Cover Type 'B'

University of Technology, Sydney

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THIS PAPER MUST NOT BE REMOVED FROM THE EXAM CENTRE.

SURNAME:	
FIRST NAME:	
STUDENT No.	
COURSE:	

AUTUMN SEMESTER EXAMINATION 2010

SUBJECT NAME : TRANSPORT IN THE ENVIRONMENT

SUBJECT NO. : 48370

DAY/DATE : Tuesday, 22 June 2010

TIME ALLOWED : 3 Hours plus 10 Minutes reading time

START/END TIME : 9.30AM – 12.40PM

NOTES/INSTRUCTIONS TO CANDIDATES

ANSWERS TO PART 'A' MUST BE IN A SEPARATE BOOK MARKED PART 'A'

ANSWERS TO PART 'B' MUST BE IN A SEPARATE BOOK MARKED 'PART B', EXCEPT WHERE REQUIRED TO BE ANSWERED ON THIS EXAM PAPER

ANSWERS TO PART 'C' MUST BE ON THIS EXAM PAPER

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) (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.

(b) (6 Marks)

The equation for the gravity is as follows:

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

Explain the terms in this equation and where it used in transport planning.

QUESTION 2 (10 Marks)

(a) (3 Marks)

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

(b) (3 Marks)

How have the changing transport systems in Sydney affected the pattern Sydney's growth?

(c) (4 marks)

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

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

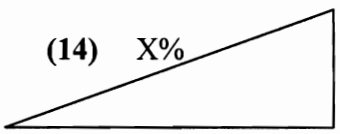
(6) $R = \frac{D_s^2}{8(W_s - 1.5)}$ **(7)** $L = 2D_s - \frac{C}{A}$

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

Over.....

QUESTION 3 (10 Marks)

Marks

2½ (a) Illustrate with a neat single line diagram with appropriate notation, the following plan alignment features:

(i) Compound horizontal curve.

(ii) Broken-back horizontal alignment.

(iii) Plan transition.

(iv) Bench.

(v) Reverse curves.

2½ (b) Assuming Superelevation and Plan Transition lengths of 70 metres and 50 metres respectively, illustrate with a neat diagram a superelevation transition development which goes from a normal crossfall of –3% to a full superelevation of +5%. Show the two pavement edges in profile with other critical information and dimensions.

5 (c) Relative to a typical rural road cross section, define (in words), the following terms. Add a sketch if you feel this will aid your description:

(i) Batter.

(ii) Verge.

(iii) Hinge point.

(iv) Formation.

(v) Catch drain.

QUESTION 4 (20 Marks)

The sketches below (Figures 1 and 2), represent a plan and longitudinal section for a segment of two-lane two-way rural road. The following design parameters apply:

(1)	Design Speed	80 km/hour	(2)	Shoulder width	2.0 metres sealed
(3)	Reaction Time	1½ seconds	(4)	Normal crossfall	–3.0%
(5)	Lane width	3.5 metres sealed	(6)	Table drain width	1.0 metres
(7)	Eye height	1.15m.	(8)	Object height	200mm.

Marks **Calculate the following for parts (a) to (h) inclusive below:-**

1 (a) The missing grade between chainage 195 and chainage 345. Show this on the Long. Section.

1 (b) The stopping sight distance for the design speed.

2 (c) The length of the crest vertical curve (VC) which fits the last grade and the one you calculated in (a) above which satisfies the **minimum** stopping sight distance. Note – your answer will not necessarily be the same length as that indicated on the Longitudinal Section.

1 (d) The superelevation value for the 240 metre radius curve.

1 (e) The length of the superelevation transition, the axis of rotation being on the centreline.

1 (f) The length of the plan transition.

1 (g) The amount of widening required for each lane.

6 (h) Calculate the finished surface RL^S at the chainages indicated on the Longitudinal Section and show these in the appropriate column, i.e. nine (9) RL^s are required.

