Cover Type 'B'

University of Technology, Sydney

TO BE RETURNED AT THE END OF THE EXAMINATION.
THIS PAPER MUST NOT BE REMOVED FROM THE EXAM CENTRE.

SURNAME:	
FIRST NAME:	
STUDENT No.	
COURSE:	

AUTUMN SEMESTER, 2008

SUBJECT NAME: **TRANSPORT IN THE ENVIRONMENT**

SUBJECT NUMBER: **48370**

DAY/DATE: **MONDAY, 23 JUNE 2008**

TIME ALLOWED: **3 Hours plus 10 Minutes reading time**

START/END TIME: **9.30 AM – 12.40 PM**

NOTES/INSTRUCTIONS TO CANDIDATES

- **ANSWERS TO PARTS 'A', 'B', 'C' & 'D' ARE TO BE IN SEPARATE BOOKLETS MARKED 'PART A', 'PART B', 'PART C' & 'PART D'**
- **ATTEMPT THREE (3) QUESTIONS ONLY FROM PART 'C'**
- This is a **CLOSED BOOK EXAMINATION**
- Non-programmable calculators are permitted
- Rough work can be done on the blank pages at the end of each answer booklet

PART A

(TRANSPORTATION ENGINEERING)

QUESTION 1 (10 Marks)

(a) (3 Marks)

What town planning measures should be adopted to encourage public transport usage?

(b) (3 Marks)

How do transport facilities shape a city? In your answer give examples of the relationship between transport facilities and patterns of development in a city with which you are familiar.

(c) (4 Marks)

In a growing city, discuss the advantages and disadvantages of implementing a heavy rail network versus a road network.

QUESTION 2 (10 Marks)

(a) (3 Marks)

Label and draw a diagram showing the concept of land-use and transport interaction and explain the mechanism.

(b) (3 Marks)

If the elasticity of demand for petrol is -0.15, how much will motor vehicle travel decrease in Sydney, if petrol increases in price from $1.40 to $1.60 per litre? (Assume that the average vehicle-kilometres travelled per day is 120 million vehicle-kilometres in Sydney).

(c) (4 Marks)

In transport planning, what is the "four-step" model? Describe each step and explain how the model is used in the overall transport planning framework.

PART B

(ROAD DESIGN AND TRAFFIC CAPACITY)

The following tables and formulae are for your use as required:

Design Speed (km/hr.)	Coefficient of Longitudinal Friction (f_l)	Coefficient of Side Friction (f)	Relative Grade (%) 1 lane*	2 lanes**
60	0.47	0.24	0.60	1.0
70	0.45	0.19	0.55	0.9
80	0.43	0.16	0.50	0.8
90	0.41	0.13	0.45	0.75
100	0.39	0.12	0.40	0.7

* normal 2 lane roadway with control on centreline

** two lane roadway with control on one edge ***OR,*** four lane roadway with control on centreline

(1) $D_s = \frac{R_t V}{3.6} + \frac{V^2}{254 f_l}$

(2) $e + f = \frac{V^2}{127R}$

(3) $C = 200(\sqrt{h_1} + \sqrt{h_2})^2$

Lateral Clearance W_l (m)	C_l (m)
3.0	0.6
3.25	0.7
3.5	0.8
3.7	0.9

(4) $\propto$ (in radians) $= \frac{D_s}{R - 1.5}$

(5) $B = R - (R - 1.5)\cos \frac{1}{2} \propto$

(6) $R = \frac{D_s^2}{8(W_s - 1.5)}$

(7) $L = 2D_s - \frac{C}{A}$

(8) $L_e = \frac{W_r (E_1 - E_2)}{G_r}$

(9) $L_p = \frac{L_e E}{(E_1 - E_2)}$

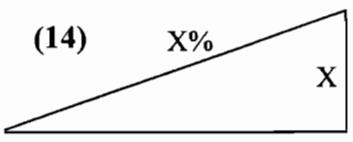
(10) $L = \frac{(D_s^2 \times A)}{C}$

(11) $W = R - \sqrt{(R^2 - 69)} + 2.5 + C_l + \frac{V}{19\sqrt{R}} - W_l$

(12) $MO = \frac{LA}{800}$

(13) $IO = \frac{X^2 \times MO}{(L/2)^2}$

(14)



Grade % $= \frac{\text{Rise or Fall}}{\text{Distance}} \times 100$

QUESTION 3 (15 Marks)

Marks

6 (a) The design brief for a new section of Highway is based on the following criteria:

1) Design speed 100 km/hr.
2) Reaction time 1½ (1.5) seconds
3) Lane width 3.5 metres
4) Shoulder width 2.5 metres
5) Driver eye height 1.15 metres
6) Object height 0.2 metres
7) Normal crossfall -3.0%
8) Max. superelevation +4%
9) Stopping sight distance 150 metres (at 1½ seconds reaction time)

Calculate the following:-

(i) the minimum horizontal curve radius that satisfies the design criteria above,

(ii) the benching offset required for a 550 metre radius curve – give your answer as an offset distance measured from the control (centreline) of the road.

