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THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY (CIVIL) - LEVEL 4
FINAL EXAMINATION - 2016/17

CEX4236 - HIGHWAY ENGINEERING

Time allowed : Three hours

Date : Tuesday, 14th November 2017 **Time : 9:30 - 12:30**

Answer any five (05) questions. All questions carry equal marks. Write down your Index Number clearly on the answer script.

(01)

(I) State the conditions to be satisfied by the length of the road selected, and the rules to be observed by the driver of the moving vehicle and the observer in the moving observer method of finding average journey speed.

(04 marks)

(II) A moving observer method survey was conducted by a group of students of OUSL for their highway engineering practicals between two stations A (Pitakotte) and B (Thalawathugoda). The distance between station A and station B was measured as 3 km. A total of ten runs were made, five runs per each direction. Field observations obtained are indicated in the tables below.

(1) Observation vehicle travelling from Station A to Station B

Trip		Number of vehicles		
Trip No	Journey Time (Min:Sec)	Overtaking the test car	Overtaken by the test car	Met in opposite direction
1	5:20	5	3	147
2	5:40	6	2	156
3	5:55	2	5	120
4	5:45	2	3	139
5	5:15	4	1	136

(2) Observation vehicle travelling from Station B to Station A

Trip		Number of vehicles		
Trip No	Journey Time (Min:Sec)	Overtaking the test car	Overtaken by the test car	Met in opposite direction
1	6:56	5	5	167
2	6:35	6	3	175
3	6:52	3	4	183
4	6:07	5	3	206
5	6:22	7	2	178

If $q = (x + y) / (t_w + t_a)$ and, $t = (t_w - y/q)$ where the terms in the expressions have the usual meanings,

(i) Calculate the average traffic flow *(a)* from A to B, and *(b)* from B to A.

(08 marks)

(ii) Calculate the average journey speed *(a)* from A to B, and *(b)* from B to A.

(08 marks)

(02)

Describe the following with neat sketches where necessary.

(a) 'Zoning' in origin-destination surveys. (05 marks)

(b) 'Desire lines' in origin-destination surveys. (05 marks)

(c) 'Passing sight distance' on a two lane road. (05 marks)

(d) The 'three types of road signs' classified according to function performed by them. (05 marks)

(03)

Two alternative road systems (A) & (B) had to be compared when preparing a Master Plan for a new township. This comparison was to be conducted through US system known as the *saturation system (or maximum utility system)*. Following field data were collected for this exercise.

	Total Road Length (km)	Productivity		Number of population centres with following population figures	
		Agriculture (Tonnes)	Industry (Tonnes)	00 to 2500	2500 - 5000
Alternative (A)	40	10	08	5	2
Alternative (B)	42	06	12	4	3

Use following units for your calculations:

Every 5 tonnes of agricultural produce to be assigned one unit.
Every 10 tonnes of industrial produce to be assigned one unit.
Population group - 00 to 2500, take as 0.5 unit.
Population group - 2500 to 5000, take as 1.0 unit.

(a) Calculate the agricultural, industrial, and population utility factors for each alternative. (04 marks)

(b) Calculate the (i) total utility factor, and (ii) average utility factor for each alternative. (08 marks)

(c) Which alternative [(A) or (B)] should be chosen for implementation? Give reasons for your answer. (04 marks)

(d) Briefly describe how you would develop a phased program in proposing an optimum road system. (04 marks)

(04)

(a) Giving examples, explain the functions of (i) Anionic Emulsifiers, and (ii) Cationic Emulsifiers. (06 marks)

(b) What are the three (3) groups that emulsions can be classified into depending on their setting time? Write down the characteristics and uses of these different groups. (06 marks)

(c) Explain briefly the softening point test carried out to evaluate the consistency of bitumen, indicating the type of apparatus used in the laboratory. (04 marks)

(d) Describe how the softening point of bitumen affects its behaviour when used on road pavements. (04 marks)

(05)

Traffic accidents cost our nation largely in both human and financial terms.

(a) Describe the following in relation to road safety, using sketches where necessary. Accidents due to (i) poor pedestrian behaviour, (ii) poor mechanical condition of vehicles, and (iii) bad road conditions. (06 marks)

(b) Name the four (4) categories of road accidents, briefly explaining each of them. (08 marks)

(c) Briefly explain what a 'collision diagram' means, and describe how it can be used to reduce accidents on a particular stretch of road. (06 marks)

(06)

(a) List five (5) types of pedestrian crossings and briefly discuss each of them. (05 marks)

(b) Briefly describe four (4) commonly used arrangements of street lanterns along straight stretches of roads illustrating with neat diagrams. (05 marks)

(c) What are the main factors that control the glare from street lanterns? Explain briefly how they affect the glare. (05 marks)

(d) In a highway development project the fact-finding survey plays an important role. Mention the main constituents that are used to gather information in these surveys. Also list down the studies that should be included in these surveys. (05 marks)

(07)

As a technical person working in a road rehabilitation project, you may be required to have an adequate knowledge of the modern surface laying methods, equipment, and their proper usage, depending on the type of construction and expected function of the road.

(a) List six (6) types of surface applications that are available in road surface construction and briefly discuss for what purposes they can be used. (06 marks)

(b) Explain the steps involved in carrying out a (i) Single Base Surface Treatment (SBST), and (ii) Double Base Surface Treatment (DBST) dressing for a road surfacing process. (05 marks)

(c) Discuss the advantages and disadvantages of an Asphaltic concrete surfacing when laid on a heavily trafficked road. (05 marks)

(d) Explain the difference between a 'seal coat', and a 'tack coat' as road surface treatments. (04 marks)

(08)

(a) Write down the empirical formula developed by Dickens which is used to calculate the flood runoff estimation, explaining all its terms. (05 marks)

(b) Although Dickens formula is popularly used for flood runoff calculations it has its limitations. Write down three (03) main limitations of the formula. (05 marks)

(c) Briefly describe the following terms which are used in highway drainage computations. If required you may get the support of neatly drawn sketches. (i) catchment boundary, (ii) rainfall intensity, (iii) runoff coefficient, and (iv) time of concentration. (05 marks)

(d) Bed level of a stream drops 3 feet in a distance of 1 mile. This stream crosses a highway and the point of crossing is 2 miles away from the start of the stream. Calculate the time of concentration of the stream catchment above the point of crossing the highway assuming the inlet time is 10 minutes. You may also use the data given in the table below for your calculations.

Average gradient of stream percent	Average velocity in (ft/sec)
$0 < 1$	1.5
$0 \leq 2$	2.0
$2 \leq 4$	3.0
$4 \leq 6$	4.0
> 6	5.0

(05 marks)