Draw the following for parts (i) to (l) inclusive below:-

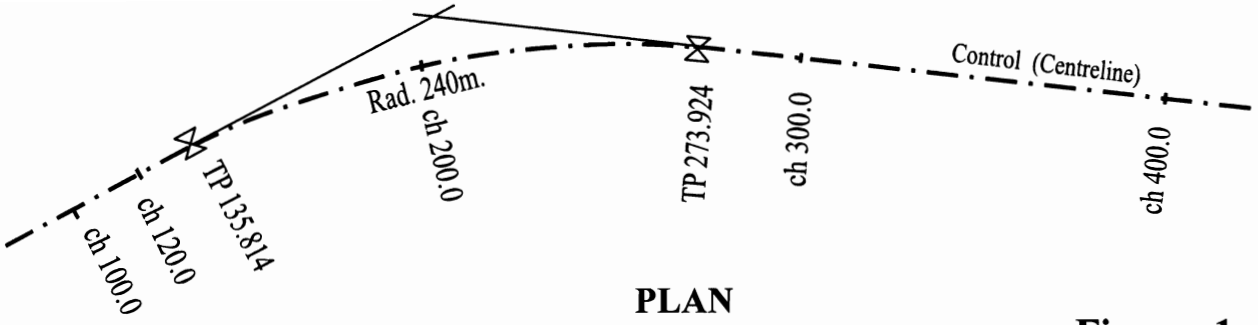
1½ (i) Draw to scale on the Plan (Figure 1), the locations of the transitions at one end of the curve. Label each of these clearly.

1½ (j) Draw in the three grades to scale on the Longitudinal Section (Figure 2).

1½ (k) Fit to scale a 150 metre sag VC between the first two grades. Note this VC length (and the VC in part (l)), will not necessarily be the same lengths as the ones you have calculated. (Figure 2).

1½ (l) Fit to scale a 150 metre length crest VC between the last two grades. (Figure 2).

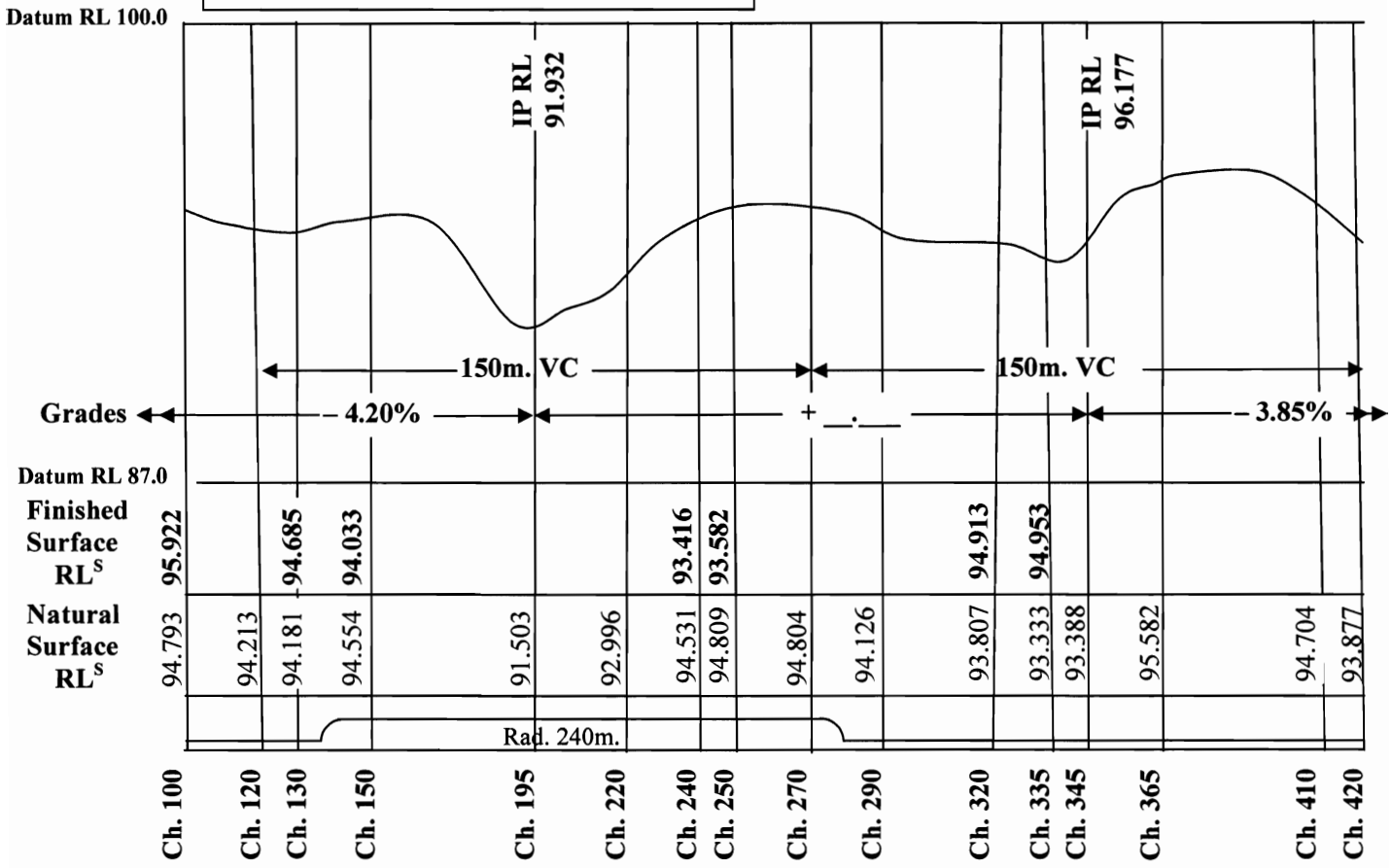
NOTE:
The page showing Figures 1 & 2 must be handed in with your answer books!