(iii) if this road had an increased reaction time of 2½ (2.5) seconds, what would be the benching amount required for the radius of 550 metres? (Note – you will need to recalculate D_s).

2 (b) A 460 metre length vertical curve (VC), is to be provided between grades of +3.0% and –3.5% on this road. Determine by calculation if this VC length is adequate to satisfy the minimum Stopping Sight Distance of 150 metres at 1½ seconds reaction time. If it is not a suitable length, show the length that the VC needs to be.

2 (c) Assuming the intersection point reduced level (RL) of the above 460m. VC is 127.620, calculate the four gradeline RL's at the following points on the VC

(i) start point, (ii) 115 metres from the start point,

(iii) the mid point, and, (iv) the end point.

5 (d) Relative to an urban arterial road with interrupted flow, explain the following terms:-
(Use a sketch or sketches if you feel this assists your description).

(i) operating speed,

(ii) mid block capacity,

(iii) level of service,

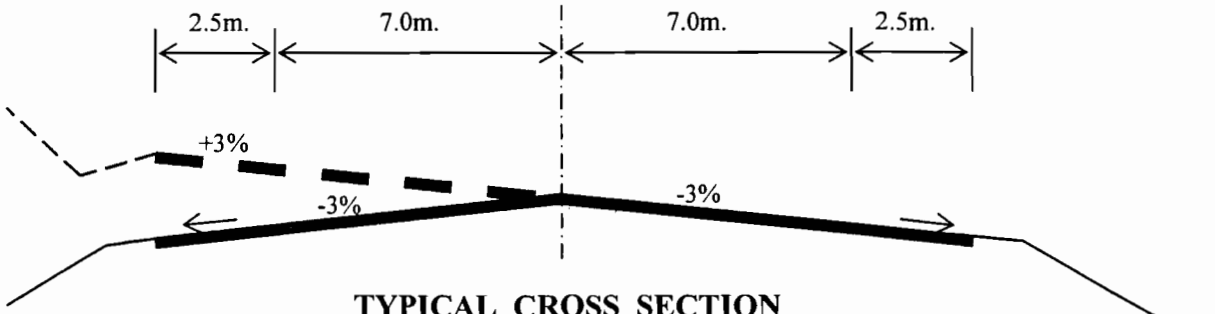
(iv) free flow speed, and,

(iv) headway.

QUESTION 4 (15 Marks)

Marks

A section of two lane Highway in very hilly terrain is to be upgraded to four lanes. The design speed is 80 km/hr. and one of the horizontal curves will be 270 metres in radius. The upgraded road has a normal crossfall of -3%, a lane width of 3.5 metres and a shoulder width of 2.5 metres, which is to be paved for the full width (see cross section below for the configuration). The maximum superelevation for this road will be limited to +3% due to the route having a high percentage of heavy vehicles in the traffic mix.



TYPICAL CROSS SECTION
(Not to scale)

Using a reaction time of 1½ seconds, calculate the following:-

1	(a)	The stopping sight distance required for the design speed of 80 km/hr. The value you calculate is to be rounded to the nearest multiple of ten (10) metres above. (*Check your answer!*).
2	(b)	Confirm that the superelevation value of +3% is adequate for the 270 metre radius curve. If it is not suitable, calculate a revised radius that would be adequate.
1½	(c)	The superelevation transition length. Round this to the nearest multiple of ten (10) metres above if warranted. (NB consider the 2.5m. shoulder in your calculations).
1	(d)	The plan transition length, also rounded to ten (10) metres above if warranted.
1½	(e)	The total amount of widening required for the 270 metre radius curve (i.e. all four lanes).
3	(f)	Draw a neat sketch showing the relative locations of all the transitions on a plan view.
5	(g)	Draw a neat sketch showing the relative locations of the transitions on an elevation view. Show profiles for the superelevation development and label appropriate values.

