

THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY (CIVIL) - LEVEL 4
FINAL EXAMINATION - 2005/2006



CED 2208 - HIGHWAY ENGINEERING

Time allowed : Three hours

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Index No.
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Date : Monday, 24th April 2006

Time : 09:30 - 12:30

Section A - Answer all questions. Each question carries 1 mark. The recommended time to answer Section A is 40 minutes.

Section B - Answer any 4 questions. Each question carries 20 marks.

Answers to Section A should be marked on the question paper itself, and answers to Section B should be written on answer books / sheets. Detach Section A from the question paper and tie it with the answer books of Section B. Write down your Index Number in the space provided above.

Section A

Answer all questions. Answers should be provided on the question paper itself.

01. What is the more desirable and economical street lamps arrangement for a two-lane dual carriageway road?

- (A). Lamps on sides, opposite to each other.
- (B). Lamps on a staggered arrangement.
- (C). Lamps supported on a central post, overhanging each carriageway.
- (D). Lamps suspended above, one for each carriageway.

02. Road transport has a clear advantage over the other modes of transport when we consider the aspect of

- (A). comfort.
- (B). flexibility.
- (C). cost.
- (D). speed.

03. The maximum temperature to which bitumen could be heated safely is determined from the

- (A). flash point test.
- (B). viscosity test.
- (C). ring and ball test.
- (D). ductility test.

04. When California Bearing Ratio test is conducted the plunger is made to penetrate into the specimen in the standard mould at the rate of
- (A). 0.50 mm/min (B). 0.75 mm/min (C). 1.00 mm/min (D). 1.25 mm/min
05. Which of the following equations represents the peak run off from a catchment as given by rational method, where Q , C , m , I , A , S , n and R have their usual meanings?
- (A). $Q = Cm^{0.75}$ (B). $Q = CIA$ (C). $Q = AC\sqrt{RS}$ (D). $Q = \frac{A}{n}R^{2/3}S^{1/2}$
06. The geometric design of a sag vertical curve should be based on
- (A). daylight visibility.
 (B). headlamp visibility.
 (C). passenger comfort and headlamp visibility.
 (D). vehicle's climbing capability.
07. For a water-bound Macadam road, the recommended camber is
- (A). 1 in 24 to 1 in 30 (B). 1 in 30 to 1 in 48
 (C). 1 in 60 to 1 in 80 (D). 1 in 80 to 1 in 120
08. When the bearing capacity of soil is poor and the intensity of traffic is high, an additional layer is provided between the base and the sub grade. This additional layer is called
- (A). base course. (B). DBST layer. (C). sub base. (D). wearing course.
09. Under good conditions, when driving behind any vehicle, at any speed, you should
- (A). stay one second behind the vehicle in front of you.
 (B). stay at least half of a second behind the vehicle in front of you.
 (C). stay at least three seconds behind the vehicle in front of you.
 (D). drive as close to the vehicle in front to improve the road capacity.
10. The overall stopping distance is made up of two components; (i) the distance covered during reaction time (ii) the braking distance. If each component has a value of 25 m at a speed of 40 km/h, the overall stopping distance at a speed of 50 km/h would be;
- (A). 40 metres (B). 50 metres (C). 60 metres (D). 70 metres

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11. The relationship between super-elevation, coefficient of lateral friction, radius of the curve and vehicle speed is given by $V^2/gR = e + f$, where, the speed is in m/s and the radius is in metres. If the vehicle speed is expressed as V km/h, the above relationship changes to
- (A). $V^2/127R = e + f$ (B). $V^2/35.3R = e + f$ (C). $e = V^2/R + f$ (D). $e = V^2/35.3R + f$
12. Which of the following studies have to be conducted first, in the route selection process?
- (A). Location study (B). Cost study (C). Topography study (D). Map study
13. On a highway pavement surfacing, which of the following terms indicate the resistance of paving mix against weathering and abrasive action?
- (A). Flexibility (B). Durability. (C). Ductility. (D). Workability.
14. Which of the following statements is incorrect?
- (A). 'No overtaking' sign is a 'warning' sign.
(B). 'Road closed for vehicles' is a 'regulatory' sign.
(C). 'Cross road ahead' is a 'warning' sign.
(D). 'No parking' is a 'regulatory' sign.
15. Results of spot speed measurements of four vehicles at a particular road location are as follows. First vehicle with a speed of 40 km/h, followed by two vehicles with speeds of 30 km/h each, and finally another vehicle with a speed of 20 km/h. The space mean speed of vehicles is
- (A). 27.8 km/h (B). 28.4 km/h (C). 30 km/h (D). 40 km/h
16. When road aggregate particles are classified by particle shape, the particles of which the 'thickness is small relative to the other two dimensions' are called
- (A). Angular particles. (B). Elongated particles.
(C). Flaky particles. (D). Irregular particles.
17. In traffic engineering, the process of two streams of vehicles combining and after mutual interaction separating again is referred to as
- (A). merging. (B). diverging. (C). platooning. (D). weaving.

