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:	

SPRING SEMESTER, 2006

SUBJECT NAME : TRANSPORT IN THE ENVIRONMENT

SUBJECT NO. : 48370

DAY/DATE : SATURDAY, 18 NOVEMBER 2006

TIME ALLOWED : 3 Hours plus 10 Minutes reading time

START/END TIME : 9.30AM – 12.40PM

NOTES/INSTRUCTIONS TO CANDIDATES

ANSWERS TO PARTS 'A', 'B' & 'C' ARE TO BE IN SEPARATE BOOKLETS MARKED 'PART A', 'PART B' & 'PART C'

ATTEMPT FOUR (4) 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) (6 Marks)

Discuss the advantages and disadvantages of the following transport options:

1. Buses running on bus only lanes
2. Light rail
3. Heavy rail

Under what conditions would you recommend the construction of a light rail network rather than an extensive freeway network?

(b) (4 Marks)

If the elasticity of demand for public transport travel is -0.25, by how much will public transport trips increase, if fares decrease from $2.00 to $1.50?

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 using an actual rural example.

(b) (4 Marks)

The equation for the gravity model is:

$$Tij = \frac{P.\ AjF(t)ijKij}{\sum_{j=1}^{n=1} AjF(t)ij}$$

Explain the terms used in this equation.

(c) (3 Marks)

When would you use the gravity model? Comment on the advantages and disadvantages of the gravity model?

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

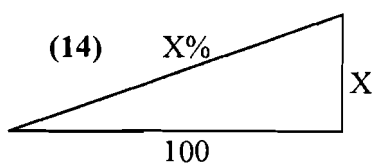
Lateral Clearance W_1 (m)	C_1 (m)
3.0	0.6
3.25	0.7
3.5	0.8
3.7	0.9

(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) $W = R - \sqrt{(R^2 - 69)} + 2.5 + C_1 + \frac{V}{19\sqrt{R}} - W_1$ **(12)** $MO = \frac{LA}{800}$

(13) $IO = \frac{X^2 \times MO}{(L/2)^2}$ **(14)** 

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

Over.....

QUESTION 3 (15 marks)

Marks

1½ (a) List the six (6) sight distances that apply to road design. No measurements are required.

4 (b) Relative to good road design practice, indicate whether the statements given below are true or false by placing a cross **(X)** in the appropriate box.

TRUE	FALSE	STATEMENT
☐	☐	The plan, longitudinal section and cross section views should all be considered relative to each other when carrying out a design for a road.
☐	☐	Good design practice means deliberately providing the driver with as many clues as possible as to what lies ahead.
☐	☐	Vertical and horizontal curves should coincide where practicable.
☐	☐	Summit vertical curves have little bearing on a driver's sight distance.
☐	☐	Short length vertical curves in sags reduce the height of embankments (and earthworks), and as such are an essential feature to have on a road.
☐	☐	Broken-back curves are a good feature to incorporate within a horizontal alignment, as they offer relief from driver boredom.
☐	☐	An isolated curve of minimum radius for a designated design speed should not be used within a section of road having larger radius curves.
☐	☐	Headlight sight distance needs to be provided on all crest vertical curves.
☐	☐	Spiral transitions on horizontal curves should always be provided in the design of high-speed roads.
☐	☐	For semi-urban roads with high traffic volumes, street lighting may be a good compromise if headlight sight distance cannot be achieved.
☐	☐	On dual carriageway roads, long straights are preferable to a continuously curved alignment.
☐	☐	Left-hand curves are recognised as bad design form and a safety hazard – they therefore should be avoided where possible.
☐	☐	Superelevation on horizontal curves is provided to assist the drainage of the road pavement.
☐	☐	The higher the speed of a road, the greater the traffic capacity it has due to more vehicles being on the road for a shorter time.
☐	☐	Vertical curves (VC's) are used between straight grades and are based on the parabola as the rate of change is constant and calculations are simple.
☐	☐	Heavy vehicles (semi-trailers), do not interfere with capacity providing they can reach the design speed on an arterial road.

3 (c) The majority of Sydney's urban arterial roads operate under interrupted flow conditions. Explain what is meant by the following terms relative to these conditions.

i)	mid block capacity	iv)	operating speed
ii)	flared intersection	v)	saturation flow rate
iii)	upstream conditions	vi)	free flow speed.

3 (d) List the various Levels of Service (LOS) in order, and give a brief description of the traffic conditions for each one.

