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.
✓ Necessary charts are attached herewith.
✓ Assume suitable data if necessary.

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]

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Full-Depth Asphalt Concrete
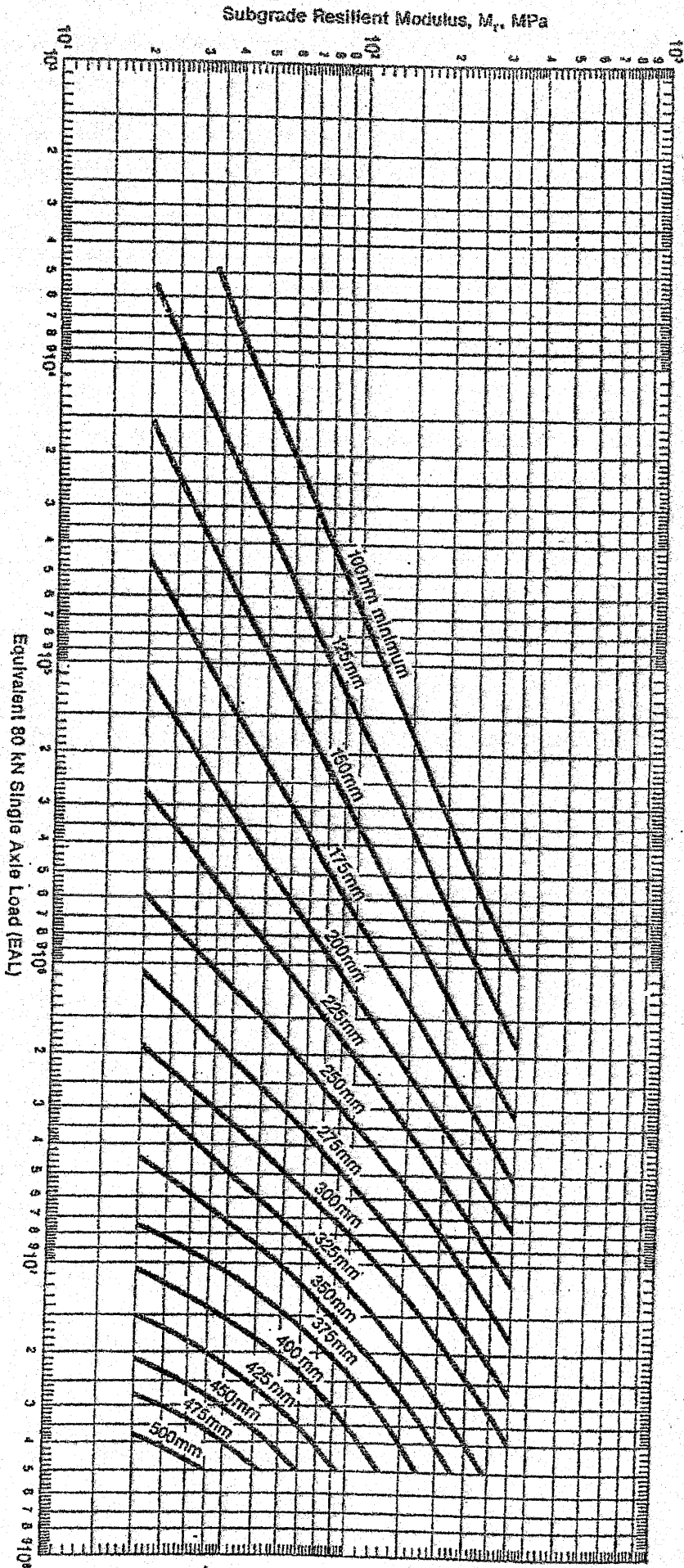
Subgrade Resilient Modulus, M_r, MPa

Equivalent 80 kN Single Axle Load (EAL)

100mm minimum
125mm
150mm
175mm
200mm
225mm
250mm
275mm
300mm
325mm
350mm
375mm
400mm
425mm
450mm
475mm
500mm

Exam.		Regular / Back	
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.
✓ _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 = 3.0×10^5 kg/cm^2
   Poisson's ratio of concrete = 0.15
   Modulus of rupture of concrete = 40 kg/cm^2
   Thermal expansion of concrete = 10×10^{-6}/°C
   Modulus of subgrade reaction = 6 kg/cm^3
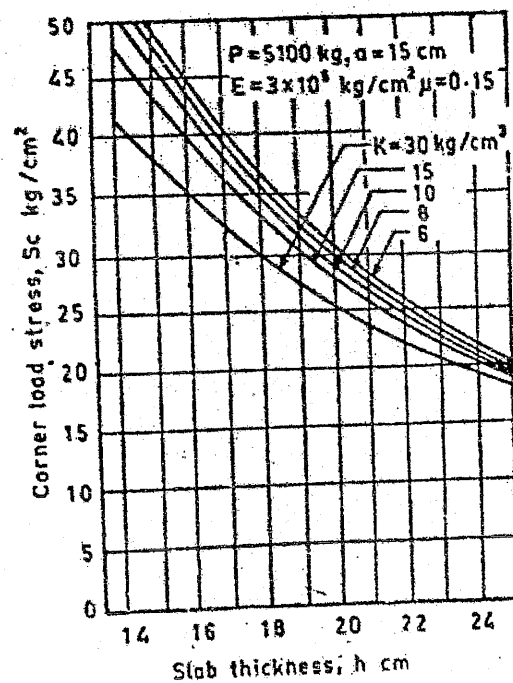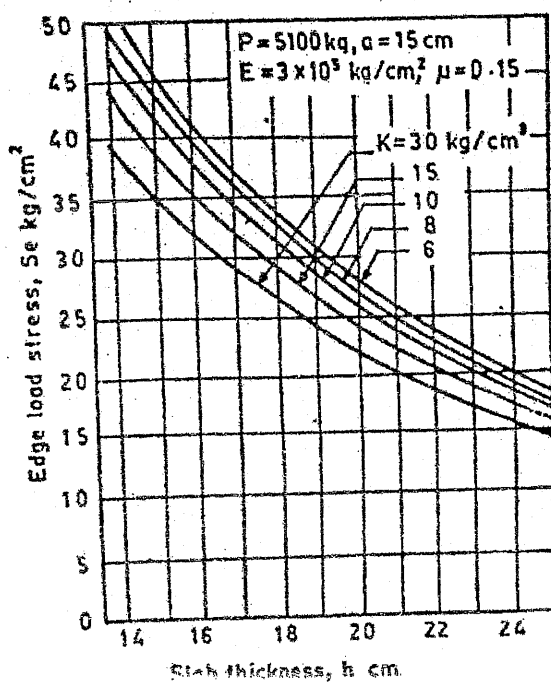   Maximum temperature in summer = 50°
   Maximum temperature in winter = 15°C
   The temperature differential in slab in the region is 17.3, 19.0 and 20.3 degree Celsius for thickness of 15, 20 and 25 cm respectively.

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

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Examination Control Division
2076 Ashwin

Exam.		Back	
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.
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✓ *Necessary charts are attached herewith.*
✓ Assume suitable data if necessary.

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 mis 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%, $E_{sub\ base}$ = 275 MPa, E_{base} = 500 MPa and $E_{surface}$ = 2400 MPa. [8]

6. Write down the assumption and analysis of Westargard 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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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.

1. Discuss the advantages and limitations of rotary intersection. Describe the factors affecting street light design.

2. Describe different types of road capacities and explain the factors affecting capacity and level of service.

3. Speed and delay studies by floating car method were conducted on a stretch of city road of 3 km length running north south. The data collected is given below. Find out

   i) Average traffic volume
   ii) Journey speed
   iii) Running speed of the traffic system along either direction

Trip no	Direction of Trip	Journey time [min]	Total Stopped Delay [min]	No. of Vehicles		
				Overtaking	Overtaken	from opposite direction
1	N-S	5.5	1.5	4	7	250
2	S-N	6.25	1.67	5	5	200
3	N-S	5.36	1.5	5	3	240
4	S-N	6.33	2.25	3	1	230
5	N-S	5.63	1.16	3	6	230
6	S-N	6.3	1.33	2	3	250
7	N-S	5.33	1.67	2	7	210
8	S-N	6.53	1.83	2	2	180
9	N-S	5.16	1.5	3	4	200

4. A traffic stream had a free flow speed of 80 kmph and jam density if 100 veh/km. Calculate the speed and density volume for highest level of service possible if the flow is 90% of capacity flow. Calculate the spacing, headway, gap and clearance when there is capacity flow if the length of vehicle is 6.0 m.

5. Design a flexible pavement by using asphalt institute method from the following data of a stretch of existing two lane roads.
   i)   Current traffic of 80 KN equivalent single axle load = $0.95*10^3$ EAL/Day. VDF = 2.0
   ii) Traffic growth rate = 7.5%
   iii) Design period = 15 years
   iv) Construction period = 16 months
   v)   CBR sun grade to be taken = 5%
   vi) Elastic modulus of asphalt concrete surface course = 2500 Mpa
   vii) Elastic modulus of granular sub-base course = 125 Mpa

   Also sketch the cross section of pavement. (Refer attach figure)

6. Discuss westergaard's concept of temperature stress in concrete pavement. How spacing of different joints is calculated in rigid pavement.

7. List out the techniques of soil stabilization. Explain the design and construction procedure of soil-cement stabilized road.

8. Explain the construction procedure of bituminous concrete road and check needed for quality control.

9. Benkelman Beam deflection studies were carried out on 12 selected points on stretch of flexible pavement during summer season. The deflection values obtained in mm are given below. If the present traffic consists of 600 commercial vehicles per day, determine the thickness of bituminous concrete overlay required, if the pavement temperature during the test was 32°C and the correction factor for subsequent increase in subgrade moisture content is 1.1. Assume annual rate of growth of traffic as 7.5%, design life as 10 years and the number of years after the last traffic count before the construction of overlay as 2 years and take equivalency factor of 2.0 for bituminous concrete. Adopt IRC guidelines.
   [1.3, 1.42,1.35,1.38, 1.38, 1.58,1.65,1.50, 1.49,1.43,1.53,1.60 mm]

Design Traffic (cvpd)	150-450	450-1500	1500-4500
Allowable deflection (mm)	1.5	1.25	1.00

10. Write the characteristics if ideal bridge site. Explain briefly the method of tunneling in firm ground.

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Subject: - Transportation Engineering II *(CE703)*

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✓ *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:

Axel 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?

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

Subject: - Transportation Engineering II *(CE703)*

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✓ Normal graph paper shall be provided.
✓ Assume suitable data if necessary.

