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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX4536/CEX4236 Highway Engineering**
Academic Year	: 2019/20
Date	: 10th August 2020
Time	: 1330-1630hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in Four (4) pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.
9. Write down your Index Number clearly on the answer script.

(01)

A spot speed survey was conducted at a site beyond Maharagama and Kottawa along High Level road with the intention of imposing a speed limit, in order to reduce the high accident rate on this stretch. Following are the spot speeds recorded in the vicinity.

55	56	48	51	33	64	55	49	31	87
54	54	62	45	42	51	53	50	48	52
65	61	51	45	42	55	51	35	59	65
61	66	54	46	33	52	68	79	56	57
74	79	46	53	34	76	72	54	41	66
75	59	85	55	43	35	57	65	41	49
64	75	54	86	47	56	53	88	72	55
65	39	44	68	53	69	52	34	40	59

Group the results into 10km/h speed intervals and plot the following:

(i). The histogram and frequency distribution curve of the spot speeds. (04 marks)
(ii). Cumulative distribution curve (ie., cumulative frequency curve). (04 marks)

From the above curves calculate,

(a) the range of speeds (02 marks)
(b) the median speed. (02 marks)
(c) the 15 percentile speed. (02 marks)
(d) the 85 percentile speed. (02 marks)
(e) the mode of frequency distribution curve of spot speeds. (02 marks)
(f) suggest a suitable speed limit, giving reasons. (02 marks)

(02)

(a). Discuss suitable measures that can be used to enhance cycling as a suitable mode of transport for short trips (less than 20km) in flat terrain coastal areas. (06 marks)

(b). Discuss the advantages and disadvantages of the three-wheeler as an urban passenger-carrying vehicle in a developing country. (05 marks)

(c). What are the <u>four</u> (4) main factors taken into consideration when roads are classified? (04 marks)

(d). Explain <u>five</u> (5) main differences between an 'expressway' and a 'main arterial road'. (05 marks)

(03)

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

(b). Briefly describe four (04) 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)

(04)

(a) A tributary of a river has a constant bed drop rate of 3 feet per mile. A minor bridge across this tributary is at 15 miles away from the start of the tributary. Calculate the time of concentration of the tributary catchment at the upstream side of the minor bridge. The following data is available for you. (05 marks)

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

(b). Draw clear diagrams of three (03) types of bridges that can be used across a wide river and indicate clearly how the loads are transferred to the foundations. (05 marks)

(c). Explain the basic concept of composite beams used in bridges. (05 marks)

(d). List and briefly explain three (03) causes of structural failure in a highway pavement. (05 marks)

(05)

(a). Discuss the main reasons for highway related accidents in Sri Lanka and suggest ways of improving the highway safety in the country. (07 marks)

(b). State the six (06) basic steps, which are required for a detailed accident study of a particular road or road network. (06 marks)

(c). Explain with illustrations what a 'collision diagram' is, in accident analysis, and describe how it is prepared. (07 marks)

(06)

State any conditions to be satisfied by the length of road selected, and the rules to be observed by the driver of the floating vehicle and the enumerators in the moving observer method of finding average journey speed. (04 marks)

During a moving observer method survey six runs were made in each direction along the two-way highway between Nawala and Rajagiriya (the distance between Nawala and Rajagiriya was found to be 4.5 kms). Flows were measured both with and against the moving vehicle, and the following field data were obtained.

(a). Vehicle traveling from Nawala to Rajagiriya

Travel Time (mm:sec)	Number of vehicles		
	Overtaking the test car	Overtaken by the test car	Met in opposite direction
5:16	3	1	410
5:22	2	2	398
5:34	5	1	402
5:30	4	2	358
4:58	4	1	388
5:09	3	2	406

(b). Vehicle traveling from Rajagiriya to Nawala

Travel Time (mm:sec)	Number of vehicles		
	Overtaking the test car	Overtaken by the test car	Met in opposite direction
5:01	3	0	330
5:26	1	0	307
5:12	5	3	356
4:46	6	3	348
4:55	4	2	302
5:27	6	1	298

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 in each direction. (08 marks)

(ii). Calculate the average journey speed from Nawala to Rajagiriya and from Rajagiriya to Nawala. (08 marks)

(07)

(a). Explain the following characteristics of road aggregates

(i). hardness
(ii). toughness
(iii). strength
(iv). texture
(v). durability (05 marks)

(b) Differentiate between 'cut-back bitumen' and 'bitumen emulsion'. (05 marks)

(c). Briefly describe the 'flash and fire point test' you carried out in the highway laboratory explaining the significance of this test. (05 marks)

(d). List down the steps involved in conducting a (i) Single Base Surface Treatment (SBST), and (ii) Double Base Surface Treatment (DBST) dressing in a road project. (05 marks)

(08)

(a). Indicate with a neat sketch the layout you may adopt for an emergency repair work of a kerb-side lane of a four lane two-way undivided carriageway. On this sketch clearly indicate all the traffic control tools that you will be using during the construction phase. (05 marks)

(b). What are the different types of longitudinal lane markings? Briefly describe each of them. (05 marks)

(c) State six (06) main types into which soil can be classified, and briefly describe the characteristics and quality of these soils. (06 marks)

(d). Define the terms 'degree of saturation', and porosity of a soil. (04 marks)