4%
 - vi) Elastic modulus of asphalt concrete for surface course, $E_{ac} = 2900$ MPa
 - vii) Elastic modulus of emulsified stabilized base, $E_b = 1600$ Mpa
 - viii) Elastic modulus of granular sub-base, $E_{sb} = 125$ Mpa

You are required to design the pavement from Asphalt Institute Method. Draw the cross section of final pavement layers considering the thickness of asphalt concrete on surface course is not less than 50 mm. (Full depth AC curve attached herewith)
4. a) What is Mass Haul Diagram? Explain its importance in road construction with diagram. (10)
- b) Discuss the construction procedure of premix bituminous carpet in brief. (6)
5. a) What are the causes that result the failure of cement concrete pavement. Explain briefly. (8)
- b) Explain pavement evaluation. (8)
6. Write short notes on any four of the following: (4x4)
 - a) Components of a bridge
 - b) Importance of ventilation in tunneling
 - c) Importance of road lighting
 - d) Thirtieth highest hourly traffic volume
 - e) Construction procedure of gravel road

Full-Depth Asphalt Concrete



Design Chart VI-1.

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary design chart is attached herewith.
- ✓ Assume suitable data if necessary.

1. a) Define traffic capacity. Describe the factors affecting capacity and level of service. [6]
- b) Design the timing of traffic and pedestrian signals of an isolated signal to be installed at a right angle intersection when road P and Q cross. The data available are: [10]

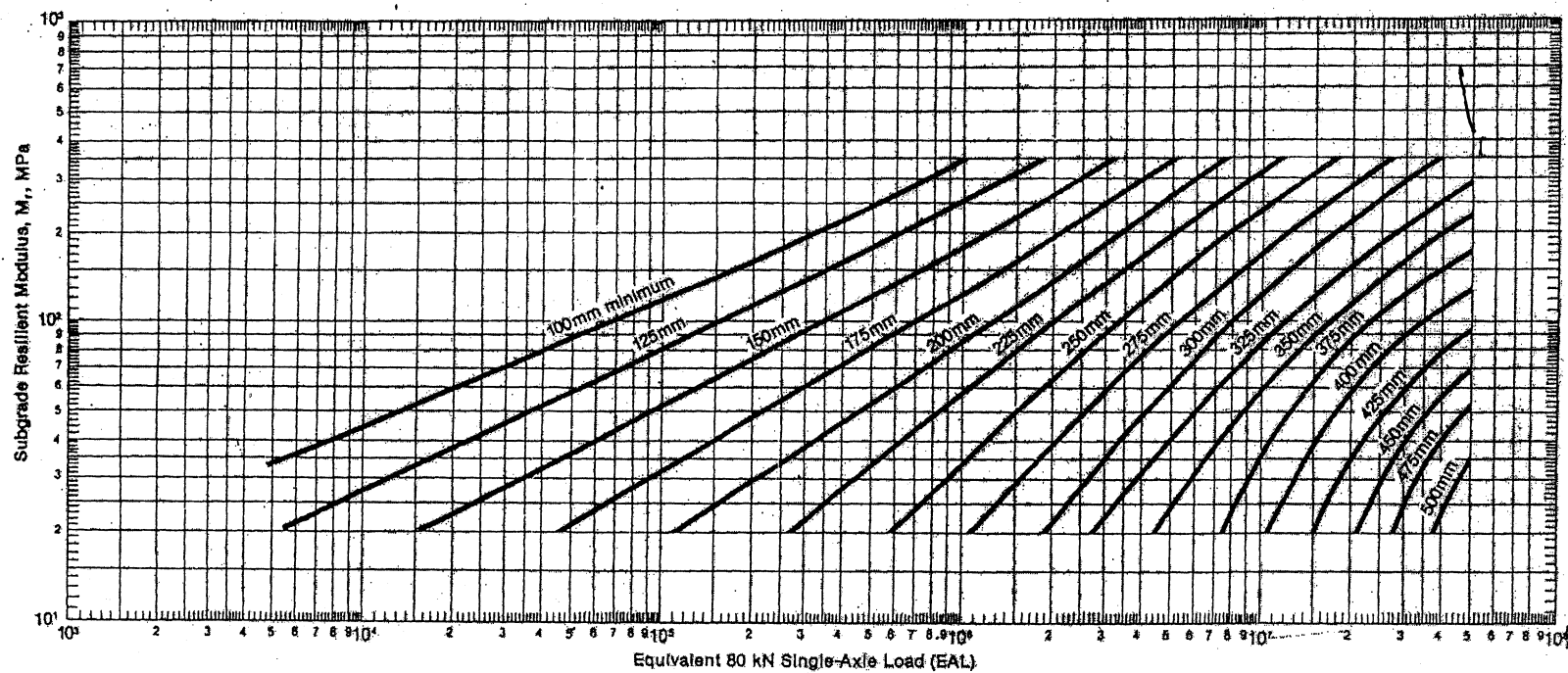
	Road P	Road Q
i) Width	14.00	10.50
ii) Peak hour traffic volume, Vehicle/hour/lane	210	120
iii) Approach speed, Km/h	50	35