1. Explain the contributing factors of road accident. Explain how accident rate can be reduced.

2. Design two phase traffic signal using Webster method. The flow on cross road X and Y during design period is 450 PCU/hr and 325 PCU/hr respectively. The capacity of road Y and X being 1400 PCU/hr and 1200 PCU/hr respectively. Take amber time as 3 sec, all red condition for pedestrian crossing is 15 sec.

3. An officer commutes daily from his home to his office. On an average the trip one way takes 24 minutes, with a standard deviation of 4 minutes. Assume the distribution of trip times to office to be normally distributed

   a) What is the probability that the trip will take at least ½ hours?
   b) If the working hour starts at 9:00 A.M and he leaves his house at 8:45 A.M in the morning, what percentage of the time is he late at work?

4. What are the importance of street lighting? Describe the factors affecting its design.

5. Differentiate between flexible pavement and rigid pavement? Explain the factors which affect pavement design.

6. Design the pavement for a given stretch of a dual three lane carriage way with following data. The result of subgrade soil CBR test at seven locations obtained in that stretch of a road are 11,8,7,6,7,5,4. The existing traffic counted on that stretch of road (ADT) are

Traffic categories	Nos.	Equivalency factors
Truck (loaded)	20	5.67
Truck (empty)	20	0.02
Bus (loaded)	40	0.1
Mini Truck (empty)	10	0.001
Mini Truck (loaded)	20	0.63
Mini Bus (loaded)	19	0.05
Cars	20	0.0005

Traffic Growth rate = 7%
Design Period = 10 years
Construction period from last date of traffic counts = 2 years

7. Explain with mass Haul Diagram the free haul, over haul and economical haul. List various activities in road construction.

8. Define prime coat and tack coat. Write down the construction procedure of Asphalt concrete.

9. Explain the importance of road maintenance. Describe the maintenance of bituminous pavement.

10. Explain the importance and methods of providing tunnel drainage, lighting and ventilation.

***

P.T.0

FSU 2073

Subject: - Transportation Engineering II *(CE703)*

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✓ 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.

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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.
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✓ Assume suitable data if necessary.

1. Describe various types of traffic control devices. Write down the advantages and disadvantages of traffic signal.

2. What are the importances of street lighting? Describe the factors affecting street light design.

3. 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.
   i) Write down the speed-density and flow-density equations
   ii) Compute speed and density corresponding to flow of 1000 veh/hr.
   iii) Compute the average headways, spacing, clearance and gaps when the flow is maximum

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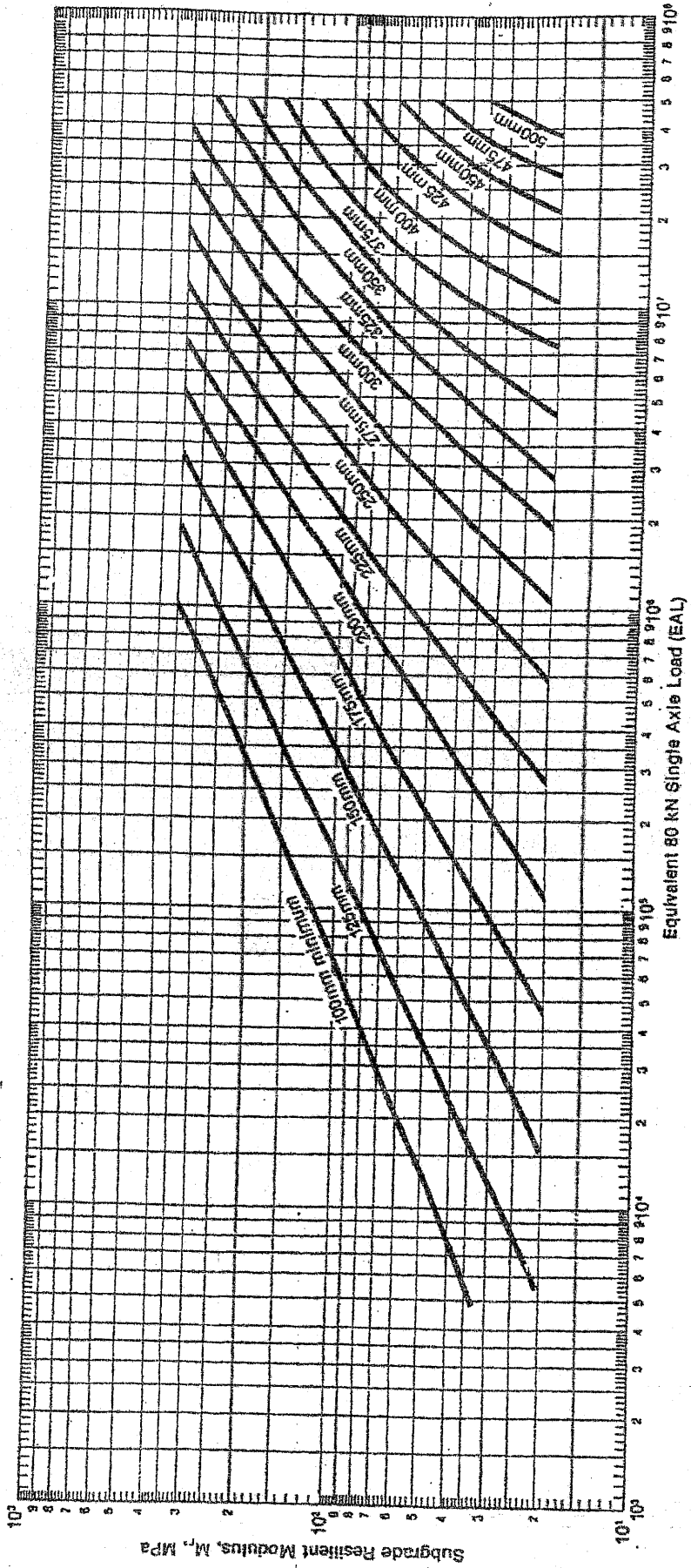
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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

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?

***

Full-Depth Asphalt Concrete

Chart axes:
- Vertical axis (left): Subgrade Resilient Modulus, M_r, MPa
- Horizontal axis (bottom): Equivalent 80 kN Single Axle Load (EAL)

Curve labels: 100 mm minimum, 125 mm, 150 mm, 175 mm, 200 mm, 225 mm, 250 mm, 275 mm, 300 mm, 325 mm, 350 mm, 375 mm, 400 mm, 425 mm, 450 mm, 475 mm, 500 mm

03   TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

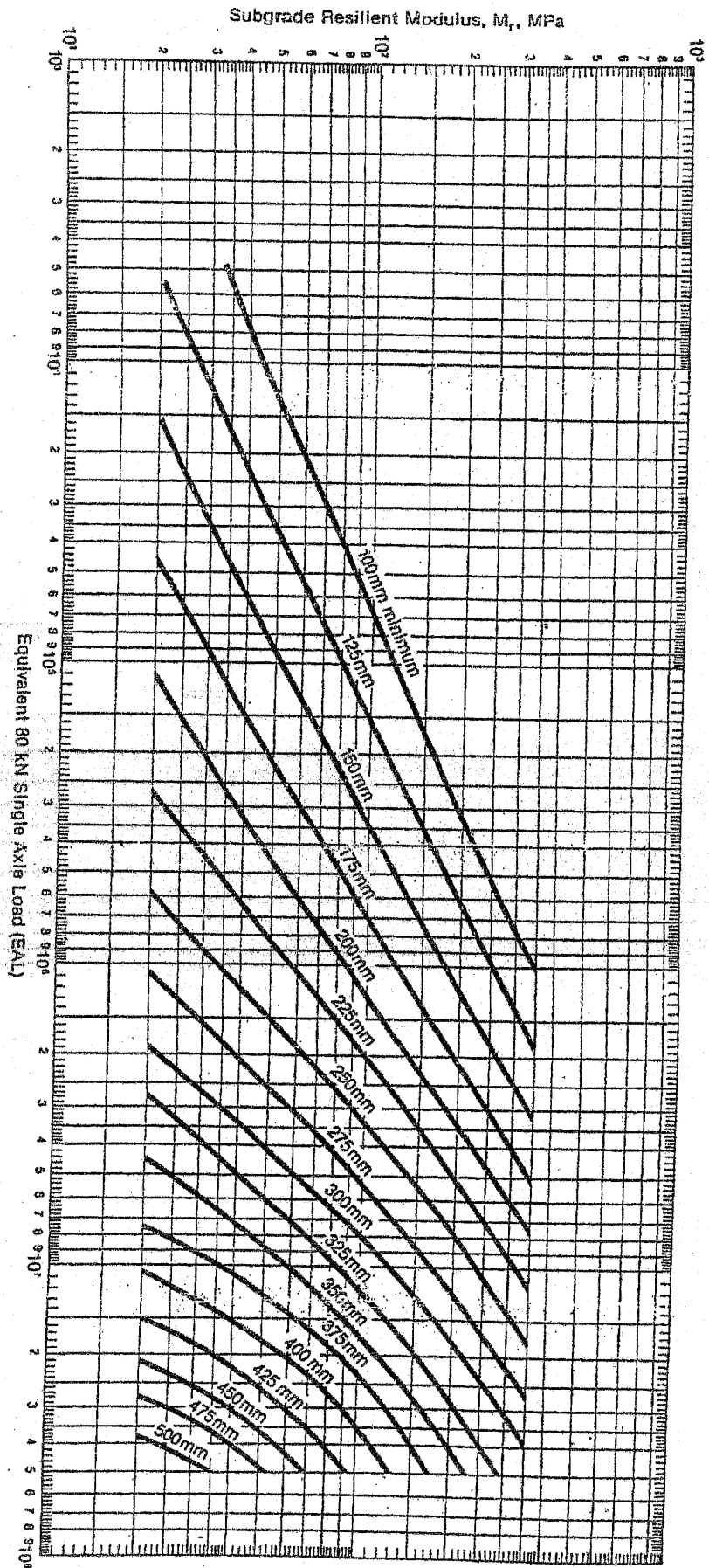| Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering II *(CE703)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ Attempt __All__ questions.
✓ The figures in the margin indicate __Full Marks__.
✓ __Necessary chart is attached herewith.__
✓ __Normal graph paper should be provided.__
✓ Assume suitable data if necessary.

1. What are the objectives of conducting speed and delay study? Describe the methods of conducting speed and delay study. [4+4]

2. Write down the basic requirements of intersection at grade. Draw a neat sketch of full cloverleaf intersection showing all the traffic movement. [4+4]

3. A van of weight 3 tonne hits a parked car of weight 0.8 tonne and both the vehicles skid together through a distance of 4.2 m before coming to stop. [8]
   i) Calculate the initial speed of the van if it does not apply brakes before collision.
   ii) Calculate the speeds of van before collision at collision and after collision if it applies brakes and skid through a distance of 2.8 m before collision.