2 (e) A 320 metre length vertical curve (VC) is to be provided between grades of +4% and –3% on a rural road with a design speed of 100 km/hr. Determine by calculation if this length is suitable – if it is not suitable, show the length that it needs to be. Use a stopping sight distance of 150 metres in your calculations.

1½ (f) Assuming the IPRL (intersection point reduced level), of the above 320 metre VC is RL 72.875, calculate the gradeline finished surface levels at the start point, the mid point and the end point of the VC.

QUESTION 4 (15 marks)

Marks

From investigations carried out, it has been shown that a 400 metre radius horizontal curve will fit the landform and the design criteria required for one of the horizontal curves on a two-lane two-way rural road upgrading. Each lane is to be 3.4 metres wide (exclusive of widening), with a 1.8 metre wide unsealed shoulder. The design speed is 90 km/hr.

Determine by calculation the following: -

2 (a) Confirm that the 400 metres radius is adequate for the design speed (i.e. 90 km/hr.), with the superelevation being limited to 3%.

2 (b) Calculate the stopping sight distance required for the design speed of 90 km/hr.

2 (c) Calculate the superelevation transition length and the plan transition length for this curve, adopting a 3% superelevation value.

2 (d) Calculate the total lane width required for the curve.

2 (e) Show with a neat line diagram (plan centreline view only), the relative positions of the three transitions. Label the transitions, their extent (or limits), and indicate with notations.

3 (f) What is the benching required for this curve (i.e. 400m. radius at 90 km/hr.)? Give your answer as an offset distance measured from the control (centreline) of the road.

2 (g) If this horizontal curve were to be designed for 100 km/hr., what would the new superelevation value need to be? Would this calculated value be acceptable under normal circumstances?

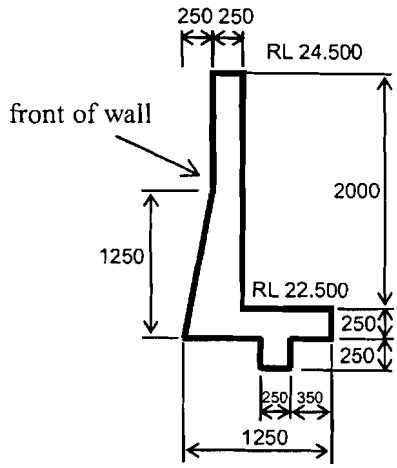
QUESTION 5 (10 Marks)

(a) (8 Marks)

The side view of a 4m long retaining wall is shown.
The retaining wall has a constant cross-section.

What is the scale of the side view? Scale 1: .....
(Show calculation)

Use a suitable scale to draw the top and front views below.
(Include dimensions appropriate for these views)



SIDE VIEW

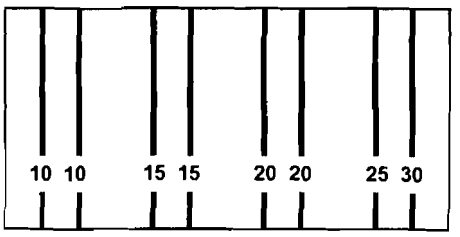
QUESTION 5 (Continued)

(b) (2 Marks)

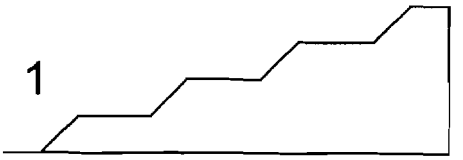
Match up the contour patterns (shown below on left: A to D) with the side view of those patterns (shown below on right: 1 to 4).

Contour pattern A = ___ Contour pattern B = ___ Contour pattern C = ___ Contour pattern D = ___