2. a) Define rotary intersection. What are the advantages and disadvantages of rotary intersection? [8]
- b) A vehicle skids through a distance of 40m before colliding with another parked vehicle, the weight of which is 75 percent of the former. After collision both the vehicles skid through 14m before stopping. Compute the initial speed of moving vehicle. Assume coefficient of friction of 0.62. [8]
3. a) An existing two lane single carriageway gravel road has to be upgraded by bituminous pavement, to cater the growing traffic demand. Present traffic in terms of ESA is 0.8×10^3 per day. The regional traffic growth rate is taken as 6.5% per annum. Data required for pavement design are as given below. [8]
 - i) Design period = 10 years
 - ii) Construction period = 1 year
 - iii) 87.5 percentile CBR value of sub grade soil from 7 sample locations = 5%
 - iv) Elastic modulus of asphalt concrete for surface course $E_{ac} = 2000 \text{ MPa}$
 - v) Elastic modulus of crushed stone base $E_{base} = 350 \text{ MPa}$
 - vi) Elastic modulus of granular sub- base $E_{sub-base} = 250 \text{ MPa}$

You are required to design the pavement by Asphalt Institute Method. Draw the cross section of final pavement layers considering the minimum thickness of asphalt concrete on surface course equal to 50mm.
- b) What are the factors affecting pavement design? Write down the steps of IRC design guidelines for rigid pavement. [8]
4. a) What is Mass Haul Diagram? What are the equipments and plants needed for the accomplishment of various activities of road construction? [2+6]
- b) Distinguish between prime coat and tack coat. Explain construction method of surface dressing. [2+6]
5. a) Explain the importance of road maintenance. Describe the maintenance of bituminous pavement. [2+6]
- b) Classify the bridges according to types of super structure and span length. Make a sketch of a bridge section (longitudinal and cross) and plan indicating its elements. [8]
6. Write short note on: (any four) [4x4]
 - a) Fixed delay and operational delay
 - b) Spacing and head way
 - c) Typical failures of the rigid pavement
 - d) Gravel road construction
 - e) Radius of relative stiffness

3(a)

Full-Depth Asphalt Concrete



Exam.	Regular / Back		
	BE	Full Marks	80
Level	BCE	Pass Marks	32
Programme	IV / I	Time	3 hrs.
Year / Part			

Subject: - Transportation Engineering II

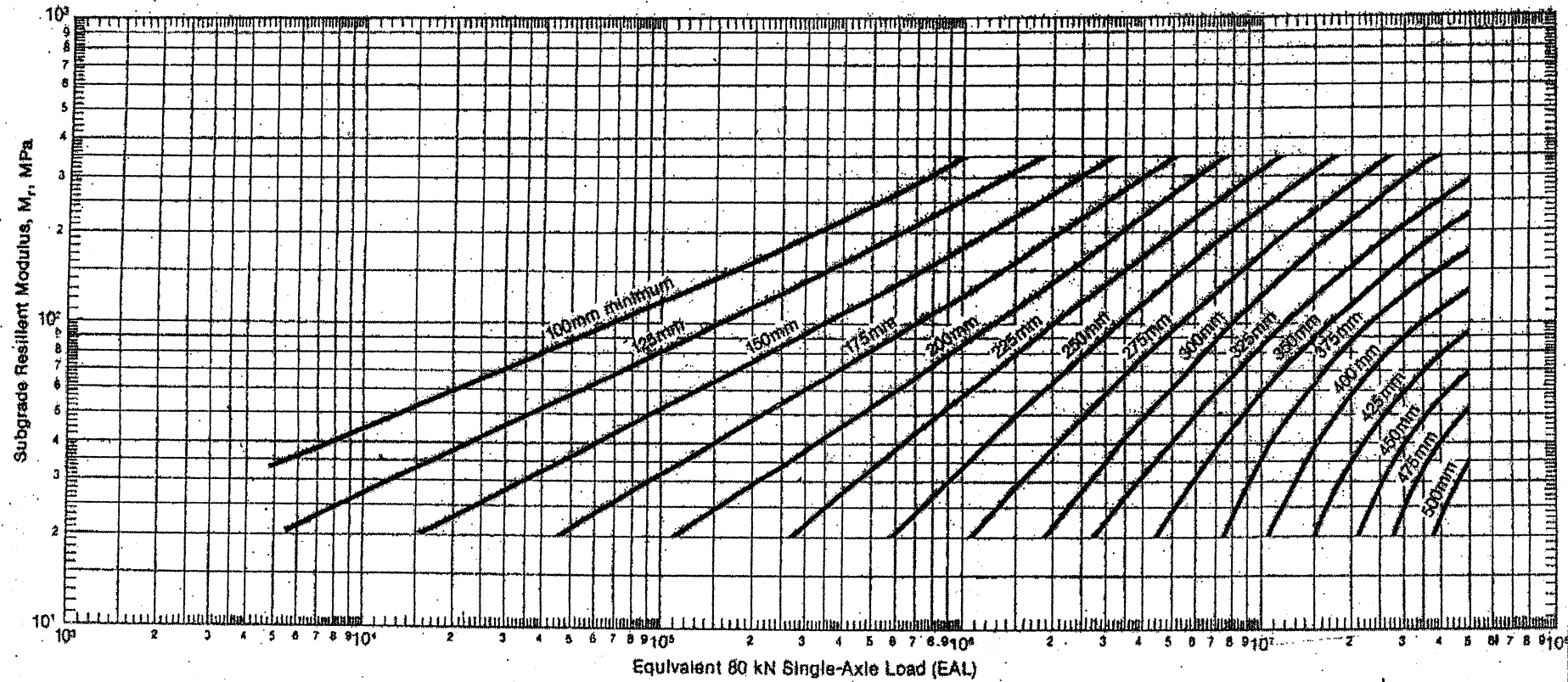
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Necessary charts are attached herewith.
- ✓ Assume suitable data if necessary.