4. An isolated signal with pedestrian indication is to be installed on a right angled intersection with road C of 12 m wide and road D of 9.6 m wide. The volume of traffic per hour per lane of roads C and D are 450 and 300 respectively. The approach speeds are 60 kmph and 40 kmph for roads C and D respectively. Design the timings of traffic and pedestrian signals, assuming amber periods of road C and D as 4 seconds and 3 seconds respectively. [8]

5. The traffic survey revealed that present ADT of 1200 cv/day (both directions). The annual growth rate of traffic is 8%. The vehicle damage factor is 1.5. The pavement construction of single lane road is to be completed in 3 years from the last traffic count. Design the pavement section by Asphalt Institute method with the following considerations. [8]
   i) Design period = 10 years
   ii) CBR test values of sub grade soil

Penetration (mm)	Load (kg)	Penetration (mm)	Load (kg)
0	0	3.0	56.5
0.5	5.0	4.0	67.5
1.0	16.2	5.0	75.2
1.5	28.1	7.5	89.0
2.0	40	10.0	99.5
2.5	48.5	12.5	106.5

   iii) Elastic modulus of Asphalt concrete surface course = 2800 MPa
   iv) Elastic modulus of Emulsified stabilized base course = 1500 Mpa
   v) Elastic modulus of Granular sub base (CBR ≥ 30%) = 120 Mpa
   Draw the cross section of final pavement layers considering the thickness of Asphalt concrete surface course not less than 5 cm.

6. What are the factors affecting pavement design? Write down the steps of rigid pavement design by IRC method. [8]

7. Describe different types of pavement. Explain the construction method of Asphalt concrete pavement. [2+6]

8. List out the soil stabilization methods. Explain the construction process of mechanical soil stabilized road. [2+6]

9. Differentiate between maintenance and rehabilitation. Explain different types of road maintenance. [2+6]

10. What are the factors to be considered in selecting bridge site? Explain the methods of river bank protection. [4+4]

***

Full-Depth Asphalt Concrete

Subgrade Resilient Modulus, M_r, MPa

Equivalent 80 kN Single Axle Load (EAL)

100mm minimum
125mm
150mm
175mm
200mm
225mm
250mm
275mm
300mm
325mm
350mm
375mm
400 mm
425 mm
450mm
475mm
500mm

| 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.

1. List the objectives of accident study. Explain briefly causes and preventive measures of accident.

2. Describe channelized intersections with their advantages and disadvantages.

3. 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

4. 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.

5. Explain how design traffic is calculated from the data obtained from traffic surveys. Give at least three different examples in various design methods.

6. Design the pavement for an existing two lane single carriageway road with the following details.
   a. Initial traffic in both direction in the year of completion of construction = 5640 CVPD
   b. Design life = 10 years
   c. Design CBR value = 6%
   d. Axle load using the road (CV) = 118 KN

7. Define road construction technology. Describe the various activities to be performed for the road construction.

8. Describe the construction procedure of bituminous concrete road and check needed for quality control.

9. Define road maintenance. Explain different measure to be taken for gully control works.

10. 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
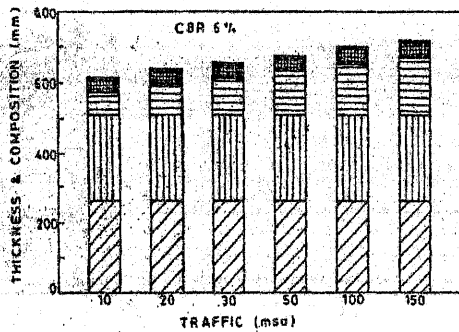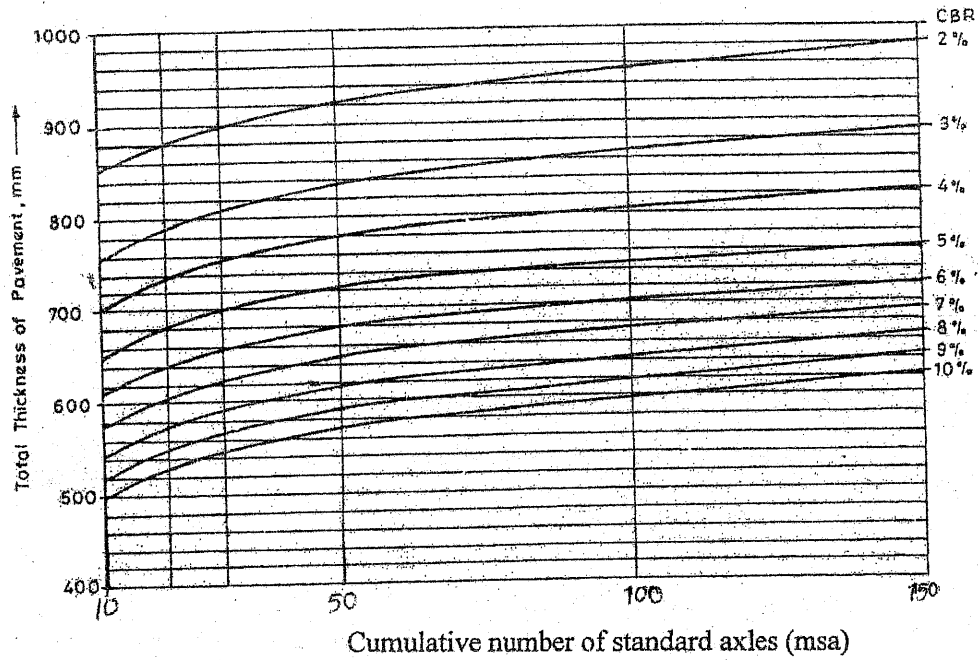
Cumulative number of standard axles (msa)

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

CBR 6%

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

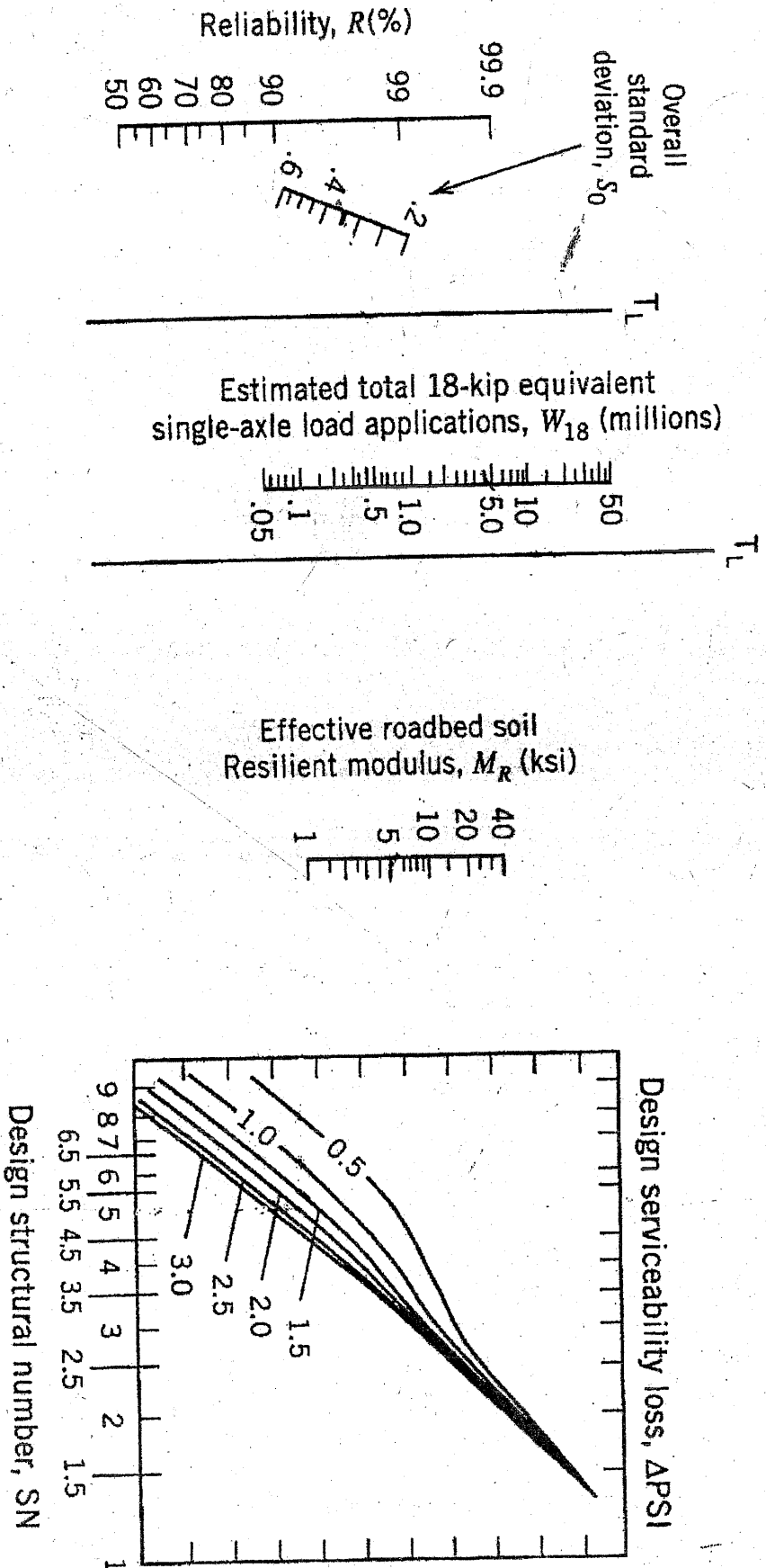## *Subject:* - Transportation Engineering II *(CE703)*

✓ 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.

1. Define traffic engineering. Describe road users and vehicular characteristics.

2. What are the uses of origin and destination study? Briefly explain the methods of conducting this study.

3. Average trip time for office is 30 minutes with standard deviation of 5 min. Assuming normal distribution of trip time, calculate the followings:
   a) Probability of trip time being at least 35 minutes
   b) If the working hour starts at 10:00 AM and trip starts at 9:40 AM what is the probability of being late?

4. 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.

5. 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?

6. 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.

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

$M_R = 5000$ psi
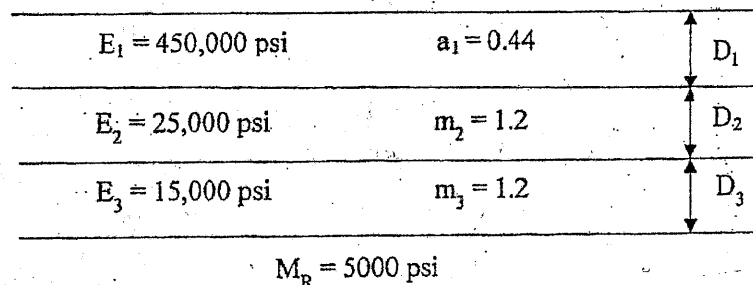
7. Draw a neat sketch of typical pavement structures. Explain in detail the construction methodology of Otta Seal.

