



University of Technology, Sydney

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SURNAME: _____

FIRST NAME: _____

STUDENT NO: _____

COURSE: _____

SPRING SEMESTER EXAMINATION 1999

SUBJECT NO. 48320

SURVEYING

CIVIL ENGINEERING DEGREE COURSE

FRIDAY, 26 NOVEMBER 1999

9:30 am - 12:40 am

Time Allowed: 3 Hours plus 10 minutes reading time

Attempt ALL questions.

Write the answers in the spaces provided.

The questions are NOT of equal value. Marks for each part are shown adjacent to that part of a question.

THIS IS A CLOSED BOOK EXAM.

Calculators and drawing instruments are allowed.

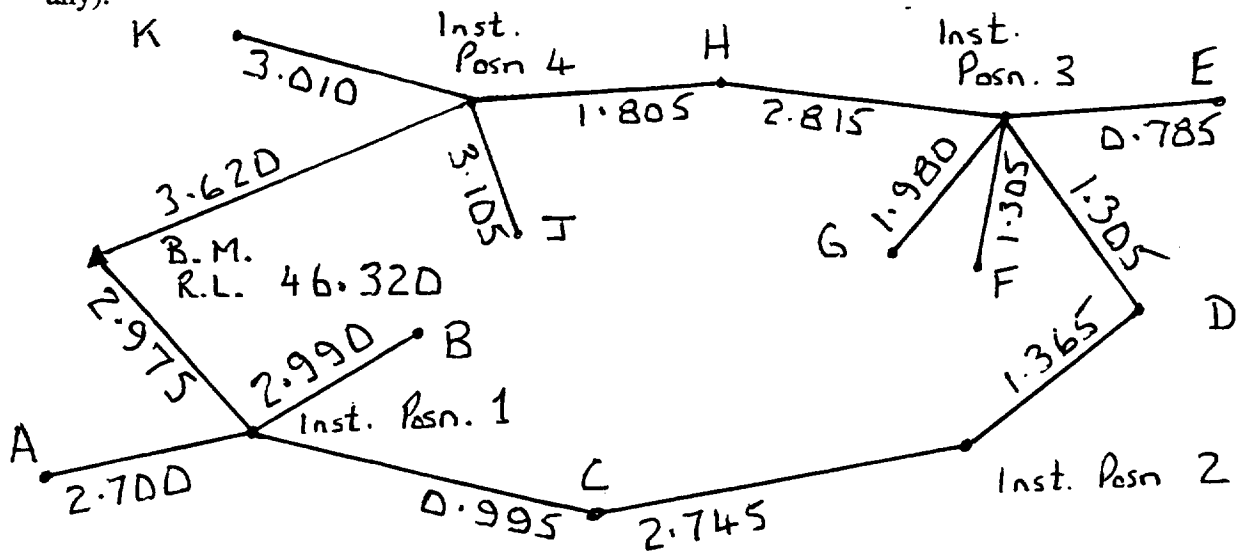
Formulae are provided at the end of the examination paper.

If not enough room for working has been provided, please use the back of adjacent pages.

QUESTION 1 (8 Marks)

The diagram below is a sketch plan made by a junior Engineer, who had forgotten the normal Rise and Fall booking method. The level run commenced at Instrument Position 1 and continued via Instrument Positions 2, 3 and 4.

- a) **Book the readings** on the Booking Sheet below, showing all the information that should be recorded in the field.
- b) Do **NOT reduce** the Levels but **calculate and state** the size of the misclose (if any).



B.S.	INT	F.S.	RISE	FALL	R.L.	REMARKS

MISCLOSE

QUESTION 2 (12 Marks)

A level was set up 13m away from A and 57m from B, exactly on the line between two pegs A and B, which are 70m apart.

Staff readings were made to A and B, respectively as follows: 2.763 and 1.792.

The R.L.s of points A and B were known to be 27.002 and 27.995 respectively.

- a) **Calculate the collimation error of the level.**

- b) **The level was immediately used without any adjustments being made to level between two points X and Y situated 1 km apart. The average length of the backsights was 45m and the foresights 55m. What is the error in the difference in height between X and Y due to the error in the instrument?**

- c) **The level was once again used, without making any permanent adjustment, to set out formwork for a building slab. A reading of 0.950 was made to one corner of the slab, 11m away from the instrument. The slab is to have a step in it and drop by 0.50m from where the staff was placed, to the lower level. Calculate the staff reading which should be observed to set formwork for the lowest part of the slab, if the staff is positioned 44m away from the level.**