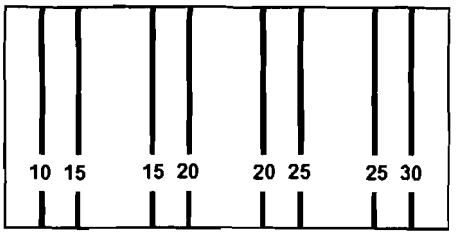
A



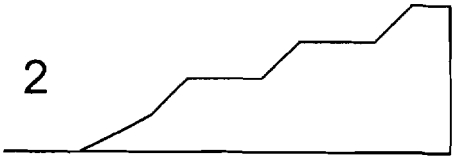
1



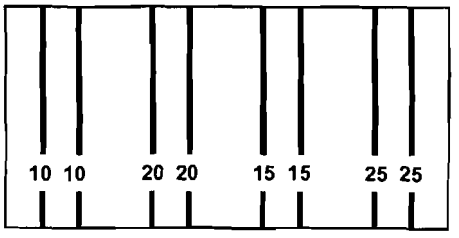
B



2

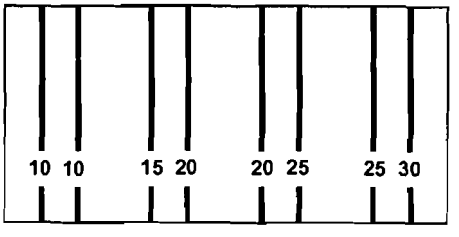


C

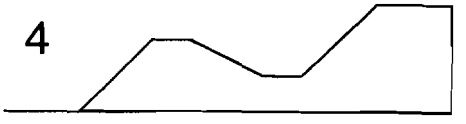


3

D



4



PART C
(ROAD ENGINEERING)
ATTEMPT 4 QUESTIONS ONLY FROM PART 'C'

QUESTION 6 (10 Marks) (CHARACTERISTICS OF MOTOR VEHICLES)

(a) (3 Marks)

"Road alignment design is dependent on the geometric and performance characteristics of the car. The road transport system is a series of interactions between the component parts of vehicles, the road and driver and nowhere is that interaction more evident to us than in the operation of the motor car."

Comment upon this statement.

(b) (1 Mark)

Calculate the Centrifugal Force acting upon a bus when negotiating a curve on a 2-lane rural road.

Buss Mass	=	6.0 tonnes (6000 kg)
Curve Radius	=	200 metres
Vehicle Speed	=	60 km/hr

(c) (6 Marks)

Given the axle loads in tonnes for three (3) "Heavy" commercial vehicles below calculate:

(i) The number of "Equivalent Standard Axles" for those loading conditions; **and**
(ii) The number of "Equivalent Standard Axles" for 'legally loaded vehicles.

* Single/Single : Tandem : Tri-axle : Tri-axle - (7 : 18 : 22 : 25)
* Single/Single : Tandem : Tandem: Tandem - (6 : 18 : 17 : 19)
* Single/Single : Tandem : Tri-axle : Tandem - (6 : 19 : 24 : 18)

QUESTION 7 (10 Marks) (CHARACTERISTICS OF ROAD USERS)

(a) (3 Marks)

The characteristics and skills of road users whether pedestrians, bicyclists or drivers, vary widely.

Comment upon this statement.

(b) (3 Marks)

A motor vehicle driver's decision-making process is the conversion of perceived information into an action upon the vehicle. Comment on this statement.

(c) (4 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".

Describe the four major aspects of driver behaviour.

QUESTION 8 (10 Marks) (ROAD SAFETY)

(a) (4 Marks)

The diagnosis of road crash problems is an important part of the Traffic Engineer's responsibility.

Describe how you might approach the task of undertaking such an investigation.

(b) (4 Marks)

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

(c) (2 Marks)

"A safe road environment incorporates numerous design principles, good all-weather, night and day delineation, adequate surface skid resistance and a roadside free of unforgiving hazards. It includes the various safety needs of all vehicles and road users".

What are the principal aims of a 'Safe Road Environment' in assisting the road user?

QUESTION 9 (10 Marks) (ROAD MAINTENANCE)

(a) (6 Marks)

"A road subjected to traffic is progressively damaged by effects of the more structurally severe portion of that traffic (i.e. heavy commercial vehicles). Its condition therefore changes and reflects its usage. The symptoms of the accumulated damage and the evidence of current condition are observed as Pavement Surface Deficiencies - these being "Deformation" related, "Cracking" related and "Surface".

Briefly outline the causes of two (2) 'Pavement Surface Deficiencies' from each of the three (3) categories.

(b) (2 Marks)

The performance of a road pavement is dependent upon a number of characteristics. What are the four (4) "Performance Indicators" used to determine the "performance" of an existing road pavement.

(c) (2 Marks)

Describe how you would patch a pothole permanently.

QUESTION 10 (10 Marks) (ROAD FURNITURE)

(a) (1 Mark)

In the pursuit of sound traffic management the engineer should ensure that a sufficient opportunity is available for the motor vehicle leaving the road pavement, to recover and return or to come to a relatively safe stop.

What is the road engineering terminology for this aspect of road and traffic engineering?

(b) (5 Marks)

Locations of high accident potential but not necessarily a high accident history can be identified by carrying out a roadside features/furniture inventory. When this is carried out features with high accident potential are identified.

List and describe five (5) of these features.

(c) (4 Marks)

There are four (4) basic types of road signs used in road engineering, what are they?