8. Explain with a neat diagram the characteristics of mass haul diagram, including free haul, over haul, economic haul, shrinkage and swelling factor.

9. Define road maintenance. Describe the failures of the flexible pavement.

10. What are the methods of providing tunnel ventilation? Explain the major factors controlling the selection of bridge sites.

***

AAHSTO Flexible Pavement Nomograph

Reliability, R(%)

Overall standard deviation, S_0

99.9

99

50
60
70
80
90

.6
.4
.2

T_L

Estimated total 18-kip equivalent single-axle load applications, W_{18} (millions)

T_L

.05
.1
.5
1.0
5.0
10
50

Effective roadbed soil Resilient modulus, M_R (ksi)

1
5
10
20
40

Design serviceability loss, ΔPSI

0.5
1.0
1.5
2.0
2.5
3.0

Design structural number, SN

1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
8
9

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

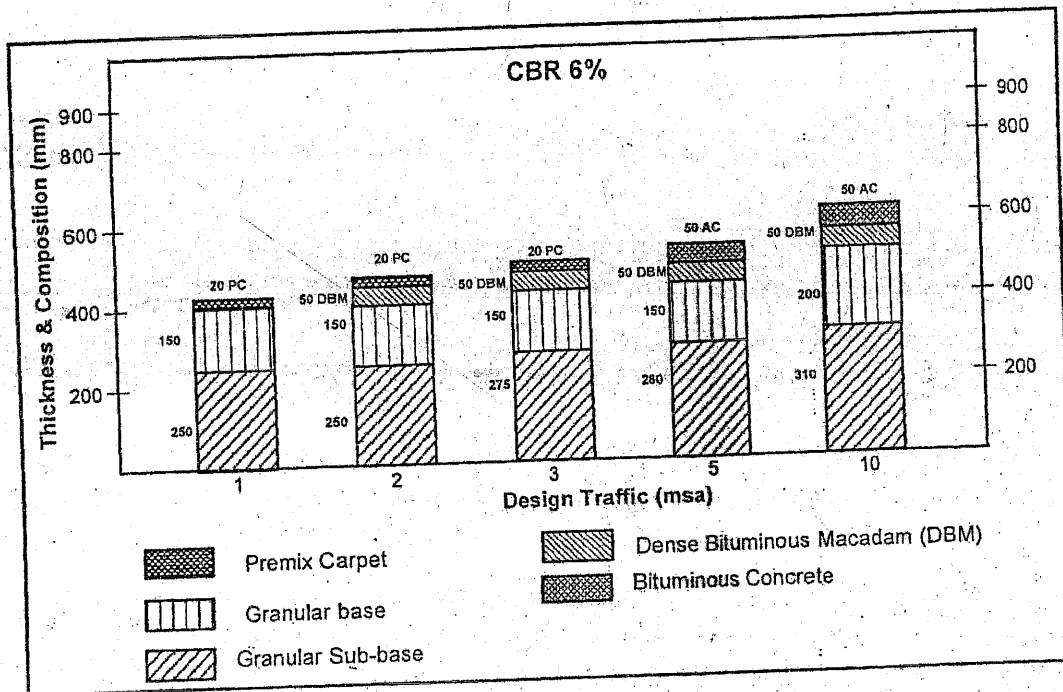*Subject:* - Transportation Engineering II *(CE703)*

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

1. Describe the types of traffic capacity and factors affecting traffic capacity.

2. A two-phase traffic signal is to be installed at a cross road of two streets N-S and E-W at right angles to each other have design hour and saturation flows of 800, 2400; 400, 2000; 750, 3000 and 1000, 3000 for North; South; East and West arms respectively. Only straight-ahead traffic is permitted. Calculate the optimum cycle time and green times for minimum overall delay. Take time lost per phase due to starting delays of 2 seconds and the amber period of 2 seconds.

3. What are the basic requirements of intersection at grade? Mention the importance of street lighting.

4. Two vehicles P and Q weights 5 tonne and 7 tonne approaching right angle, vehicle P from west and vehicle Q from south collide with each other. After the collision vehicle P skids in a direction 54° north of east and vehicle Q 42° north of east. The skid distances of vehicles P and Q before collision are 20 m and 28 m and the skid distances after collision are 26 m and 30 m respectively. Find out the initial speed of the vehicles. Assume average skid resistance of the pavement is 0.46.

5. What are the factors affecting pavement design? Write down the step by step procedure for determining rigid pavement thickness based on IRC guidelines.

6. Design the flexible pavement for a new road with following data:

   a) Two lane single carriageway road in plain terrain
   b) Initial traffic composition in the year of completion of contruction (sum of both directions)

Vehicle type	No.	VDF
Heavy 3 axle truck	40	6.5
Two axle truck	100	4.75
Mini truck	120	1.0
Bus	100	0.5

   c) Traffic growth rate is 8% per annum
   d) Designed CBR of sub grade soil is 6%
   e) Design life is 12 years
   Necessary chart is attached.

7. What do you mean by road construction technology? What are the equipment and plants do you need to execute different activities of road construction?

8. What is otta seal? Write the construction procedure of otta seal.

9. Define highway maintenance. Write down difference between maintenance, rehabilitation and reconstruction. Explain types of road maintenance.

10. Write the characteristics of ideal bridge site. Explain briefly the methods of tunneling in firm ground.

***

CBR 6%					
Cumulative Traffic, msa	Total Pavement Thickness, mm	Pavement Composition			
		Bituminous Surfacing		Granular Base, mm	Granular Sub-base, mm
		Wearing Course, mm	Binder Course, mm		
1	400	20 PC		150	250
2	450	20 PC	50 DBM	150	250
3	475	20 PC	50 DBM	150	275
5	530	50 AC	50 DBM	150	280
10	610	50 AC	50 DBM	200	310

CBR 6%

Thickness & Composition (mm) vs Design Traffic (msa)

Legend:
- Premix Carpet
- Granular base
- Granular Sub-base
- Dense Bituminous Macadam (DBM)
- Bituminous Concrete

04   TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

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) Define the traffic volume and write down the objectives of traffic volume study. [8]

   b) Road A is 13.5 m wide and road B is 10.5 m wide. An isolated signal with pedestrian indication are to be installed at right angled intersection of these roads. The peak volume per hour for road A is 250 and for road B is 200. The approaching speeds for road A and road B are 60kmph and 45 kmph, the amber periods for road A and road B are 4 seconds and 3 seconds respectively. Design traffic and pedestrian signal timing. [8]

2. a) Write the ill effects of parking and describe the types of off street parking. [8]

   b) A vehicle of weight 1.4 tonne applies brakes and skids through a distance of 40 m before colliding with a parked vehicle of weight 1 tonne. After colliding both vehicles skid through a distance of 18 m before stopping. If the coefficient of friction of road is 0.43, find the initial speed of the moving vehicle. [8]

3. a) Describe the design procedure of rigid pavement. [8]

   b) A pavement has to be designed for a certain length of existing single lane carriage way road from the following considerations:

   i) Current traffic of 80kN equivalent single axle load = 129 ESAL.
   ii) Design period = 12 years
   iii) Construction period = 18 months from the initial traffic count.
   iv) Growth rate of traffic = 5%
   v) 87.5% CBR value of sub grade soil from 7 samples collected = 5%
   vi) Elastic modulus of asphalt concrete for surface course E_{acs} = 2200 MPa
   vii) Elastic modulus of emulsified stabilized base E_{csb} = 1200 MPa.
   viii) Elastic modulus of granular sub-base (CBR≥30%) E_{sb} = 130 Mpa.

   You are required to design the pavement using asphalt institute method. Draw cross section of final pavement layers considering the thickness of asphalt concrete on surface course not less than 50 mm. [8]

4. a) What is an interface treatment? Write the construction procedure of grouted macadam. [8]

   b) Explain the maintenance process of bituminous surface. [8]

5. a) List the components of a bridge and discuss the factors to be considered in bridge site selection. [8]

   b) Explain the different types of failure in flexible pavement. [8]

6. Write short notes on: [4×4]

   a) Causes of accident
   c) Methods of spot speed studies
   b) Construction of WBM roads
   d) Types of maintenance

***

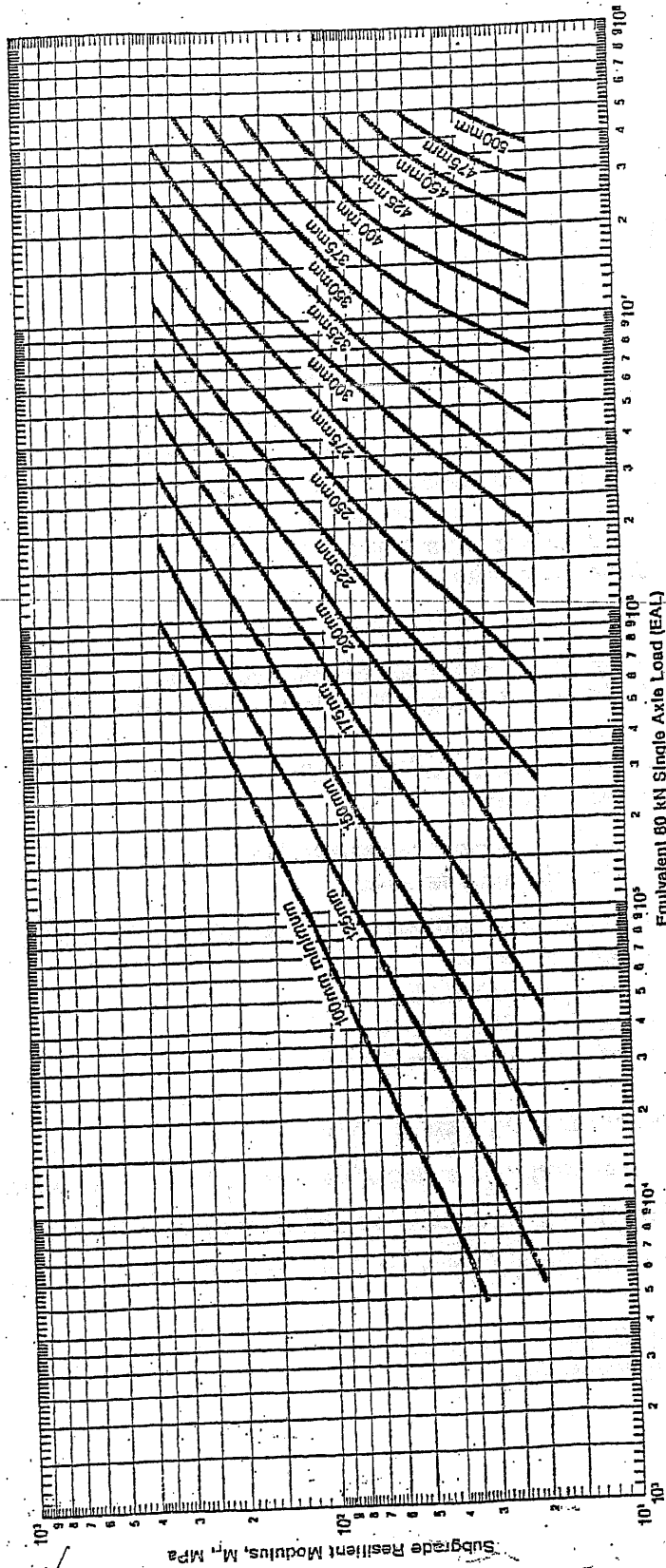| Exam.		Regular / Back	
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Transportation Engineering