QUESTION 5 (10 Marks)

Marks

5	(a)	Compound horizontal curves are recognized as an undesirable configuration in a road alignment. List at least five other like undesirable geometric elements that need to be avoided in the horizontal alignment of a road design.
5	(b)	The "constructability" or practicability of any large civil project is critical to ensure smooth continuance of the works programme and keeping within a realistic budget. List at least five construction related factors (excluding things like bad weather, industrial relations and the like), that could cause <u>significant</u> delay to the construction if not adequately researched (i.e. "surprises").

PART C

(ROAD ENGINEERING)
ATTEMPT THREE (3) QUESTIONS ONLY

QUESTION 6 (10 Marks) (CHARACTERISTICS OF ROAD USERS)

(a) (4 Marks)

"Driving a motor vehicle is basically a decision-making process, which is dependent on perception and judgements. Since it is commonly accepted that between 85% and 90% of the perceptions are of a 'visual' nature, then driving and visual perception are very closely related."

Comment on this statement.

(b) (6 Marks)

"There are many aspects of driver behaviour involved in performing the required navigation, guidance and control tasks involved in driving. These must be taken into account in predicting both normal traffic behaviour and the type of abnormal behaviour that leads to many traffic accidents."

Discuss the four (4) prime aspects of driver behaviour.

QUESTION 7 (10 Marks) (CHARACTERISTICS OF MOTOR VEHICLES)

(a) (4 Marks)

Calculate the 'Equivalent Standard Axle Load' for the following heavy commercial vehicles:-
Single/Single : Tandem : Tri-axle (6t : 16.5t : 20t) - 6 Axle Semi-trailer
Single/Single : Tandem : Tri-axle : Tri-axle (6t : 17t : 21t : 22.5t) - 9 Axle 'B' Double

(b) (3 Marks)

"Load limits on individual tyres and axles exist to primarily restrict pavement damage, although other characteristics of motor vehicles and road users are affected by overloading".

Comment on this statement.

(c) (3 Marks)

"The manner in which a vehicle handles and steers is of obvious importance, as are vehicle dimensions. From a traffic engineering view, it influences the layout of turning and manoeuvring areas".

Comment on this statement.

QUESTION 8 (10 Marks) (ROAD SAFETY)

(a) (4 Marks)

What are the four (4) driver 'behavioural' factors that contribute to serious road crashes?

(b) (4 Marks)

Road engineers are required to investigate road accidents. In doing so they must carry-out a "Diagnosis of road crash problems". Discuss this process in detail.

(c) (2 Marks)

Four (4) 'Road Safety' initiatives have been adopted by the Roads and Traffic Authority of NSW since 1970, which have substantially reduced the rising road toll in New South Wales. What are they?

QUESTION 9 (10 Marks) (ROAD MAINTENANCE)

(a) (5 Marks)

"The life of a road pavement is dependent upon an array of engineering and environmental factors."

Discuss this statement.

(b) (5 Marks)

List and describe in detail five (5) "Surface" related deficiencies in road pavements.
Use sketches where possible in your answers.

PART D

(CONCRETE ROAD PAVEMENTS)

QUESTION 10 (10 Marks)

(a) (2 Marks)

(i) What 'Design Life' would you adopt for a concrete road pavement for a State Highway or Main Road?

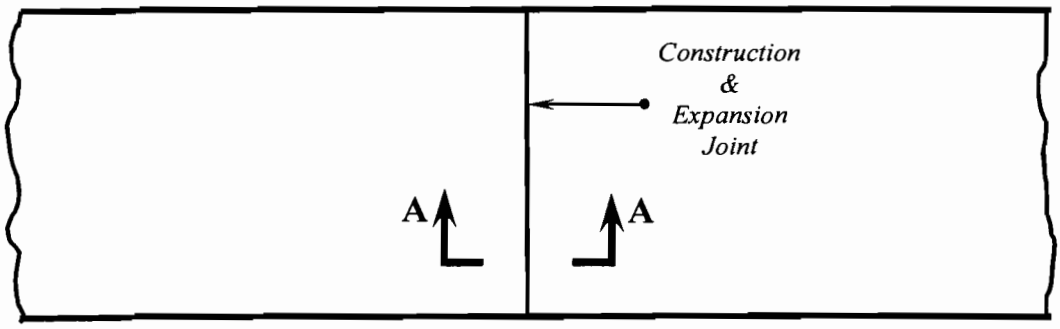
(ii) What is the cost differential between concrete road pavements and flexible road pavements?

(b) (4 Marks)

Outline two (2) different construction methods/techniques used in the road building industry.

(c) (4 Marks)

(i) Draw Section A-A through the reinforced concrete road pavement shown below.



PLAN

(ii) Outline one of the recently embraced innovative construction techniques used in the construction of concrete pavements on major Arterial roads in NSW?