1. a) Describe the road user characteristics. Explain their importance in traffic engineering. [4+2]
b) The following speed data were collected during a two-minute segment of a spot speed study (speed in Kmph). [3+3+4]
45, 55, 48, 52, 60, 48, 60, 42, 52, 65, 64, 63, 58, 56, 68, 54, 68, 64, 66, 70
Calculate: (i) The time mean speed; (ii) The space mean speed.
What will be the average density of the above traffic stream if the mean headway is 4.5 sec?
2. a) What is grade separation? Mention their types with sketches. Draw a right angle four legged intersection of two roads and show their various types of conflict points if (i) both roads are with two way movements; (ii) one road is with one-way and another is with two way movements. [1+3+4]
b) What are different methods of traffic control at an intersection? The average normal flow of traffic on cross roads A and B during design period are 400 and 300 PCU per hour; the saturation flow values on these roads are estimated as 1450 and 1150 PCU per hour respectively. The all-red time required for pedestrian crossing is 12 sec. Design two phase traffic signal by Webster's method. [2+6]
3. a) Classify pavement and explain the functions of different layers of flexible pavement. [6]
b) An existing single lane gravel road has to be upgraded by bituminous pavement for a specified length as it is the demand for catering the increment in volume of heavy traffic. In order to estimate the base traffic, traffic survey was carried out at two points on the existing roads. The pavement design is based on the following assumptions. [10]
 - i) Base traffic of 82 kN equivalent single axle load (ESAL) = 1.888×10^3 ESAL per day
 - ii) Design period = 10 years
 - iii) Construction period = 18 months
 - iv) Growth rate = 6%
 - v) 87.5 percentile CBR value of sub-grade soil from 7 sample locations = 5%
 - vi) Elastic modulus of asphalt concrete for surface course $E_{ac} = 2000$ MPa
 - vii) Elastic modulus of crushed stone base $E_{base} = 250$ MPa
 - viii) Elastic modulus of granular sub-base $E_{subbase} = 125$ MPa

You are asked to design the pavement by Asphalt Institute Method. Draw the cross section of final pavement layers considering the minimum thickness of asphalt concrete on surface course where is equal to 50mm. Chart is provided.

4. a) Explain the features of mass-haul diagram with neat sketches. Describe free haul, over-haul and economic-haul. [8]
- b) Write down the explanatory note on bituminous constructions types: interface treatment; surface dressing; premixed carpet; asphalt concrete. [2×4]
5. a) Write down the methods of structural evaluation of pavement. A number of deflection readings were taken on a pavement. The mean and standard deviation were 1.5 and 0.2 respectively. The allowable deflection is 1.0mm. Determine overlay thickness. [2+6]
- b) Classify the bridges according to their structure, material and loading. Draw a sketch of the bridge with all its components. [4+4]
6. Write short note on (any four): [4×4]
- a) Traffic flow parameters
 - b) Maintenance in bituminous road
 - c) Construction procedure of WBM road
 - d) Importance of lighting in tunnel
 - e) Reverse or tidal flow operation

Full-Depth Asphalt Concrete



Design Chart VI-1.

66 Shapra
Transposition