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

1. a) What are the basic requirements of intersection at grade? Describe channelized intersections with their advantages. [8]

   b) A driver of a car applied brakes and avoided hitting the parked vehicle on the roadway. The car left the skid marks of 37m. Assuming f = 0.62 and braking efficiency of 90%, determine whether the driver was violating the 50 kmph speed limit at that location if the driver is travelling (i) up hill on 3.5°slope (ii) downhill on 2.45° slope (iii) on the level roadway [8]

2. a) Explain human-vehicle-environment operating system. [8]

   b) The spot speeds at a particular location are normally distributed with a mean of 51.7 kmph and standard deviation of 8.3 kmph. What is the probability that [8]
      i) The speed exceeds 65 kmph?
      ii) The speed lies between 40 kmph and 70 kmph?
      iii) What is the 98th percentile speed?

3. a) Differentiate between flexible and rigid pavements. How the load is transferred to the layer underneath in flexible and rigid pavaments? [8]

   b) Design the flexible parament using CBR curve with the help of following data: [8]
      i) Subgrade soil (soaked) CBR = 5%
      ii) Laterite sub-base (soacked) CBR = 15%
      iii) Water bound macadam base CBR = 95%
      iv) Number of heavy traffic per day in may 2003 = 150
      v) Design life = 15 years
      vi) Annual rate of increase in heavy vehicle = 5%

      The road is purposed to be completed in may 2008. (Use CBR curve for design).

4. a) Draw a mass haul diagram with neat sketch and explain the properties of the diagram. [8]

   b) Distinguish between prime coat and tack coat. Write down the construction procedure of surface dressing. [8]

5. a) Explain the factors that should be considered in selecting the bridge site. What are different method available for protecting river bank? [8]

   b) Define road maintenance. Explain the causes of flexible pavement failure with sketches. [8]

6. Write short notes on : (any four) [4×4]
   a) On street and off street parking
   b) Pavement evaluation
   c) Define with neat sketch
      i) Pot holes in flexible pavement   ii) Mud pumping
   d) Road construction equipments and plants
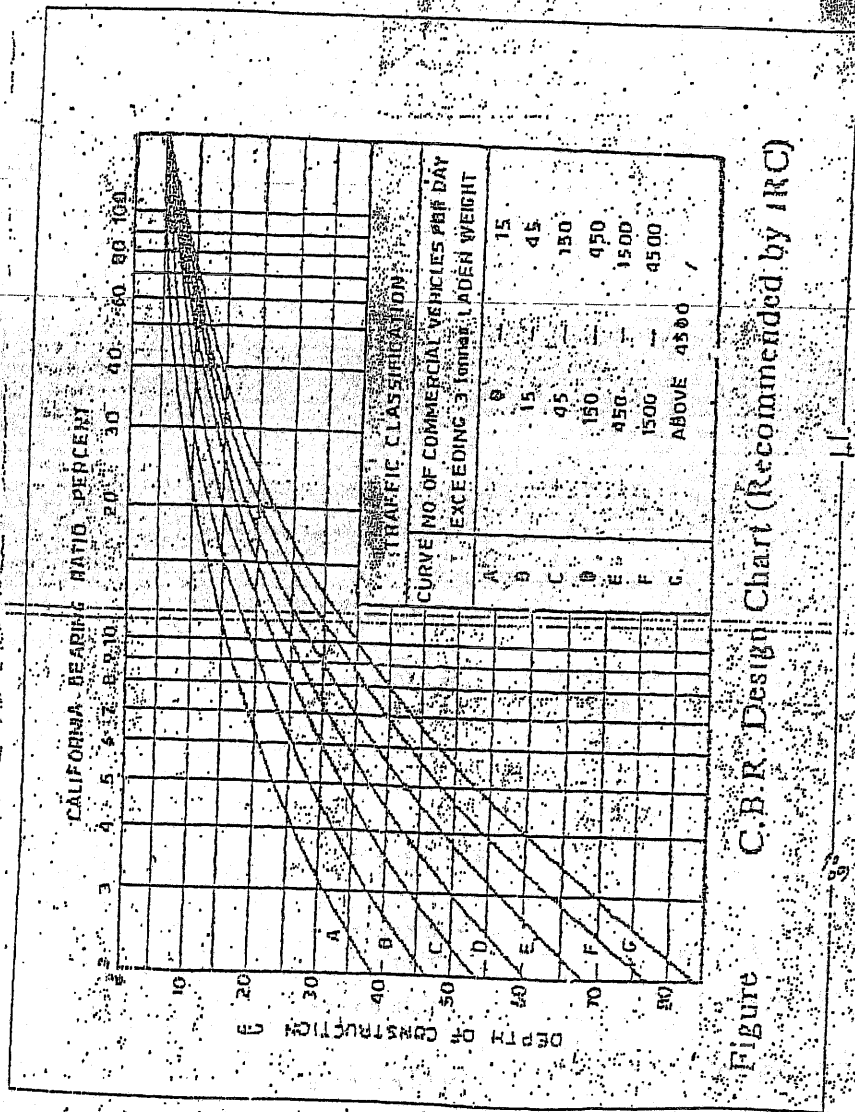   e) Types of maintenances

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Full-Depth Asphalt Concrete

Full-Depth Asphalt Concrete design chart.

Horizontal axis: Equivalent 80 kN Single Axle Load (EAL)

Vertical axis: Subgrade Resilient Modulus, M_r, MPa

Curves labeled: 100mm minimum, 125mm, 150mm, 175mm, 200mm, 225mm, 250mm, 275mm, 300mm, 325mm, 350mm, 375mm, 400mm, 425mm, 450mm, 475mm, 500mm

Q no 3 (b)

QND 3(b)

CALIFORNIA BEARING RATIO PERCENT

DEPTH OF CONSTRUCTION cm

CURVE	TRAFFIC CLASSIFICATION NO OF COMMERCIAL VEHICLES PER DAY EXCEEDING 3 tonnes LADEN WEIGHT	
A	0	15
B	15	45
C	45	150
D	150	450
E	450	1500
F	1500	4500
G	ABOVE 4500	

Figure   C.B.R. Design Chart (Recommended by IRC)

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

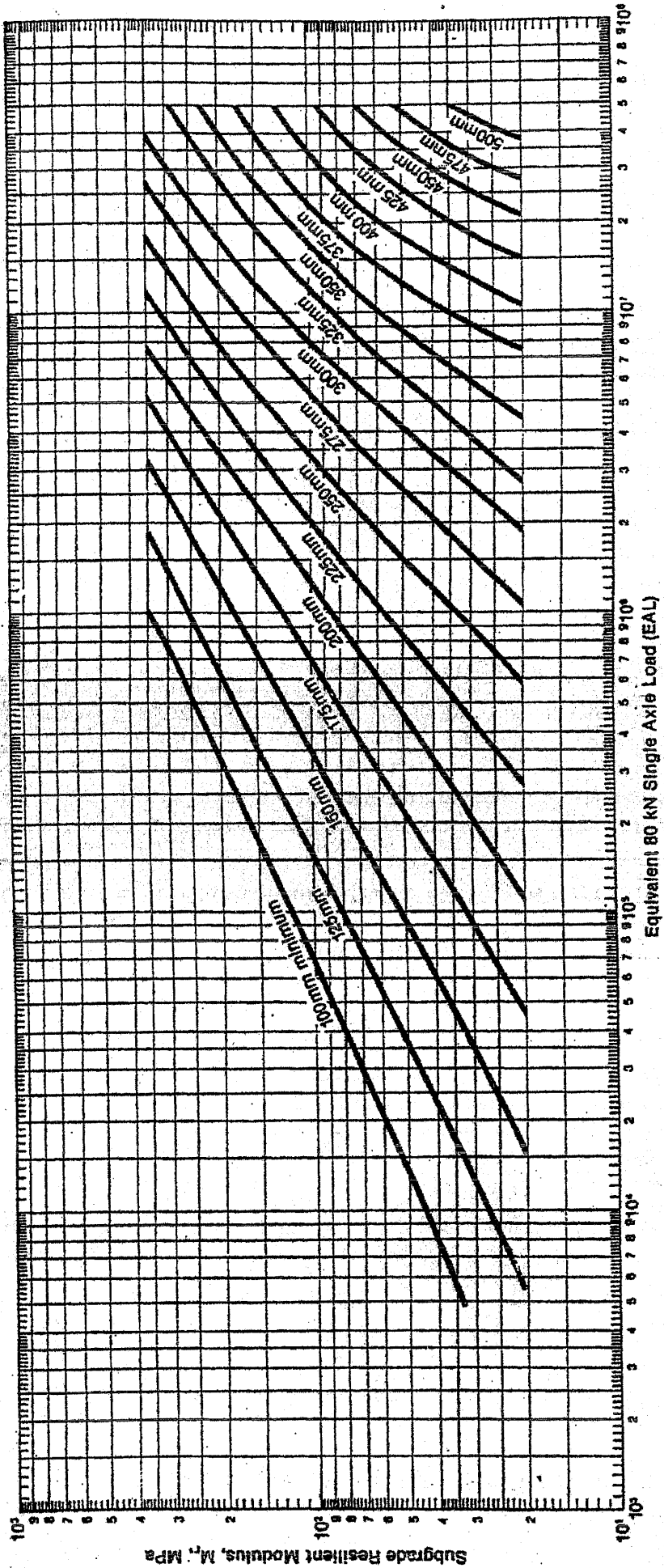## *Subject:* - Transportation Engineering II (CE703)

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt __All__ questions.*
✓ *__All__ questions carry equal marks.*
✓ *__Necessary charts are attached herewith.__*
✓ *Assume suitable data if necessary.*

1. Describe on - street and off - street parking in detail. Where is on - street parking prohibited?

2. Describe road users and vehicular characteristics.

3. What is saturation flow rate? The average normal flow of traffic on cross road A and B during design periods are 375 and 225 pcu per hour. The saturation flow values on these roads are estimated as 1135 and 960 pcu per hour respectively. The all red time required for pedestrian crossing is 14 sec. Design two phase traffic signal by Webster's method. Assume amber time of 2 sec. each for clearance.