PLAN
Scale – 1 : 2 000

Figure 1

NOTE: RL's are to be calculated to 0.001 metres (i.e. 1 millimetre) accuracy.



LONGITUDINAL SECTION
Scales – Horizontal 1 : 2 000 and Vertical 1 : 200

Figure 2

NOTE:
This page (Figures 1 & 2), must be handed in with your answer books!

QUESTION 5 (10 Marks) DRAWING

(1) What is the scale of the side view? (0.5 mark)

Scale 1: .....

(show your calculation)

(2) Draw the top and front views of the retaining wall at this scale in the spaces provided. (4 marks)

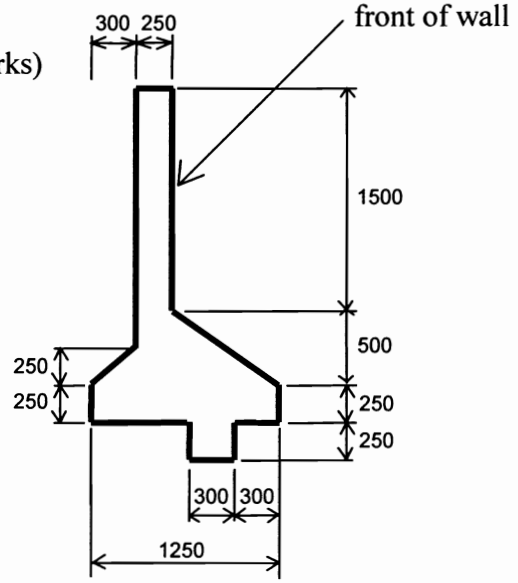
Note: The structure has a constant cross-section. The natural surface levels are given at four corners of the structure in the top view.

(3) Label the front view only. (1.5 marks)

(4) Draw on the top view the RL 29.5 and RL30.0 contour lines. (2 marks)

(5) Draw on the front view the natural surface profile at the front of the wall. (2 marks)

Note: Top of retaining wall is at RL 30.500



SIDE VIEW

TOP VIEW

FRONT VIEW

PART C
(ROAD ENGINEERING)

QUESTION 6 (10 Marks) CHARACTERISTICS OF MOTOR VEHICLES & ROAD USERS

(a) (1 Mark)

(i) Calculate the number of 'Equivalent Standard Axles' for the B-Double (Heavy commercial vehicle) with axle loadings as shown below. Single/Single : Tandem : Tri-axle : Tri-axle:

7t : 17.5t : 23t : 22t

Place a Tick (√) in the box containing the correct answer

☐	9.3	☐	11.4	☐	9.8	☐	7.8
☐	10.8	☐	8.9	☐	12.3	☐	14.5

(b) (2 Marks)

"A study of traffic behaviour requires a detailed knowledge of the characteristics of the common types of vehicle found in the traffic stream.

What are four (4) of these characteristics?

Place a Tick (√) in the box containing the correct answers

☐	Visibility restrictions	☐	Manoeuvrability	☐	Axle spacing	☐	Braking
☐	Acceleration	☐	Wheel size	☐	Suspension type	☐	Steering

(c) (2 Marks)

Calculate the Centrifugal Force on the following vehicles travelling around a design curve:

Vehicle	Mass	Curve Radius (m)	Vehicle Speed (Km/Hr)
Bus	10 Tonne	250	80
Single Unit Truck	26 Tonne	400	95

Place a Tick (√) in the box containing the correct answers

Bus

☐ 8.9 kN ☐ 16.67 kN ☐ 19.75 kN ☐ 21.2 kN

Truck

☐ 39.85 kN ☐ 45.3 kN ☐ 39.20 kN ☐ 23.45 kN

(d) (3 Marks)

Night vision of road signage

"As the pupil ages, it reduces in size, until in old age it is only 10% of its original size. Thus over the age of 40, illumination of levels must double for every 13 years, to maintain equivalent visual performance."