18. One of the objectives of providing 'bus only' lanes is to reduce
- (A). travel time of buses.
 - (B). congestion of all vehicles.
 - (C). travel time of non-bus traffic.
 - (D). road space available for non-bus traffic.
19. During the process of hydrologic cycle the stage where water is absorbed by plants from the soil through their roots and discharge to the atmosphere as water vapor is called
- (A). evaporation.
 - (B). infiltration.
 - (C). percolation.
 - (D). precipitation.
20. Highway capacity is defined as the total number of vehicles
- (A). that can pass a given point in a unit period of time.
 - (B). that can be accommodated on a unit length of road.
 - (C). that can pass a given point in a specified period of time.
 - (D). that can be accommodated on a unit length of road in a unit period of time.

Section B

Answer any four questions. All questions carry equal marks.

(01)

Describe the following (with sketches where necessary)

- (a). 'Enoscope method' for measuring spot speeds. (5 marks)
- (b). Tidal flow (reversible lanes). (5 marks)
- (c). Passing sight distance. (5 marks)
- (d). Three types of "peripheral car park developments" available in developed countries (5 marks)

(02)

- (a). Draw a neat cross-section of a four-lane, two-way road with a centre median running along a cut and fill section, clearly indicating and labelling all the important elements. (8 marks)
- (b). Write down the expected functions of a median. (4 marks)
- (c). Write down the functions of a shoulder. (4 marks)
- (d). When a carriageway is to be widened on a curve, what are the four main considerations to be taken in to account? (4 marks)

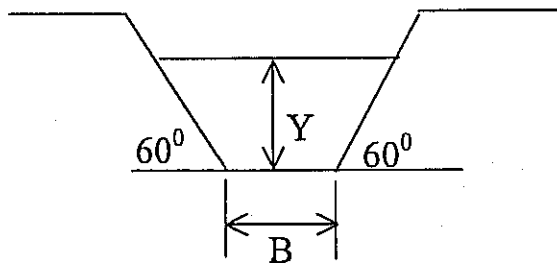
(03)

In designing an appropriate drainage system, the most important design considerations are hydrologic and hydraulic. Discuss the elements to consider under each of these. (5 marks)

One of the major causes of road failure is its improper drainage. List out the ways in which improper drainage can cause destruction. (5 marks)

In a roadside open drain, water flows at uniform depth along a trapezoidal section as shown below. Channel slope, $s = 0.001$. The appropriate value of Manning's $n = 0.014$ and the side slope angle is 60° .

Given the bottom width $B = 1.2$ m, and the depth of flow $Y = 0.1$ m, find the velocity V and the discharge Q . (10 marks)



(04)

- (a). When a major road intersects a minor road, the safety at the intersection may be improved by staggering the minor approaches of the intersection to form two T-junctions:

Explain in brief:

1. The conditions of application for above treatment. (4 marks)
2. Advantages of above treatment. (3 marks)
3. Disadvantages of above treatment. (3 marks)

- (b). When two local roads intersect, the operation of the intersection may be improved by introduction of a small roundabout.

Explain in brief:

1. The conditions of applications for above treatment. (4 marks)
2. Advantages of above treatment. (3 marks)
3. Disadvantages of above treatment. (3 marks)

(05)

Bitumen is one of the main materials used in highway pavement construction, and also we know that the origin of highway bitumen is either 'natural asphalt' or 'crude petroleum'.

- (a). Discuss the different types of 'natural asphalt' bitumen. (8 marks)
- (b). Describe 'crude petroleum' based bitumen in short. Draw the schematic diagram showing components of asphaltic base petroleum crude oil indicating the components in order of decreasing volatility. (12 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 moving vehicle and the observer in the moving vehicle method of finding average journey speed.

(4 marks)

During a moving vehicle method survey six runs were made in each direction along the two-way highway between Nugegoda and Maharagama (assume that the distance between Nugegoda and Maharagama to be 6.5 kms). Flows were measured both with and against the moving vehicle, and the following observations were recorded.

(a). Vehicle traveling from Nugegoda to Maharagama

Trip		Number of vehicles		
Start (mm:sec)	End (mm:sec)	Overtaking the test car	Overtaken by the test car	Met in opposite direction
16:05	16:16	2	1	410
16:34	16:44	3	2	398
17:05	17:17	4	1	402
17:35	17:44	5	3	358
18:05	18:18	2	1	388
18:35	18:45	2	2	406

(b). Vehicle traveling from Maharagama to Nugegoda

Trip		Number of vehicles		
Start (mm:sec)	End (mm:sec)	Overtaking the test car	Overtaken by the test car	Met in opposite direction
16:19	16:31	3	2	330
16:50	17:03	7	0	307
17:20	17:32	4	2	356
17:50	17:59	4	3	348
18:20	18:33	5	2	302
18:50	19:01	7	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. (8 marks)

(ii). Calculate the average journey speed from Nugegoda to Maharagama and from Maharagama to Nugegoda.

(8 marks)