4. Two vehicles A and B approaching at right angle, A from west and B from south collide with each other. After the collision, vehicle A skids in a direction 50°North of East and vehicle B skids 60°South of East. If the weight of vehicles A and B are 4 tonne and 5 tonne respectively, the initial skid distances of vehicles A and B before collision are 3.5 m and 4.2 m and after collision 7.0 m and 8.2 m respectively, calculate the initial speeds of vehicles if the average skid resistance of pavement is 0.61.

5. Design a flexible pavement by using Asphalt Institute method from the following data of a stretch of existing two lane roads.
   Current traffic of 80 KN equivalent single axel load = 1000 EAL/day
   Traffic growth rate = 7.5%
   Design period = 15 years
   Construction period = 18 months
   CBR of sub-grade to be taken = 5%
   Elastic modulus of asphalt concrete surface course = 2200 MPa
   Elastic modulus of bituminous treated base = 1000 MPa
   Elastic modulus of granular sub base course = 125 MPa
   Draw a neat sketch of the pavement layers.

6. What are the different factors that affect the pavement design? Compare the flexible and rigid pavements from different criteria.

7. Define road construction technology. Describe the various activities to be performed for the road construction.

8. Draw a mass haul diagram with neat sketch explaining the properties of the diagram.

9. Define road maintenance. Explain different measures to be taken for land slide stabilization.

10. Classify the bridge considering span, loading and materials. Describe the different methods of tunneling in soft soils with the help of neat sketch.

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Full-Depth Asphalt Concrete

Full-Depth Asphalt Concrete design chart. The vertical axis is labeled "Subgrade Resilient Modulus, M_r, MPa" and the horizontal axis is labeled "Equivalent 80 kN Single Axle Load (EAL)". Curves are labeled for asphalt concrete thicknesses: 100 mm minimum, 125 mm, 150 mm, 175 mm, 200 mm, 225 mm, 250 mm, 275 mm, 300 mm, 325 mm, 350 mm, 375 mm, 400 mm, 425 mm, 450 mm, 475 mm, and 500 mm.

03   TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 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.

1. Describe different types of traffic capacity and factors affecting traffic capacity.

2. Describe the causes and preventive measures of road accident.

3. A driver travelling at 35 kmph behind another car decides to pass it and accelerate. If the rate of acceleration is given by the relation $\dfrac{dv}{dt} = (1.12 - 0.014\ V)$ where v is speed in m/sec and t is time in second.

   Find: (i) Rate of acceleration after 10 secs
   (ii) Time taken to attain a speed of 85 kmph
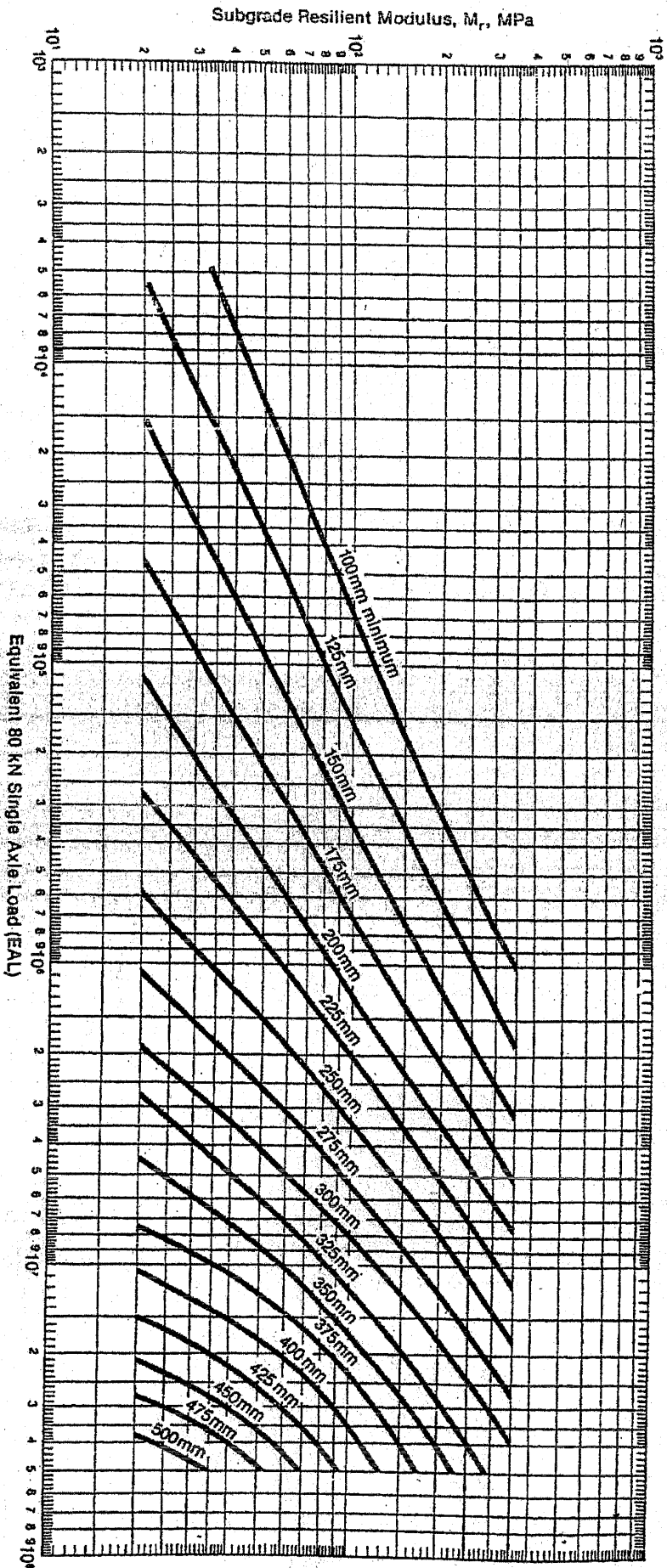   (iii) How far will car travel in 210 secs

4. At a right angled intersection of two roads, road A with a total width of 13.5m and road B 10.5m. The traffic volume per hour for road A and B are 325 and 275 respectively. The amber periods of road A and road B are 5 secs and 4 secs. Design the timing of traffic and pedestrian signals.

5. Explain the different factors that affect the pavement design.

6. Results of seven tests produced the following subgrade resilient modulus test values 44.8, 67.3, 68.3, 58.6, 68.3, 106.9, 80.0 MPa. The traffic classification at the end of construction is projected as below:

Number of vehicles (both direction)	Truck factor
4000	0.003
2050	0.28
1000	1.06
1100	0.62
1200	1.05

   Design the flexible pavement using Asphalt Institute Method for two lane two way road to cater the above traffic with the following details.

   i) Minimum depth of Asphalt concrete wearing course with modulus of elasticity 2500 MPa = 50mm
   ii) Emulsfied asphalt base course with modulus of elasticity 1250 MPa
   iii) Granular sub-base course with modulus of elasticity 150 MPa
   iv) Annual growth rate of traffic 6.5%
   v) Design period 12 years
   vi) Use 87.5 percentile resilient modulus value for the design.
   Draw the cross section of the pavement layers with your design output.

7. What is Mass-Haul Diagram? What are the equipment and plants needed for the accomplishment of different activities of road construction?

8. Describe prime coat and tack coat. Explain the construction procedure of surface dressing.

9. Explain the importance of road maintenance and methods of road side slope stabilization.

10. Classify the highway bridges. Explain the methods of providing tunnel drainage lighting and ventilation.
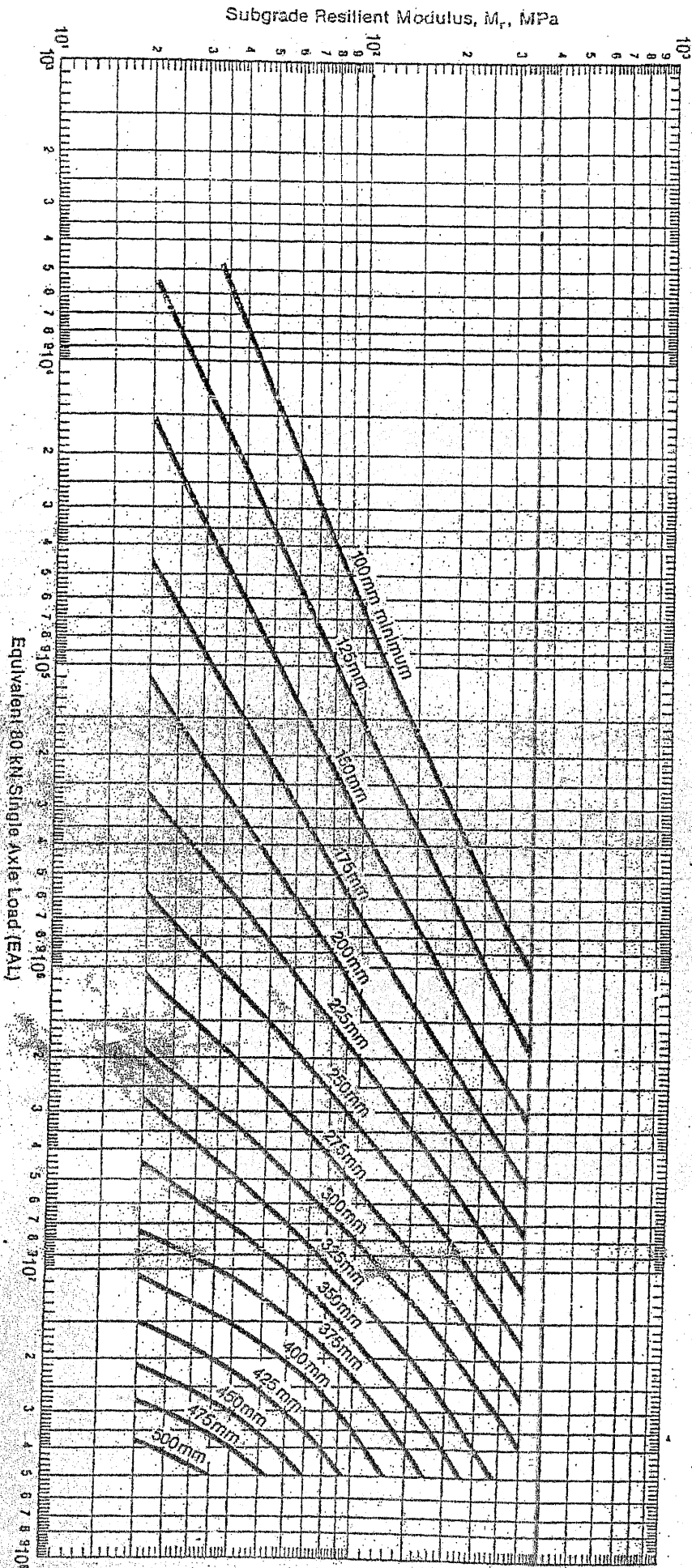
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Full-Depth Asphalt Concrete