What are the three (3) essential factors to good viewing conditions?

Place a Tick (√) in the boxes containing the correct answers

☐ Viewing time	☐ Signs with white background	☐ Background form	☐ Luminance
☐ Detail and structure	☐ Ambient light level	☐ Angled signage	☐ Well lit signage
☐ Sign size	☐ Fluorescent lighting	☐ Shape	☐ Form

(e) (1 Mark)

What is the 'Stopping distance' for a car travelling at a speed of 85 km/hr.
Data: t = 2.5seconds. Determine an 'f' value from the data provided in Part 'B' of this paper.

Place a Tick (√) in the box containing the correct answer.

☐ 110m	☐ 220.5m	☐ 150m	☐ 98.5m
☐ 165m	☐ 126.5m	☐ 275m	☐ 175m

(f) (1 Mark)

Identify the type of vehicle shown below:

Place a Tick (√) in the box containing the correct answer.

☐ Cat trailer	☐ Construction trailer	☐ Ford trailer	☐ Dog trailer
☐ Flatbed trailer	☐ Tandem axle rigid trailer	☐ Pig trailer	☐ Short trailer

QUESTION 7 (10 Marks) ROAD MAINTENANCE & ROAD SAFETY

(a) (3 Marks)

"The prime road environment safety objective is to reduce accidents and casualties by improving road engineering, the road environment and the management of traffic"

Identify three (3) major initiatives taken since the mid-1970s to reduce the road toll in N.S.W.

Place a tick (√) in the boxes containing three (3) correct answers

☐ Random breath testing	☐ Red light cameras	☐ Double De-merit points	☐ Speed humps
☐ Speed cameras	☐ Fixed speed cameras	☐ Compulsory seat belts in vehicles	☐

(b) (3 Marks)

Road pavements are subjected to a number of Deficiencies including "Deformation" related.

Place a tick (√) in the boxes containing the three (3) correct answers.

☐ Stripping	☐ Rutting	☐ Faulting	☐ Reflection cracks
☐ Glaze	☐ Longitudinal cracks	☐ Blistering	☐ Scoring
☐ Wheelpath cracking	☐ Heaving	☐ Ravelling	☐ Potholes

(c) (1 Mark)

What is the most important single factor in the road design process?

☐ Speed limit	☐ Vertical gradient	☐ Superelevation	☐ Stopping Sight Distance
☐ Horizontal curve radius	☐ Reaction time	☐ Vertical curve length	☐ Braking distance

(d) (3 Marks)

Draw a diagram below to show you would repair a 'pothole' in a traditional two- coat bitumen sealed road pavement.

QUESTION 8 (10 Marks) ROAD FURNITURE & PAVEMENT DESIGN

(a) (2 Marks)

There are four (4) permanent types of signs used on roads, what are they?

Place a tick (√) in the boxes containing the correct answers

☐ Red	☐ Temporary	☐ Guide	☐ Information
☐ Illuminated	☐ Guide	☐ Green	☐ Detour
☐ Speed	☐ Regulatory	☐ Repeated signs	☐ Warning

(b) (2 Marks)

Road crash barriers are classified into two (2) main groupings related to function. What are they?

Place a tick (√) in the box containing the correct answers

☐ Gated	☐ Yielding	☐ Frangible
☐ Rigid	☐ Flexible	☐ Non-Gated

(c) (2 Marks)

Road furniture comprises many structural items. Select four (4) from the list below.

Place a tick (√) in the box containing the correct answers

☐ Bus shelter	☐ Guardrail	☐ Pavement
☐ Subsoil drain	☐ Pipeline	☐ Kerb & gutter
☐ Geotextile layer	☐ Traffic lights	☐ Light pole
☐ Traffic cone	☐ Gully pit	☐ Sub-grade

(d) (2 Marks)

The Caliornia Bearing Ratio (CBR) is an important measure of the capacity of a sub-grade to support traffic loadings.

What would the typical CBR value be for well drained sandy clay?

Place a tick (√) in the box containing the correct answer.

☐	1-2	☐	12-14	☐	10-15
☐	6-7	☐	8-10	☐	20-25

(e) (2 Marks)

Calculate the design pavement thickness over a well drained sandy clay sub-grade.
Design Life = 20 years. Design Traffic Loading (ESA's) = 8×10^6

Refer to table on page 16 of this examination paper.

Place a tick (√) in the boxes containing the correct answer.

☐	490mm	☐	400mm	☐	250mm	☐	175mm
☐	290mm	☐	330mm	☐	175mm	☐	440mm

Determination of Total Pavement Thickness
Having estimated the design subgrade CBR and the design traffic, the total thickness of granular pavement required over the subgrade can be read directly from Figure 11.8.

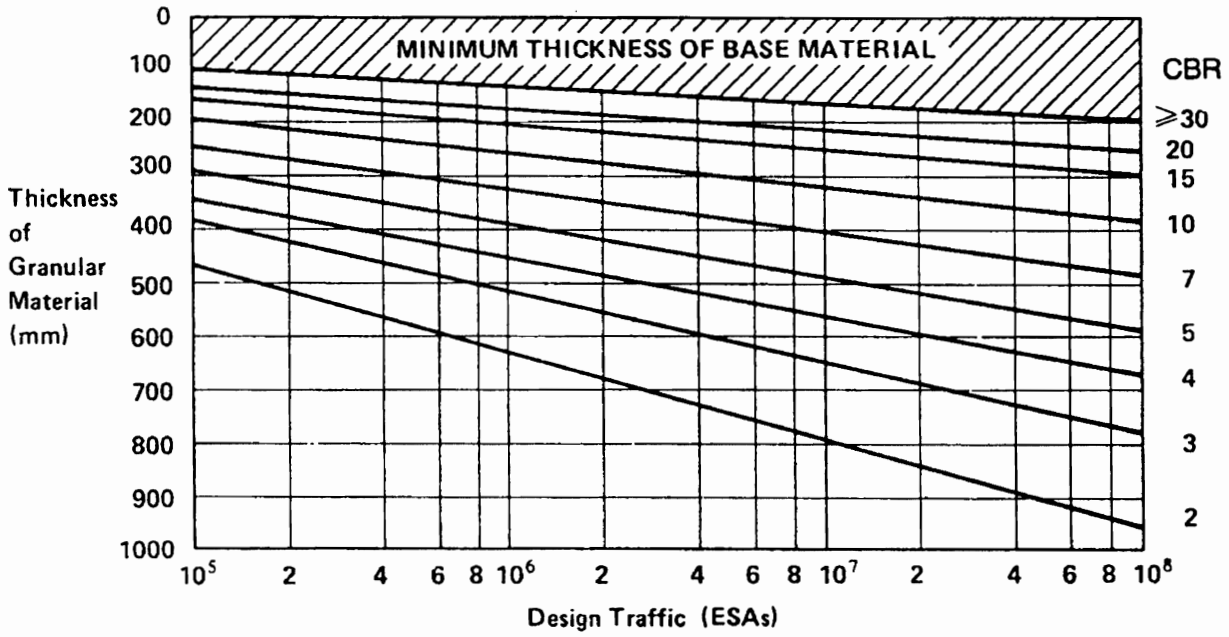


Figure 11.8 *Design chart for granular pavements with thin bituminous surfacing (source: Austroads, 1992, Figure 8.4)*

QUESTION 9 (10 Marks) FREIGHT IN AUSTRALIA

(a) (2 Marks)

The cost of distribution of freight $\mathbf{C_f}$ is given by a Formula with four (4) terms; what are they?

Place a tick (√) in the boxes containing the correct answers.

☐ P	☐ Ws	☐ S	☐ Ay
☐ Qf	☐ T	☐ Mc	☐ Lv
☐ Gn	☐ I	☐ Fx	☐ Op

Explain what each term in the equation represents, and indicate what the components make-up the term 'T'.

(b) (2 Marks)

What are the four (4) prime modes of freight movement in Australia?

Place a tick (√) in the boxes containing the correct answers.

☐ Inter-modal	☐ Submarine	☐ Air	☐ Pipeline
☐ Rail	☐ Sky hooks	☐ Sea	☐ Road
☐ Light rail	☐ Rocket ship	☐ Multi-modal	☐ Flatbed trailer
☐ Trailerail	☐ Truck & 'pig'	☐ Roadrailer	☐ Truck & 'dog'

(c) (6 Marks)

A major pipe manufacturing company located in Wollongong, NSW has won a contract to manufacture and deliver 43,000 m of 450mm diameter 'high strength' steel pipe to a civil engineering contractor in Bunbury, WA, for the construction of a water supply pipeline. Bunbury is located 150 km south of Perth.

Using 'freight' terminology, discuss the options available to the company.