Subgrade Resilient Modulus, M$_r$, MPa

Equivalent 80 kN Single Axle Load (EAL)

100mm minimum
125mm
150mm
175mm
200mm
225mm
250mm
275mm
300mm
325mm
350mm
375mm
400 mm
425 mm
450mm
475mm
500mm

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

✓ 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) Describe traffic characteristics. [8]

   b) Two trucks A and B weight 7 tonne and 12 tonne approaching from west and south direction applied brakes and skid through distances 3.2cm and 1.9 m respectively before collision. After collison truck A was thrown making an angle of 50° from West to North ands skid through a distance of 2.8 m. Truck B skids along a distance of 3.8 m from North to East making an angle of 60°. Calculate the initial speeds of approaching vehicles. [8]

2. a) What is street lighting? Write the importance of street lighting and factors influencing night visibility. [8]

   b) Twenty spot speed observations were taken in kmph were as under: [8]

   45, 50, 42, 41, 60, 72, 65, 46, 62, 45, 56, 54, 49, 60, 70, 62, 43, 47, 42 and 40. Calculate: (i) Time mean speed (ii) Space mean speed (iii) Verify the relation between two.

3. a) Describe the different factors affecting pavement design. [8]

   b) Design a flexible pavement by using Asphalt Institute Method for a two lane two way pavement carrying traffic of 1500 cv/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 2500 MPa, 1200 MPa and 125 MPa respectively. Assume construction period of 18 months. Draw a net sketch of pavement layers. [8]

4. a) What are the different tools, equipment and plants used in road construction? [8]

   b) What is surface dressing? Write the construction procedure of double bituminous surface dressing. [8]

5. a) Write the importance of road maintenance. Describe the maintenance of rigid pavement. [8]

   b) Write the methods of bridge classification. [8]

6. Write short notes on: [4×4]

   a) On - street and off-street parking
   b) Prime coat and tack coat
   c) Fixed delay and operational delay
   d) Radius of relative stiffness

***

Full-Depth Asphalt Concrete

Subgrade Resilient Modulus, M_r, MPa

Equivalent 80 kN Single Axle Load (EAL)

100mm minimum
125mm
150mm
175mm
200mm
225mm
250mm
275mm
300mm
325mm
350mm
375mm
400mm
425mm
450mm
475mm
500mm

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**.
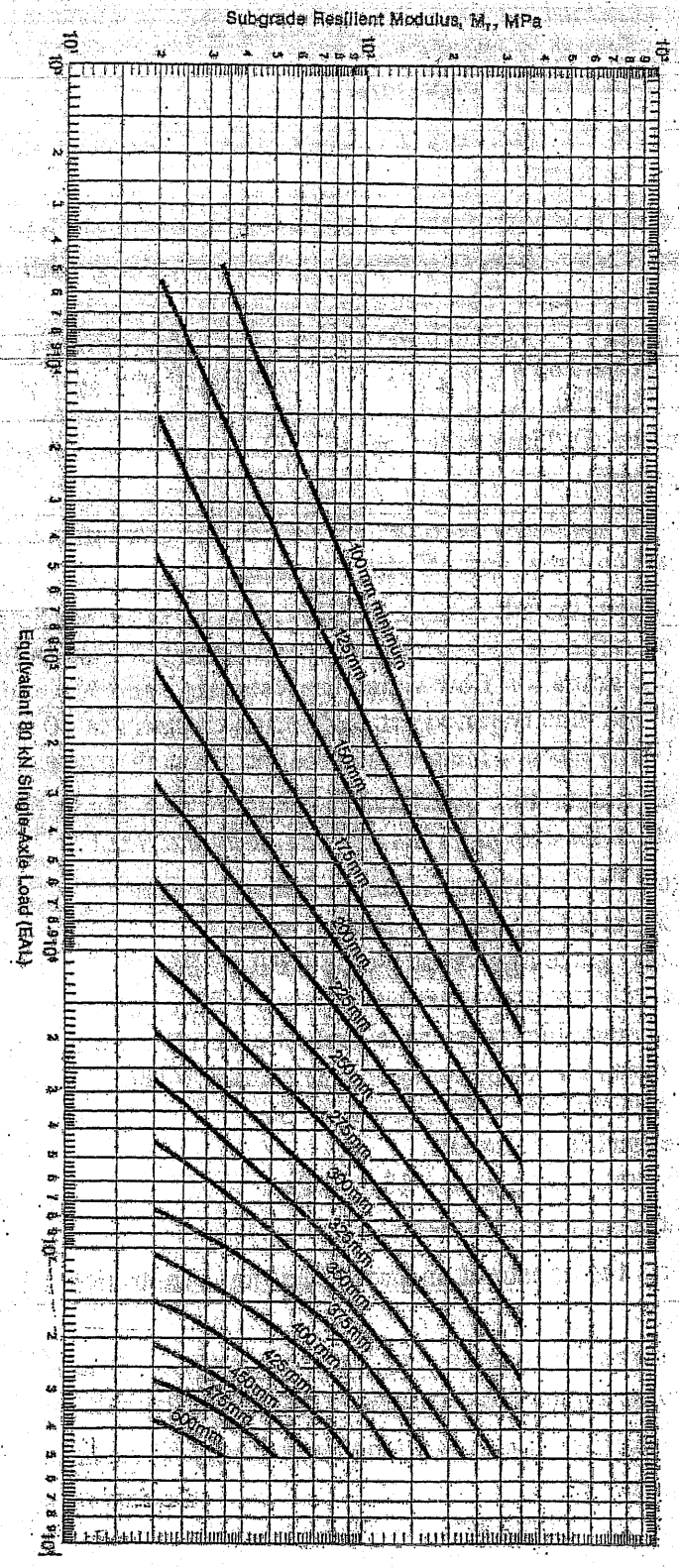✓ **Necessary design chart is attached herewith.**
✓ Assume suitable data if necessary.

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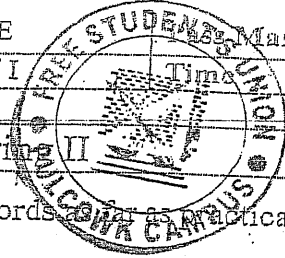
	Road P	Road Q
i) Width	14.00	10.50
ii) Peak hour traffic volume, Vehicle/hour/lane	210	120
iii) Approach speed, Kmph	50	35

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 $E_{ac} = 2000 MPa$
   v) Elastic modulus of crushed stone base $E_{base} = 350 MPa$
   vi) Elastic modulus of granular sub- base $E_{sub-base} = 250 MPa$
   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) [4×4]
   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

***

Full Depth Asphalt Concrete

Subgrade Resilient Modulus, M, MPa

Equivalent 80 kN Single-Axle Load (EAL)

100 mm minimum
125 mm
150 mm
175 mm
200 mm
225 mm
250 mm
275 mm
300 mm
325 mm
350 mm
375 mm
400 mm
425 mm
450 mm
475 mm
500 mm

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 figures is attached herewith._
✓ Assume suitable data if necessary.

1. a) What are the road user's characteristics? Describe the factors that affect the road user's characteristics. [8]

   b) Speed observations from a radar speed meter have been taken, giving the speeds of the subsidiary streams composing the flow along with the volume of traffic of each subsidiary stream. The readings are as given below: [8]

Speed (Kmph)	2-5	6-9	10-13	14-17	18-21	22-25	26-29	30-33	34-37	38-41	42-45	46-49	50-53	54-57	58-61
Volume of subsidiary stream (Vehicle/hr)	1	4	0	7	20	44	80	82	79	49	36	26	9	10	3

   Calculate: (i) Time mean speed, (ii) Space mean speed, (iii) Variance about space mean speed.

2. a) How are accidents recorded? Discuss the preventive measures of accident? Also compare on-street and off-street parking. [8]

   b) Write down the advantages and disadvantages of traffic signals. The average normal flow of traffic on cross roads A and B during design period are 500 and 400 PCU per hour, the saturation flow values are estimated as 1500 and 1250 per hour respectively. The all red time required for pedestrian crossing is 10 secs. Design two-phase traffic signal by Webster's method. Sketch the phase diagram. [8]

3. a) Explain temperature gradient, modulus of sub-grade reaction and radius of relative stiffness in the design of cement concrete pavement. [6]

   b) Design a flexible pavement using following data: [10]
      i) Compacted sub-grade soil CBR = 5%
      ii) Poorly graded gravel sub-base CBR = 18%
      iii) Water bound macadam base course = 80%
      iv) Minimum thickness of the asphalt concrete = 5cm
      v) Present number of heavy traffic per day = 180
      vi) Annual rate of traffic growth = 6%
      vii) Design life = 12 years
      viii) Construction period = 18 months
      Use the chart given herewith.

4. a) Describe the construction procedure for Penetration (Grouted) Macadam? Explain briefly. [8]

   b) Write down the explanatory note on types of bituminous constructions: interface treatment; surface dressing; premixed carpet; asphalt concrete. [2×4]
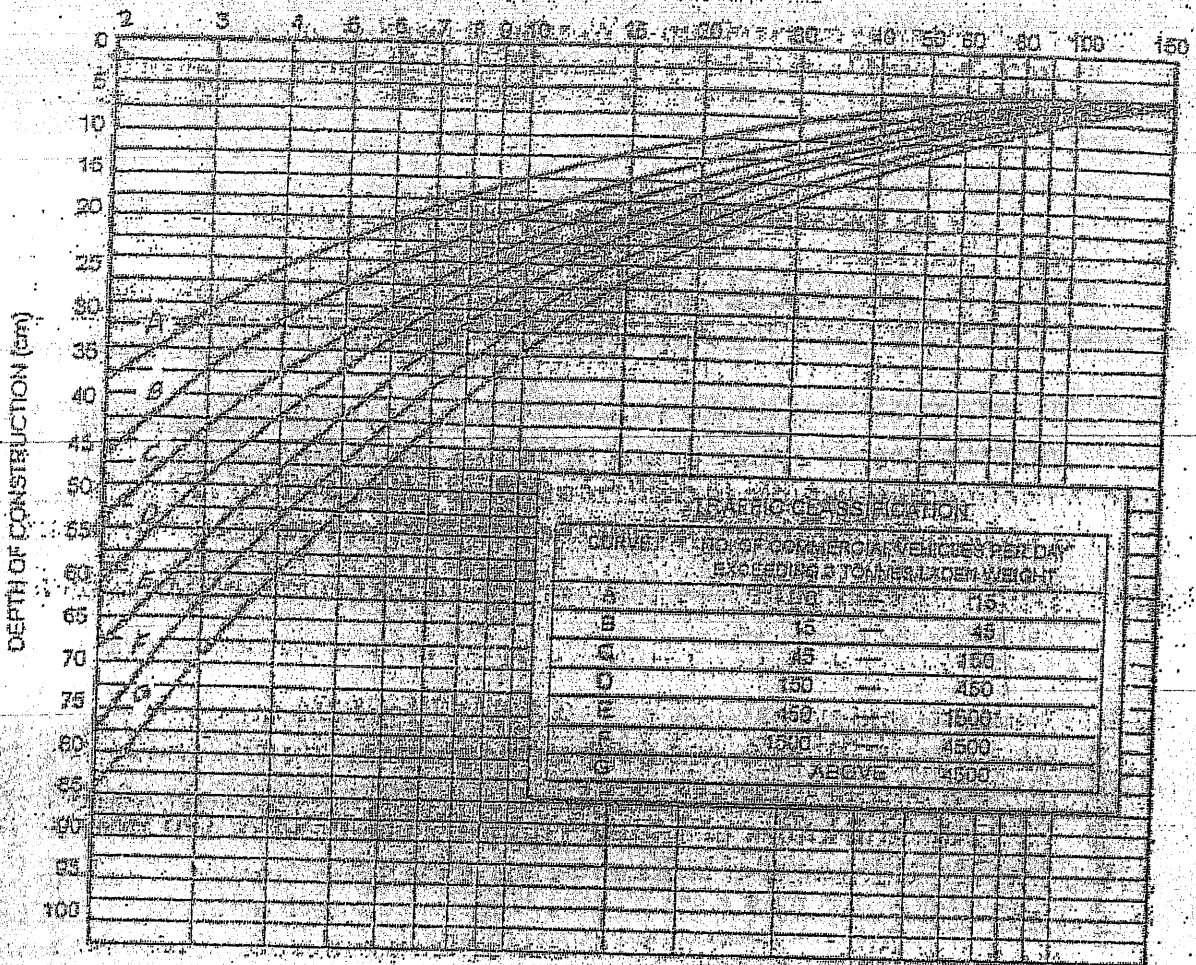
5. a) Explain different types of maintenance and path repairing works. [8]

   b) Explain the factors affecting the choice of location of bridge site? Discuss the bridge abutment protection and river bank protection works in brief. [4+4]

6. Write short notes on: (any four) [4×4]
   a) Importance of ventilation in tunneling
   b) Tunnel lining
   c) River-training structures
   d) Mud pumping
   e) Repair of cracks in cement concrete pavement

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CALIFORNIA BEARING RATIO — PER CENT

DEPTH OF CONSTRUCTION (cm)

TRAFFIC CLASSIFICATION

CURVE	NO. OF COMMERCIAL VEHICLES PER DAY EXCEEDING 3 TONNES LADEN WEIGHT	
A	0	15
B	15	45
C	45	150
D	150	450
E	450	1500
F	1500	4500
G	ABOVE	4500

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 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

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2065 Shrawan

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.
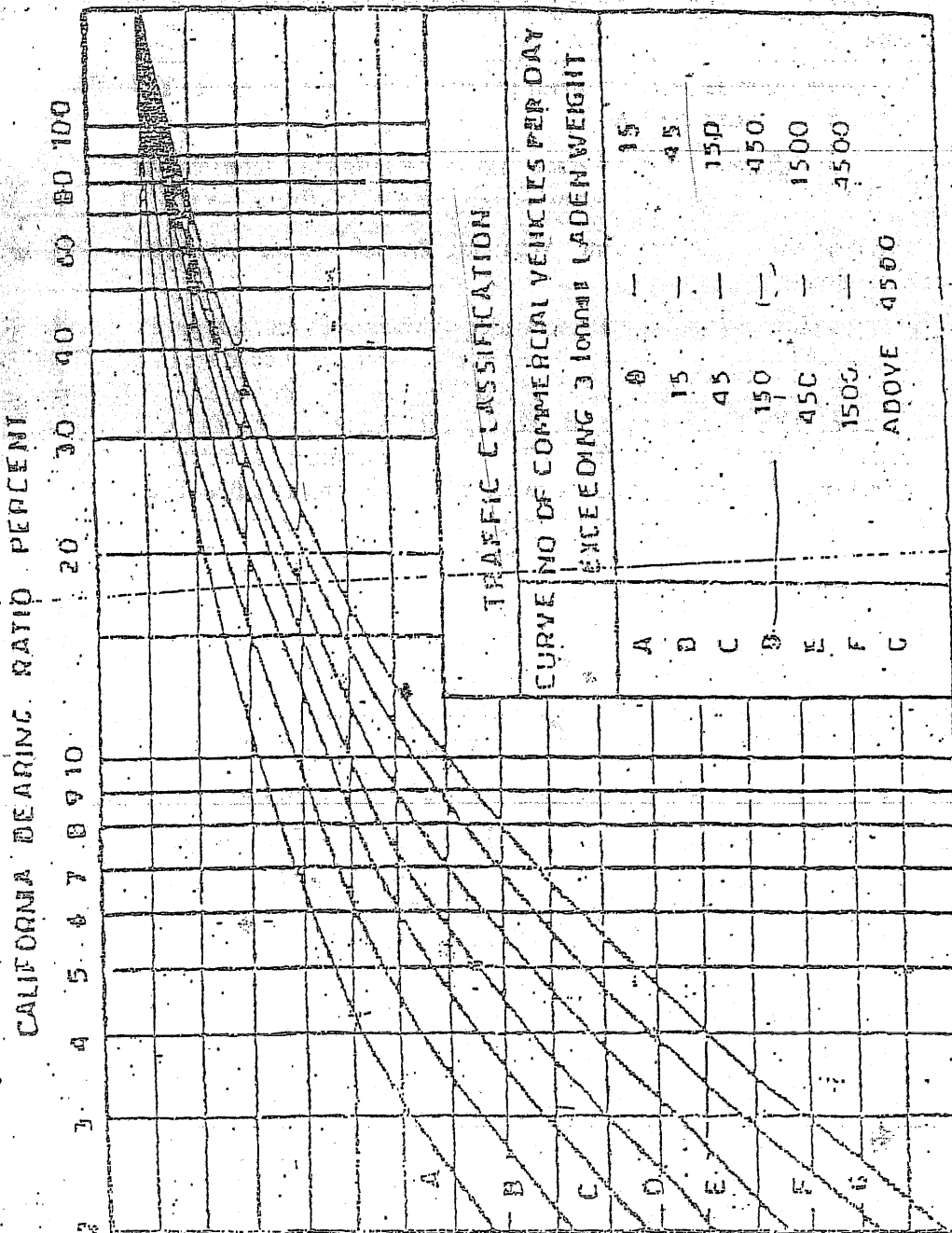*Necessary chart is attached herewith.*
Assume suitable data if necessary.

a) Explain human-vehicle-environment operating system. [8]

b) A car travelling at 40 kmph is approaching a stop sign. At time t_0 and at a distance of 20m the truck begins to slow down by decelerating at $4ms^{-2}$. Will the truck be able to stop at a time? [4]

c) An impatient car stuck behind a slow truck travelling at 32 kmph to overtake the truck. The accelerating characteristics of car is given by $\frac{dv}{dt} = 1 - 0.04v$, where v is speed in ms^{-1}. What is the acceleration after 300 sec? How far will the car travelled in 300 sec? [2+2]

a) What is rotary intersection? Discuss advantages and limitations of rotary intersection. List out IRC design guidelines for the element of rotary intersection. [2+4+2]

b) Average normal flow of a traffic on cross road. A and B during design period are 400 and 250 PCU per hour, the saturation flow value on these roads are estimated as 1250 and 1000 PCU per hour respectively. The all red time required for pedestrian crossing is 12 sec. Design two phase traffic signal by Webster's method. [8]

a) Explain the objectives of accident study. How accidents are recorded? Discuss the preventive measure of accident. [8]

b) Compare on street and off street parking with their merits and demerits. Draw neat sketch showing parallel and angle parking geometry. [8]

a) Discuss the importance of road lighting. [3]

b) Differentiate between rigid and flexible pavement. [5]

c) Design a flexible pavement, using CBR curves, given the following data: [8]

   i) Subgrade soil (soaked) CBR = 5%
   ii) Laterite sub-base (soaked) CBR = 15%
   iii) Water bound macadam base CBR = 95%
   iv) Number of heavy traffic per day in May 2003 = 150
   v) Design life = 15 years
   vi) Annual rate of increase in heavy vehicle = 5%

The road is purposed to be complete in May 2008. Give CBR curve of flexible pavement.

(SAMPLE)
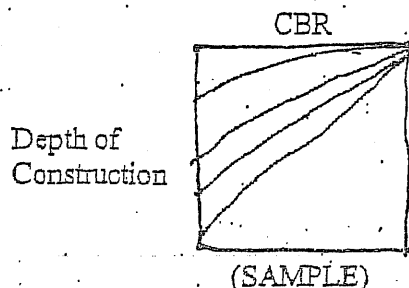
5. a) Briefly explain the construction of earth roads. Discuss mass haul diagram with its characteristics. [4+4]

   b) What are the materials required, plants and equipment and construction step for bituminous bound macadam construction? [2+2+4]

6. a) Define highway maintenance. Explain the various typical failure in flexible pavement. Give sketch where possible. [2+6]

   b) Explain briefly the choice of location of bridge site. What are the essential components of bridge? Show with sketch. [4+4]

7. Write short notes on (any four): [4×4]

   a) Road construction equipments
   b) River bank protection structures
   c) Methods of tunnelling in firm and soft soil
   d) Differentiate between repair, maintenance, rehabilitation and reconstruction
   e) Surface dressing works

C.B.R. Design Chart (Recommended by IRC)