COLLIMATION ERROR OF THE LEVEL

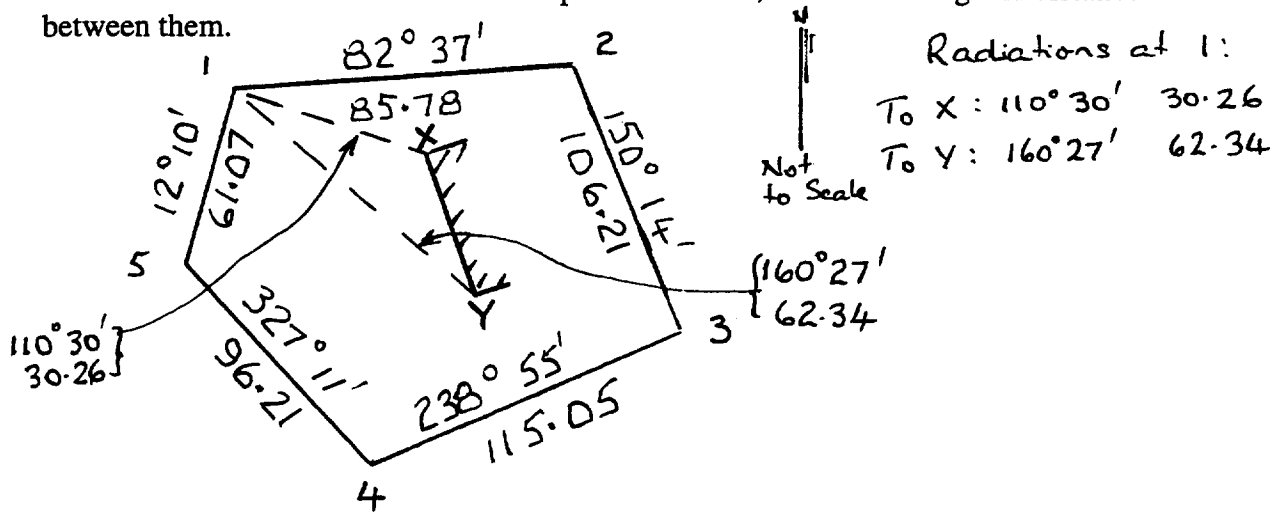
ERROR IN LEVEL BETWEEN X AND Y

STAFF READING REQUIRED TO SET LOWER PART OF SLAB

QUESTION 3 (14 Marks)

a) Determine the misclose and the proportional accuracy of the traverse, 1, 2, 3, 4, 5, 1, which is shown on the diagram below.

b) From station 1, two radiations were observed to points X and Y at the corners of a house. Calculate the coordinates of the points X and Y, and the bearing and distance between them.



LINE	Adjusted Bearing	Distance	Δ E		Δ N		CO-ORD INATES		PT.
			E (+)	W (-)	N (+)	S (-)	E	N	
							1500.000	3000.000	1
1-2	82° 37'	85.78							2
2-3	150° 14'	106.21							3
3-4	238° 55'	115.05							4
4-5	327° 11'	96.21							5
5-1	12° 10'	61.07							1

Misclose of Traverse ----- Prop Accuracy -----

Coordinates of XE,N

Coordinates of YE,N

Bearing and Distance X Y

QUESTION 4 (14 Marks)

It is proposed to relocate an existing road with the relocation following a circular arc between existing straights AB ($56^{\circ} 26'$) and CD ($82^{\circ} 54'$) with the first tangent point at X. X is 39.96m away from B towards A on the straight AB.

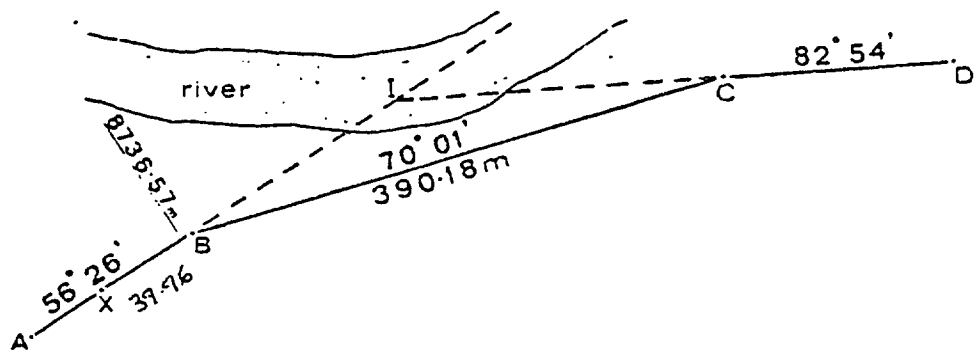
The intersection point is inaccessible. Two convenient points B and C have been selected on the straights AB and CD such that the distance BC is 390.18m. The line BC has a bearing of $70^{\circ} 01'$.

Given that the running chainage of B is 8736.57m, calculate:

- the radius of the curve to exactly meet these criteria,
- the chainages of the two tangent points X and Y, and
- deflection angles and chords to place pegs at chainages 8800 and 9000, using an instrument set up at the first Tangent Point (X). Show these angles to the nearest second and distances to 0.001.

IF YOU CAN NOT FIND THE RADIUS OF THE CURVE, ASSUME IT IS 950m and calculate parts b) and c).

Not
to
Scale



Radius Chainage of TP(1) X Chainage of TP(2) Y.....

Data for setting out peg at 8800 peg at 9000

Deflection Angle

Chords

QUESTION 5 (14 Marks)

On a road design, a falling grade of 3.2% meets a rising grade of 1.8% at an I.P. located at chainage 760.0 and R.L. 47.300. The low point of the vertical curve must be located at chainage 785.2.

a) Calculate the length of the vertical curve to ensure that the low point specification is met exactly. **(5 Marks)**

b) Calculate the R.L. of low point of the curve, **(3 Marks)** and

c) Calculate the R.L.s on the finished surface of the road at chainages 700, 750, 760 and 800. **(6 Marks)**

If you can not find a vertical curve length, use $L = 200\text{m}$ and continue with parts b) and c). Similarly, if your calculated value for L is greatly different to 200m , please use 200m for the subsequent calculations.

CHAINAGE	GRADE	GRADE LEVEL	ORDINATE	DESIGN R.L.

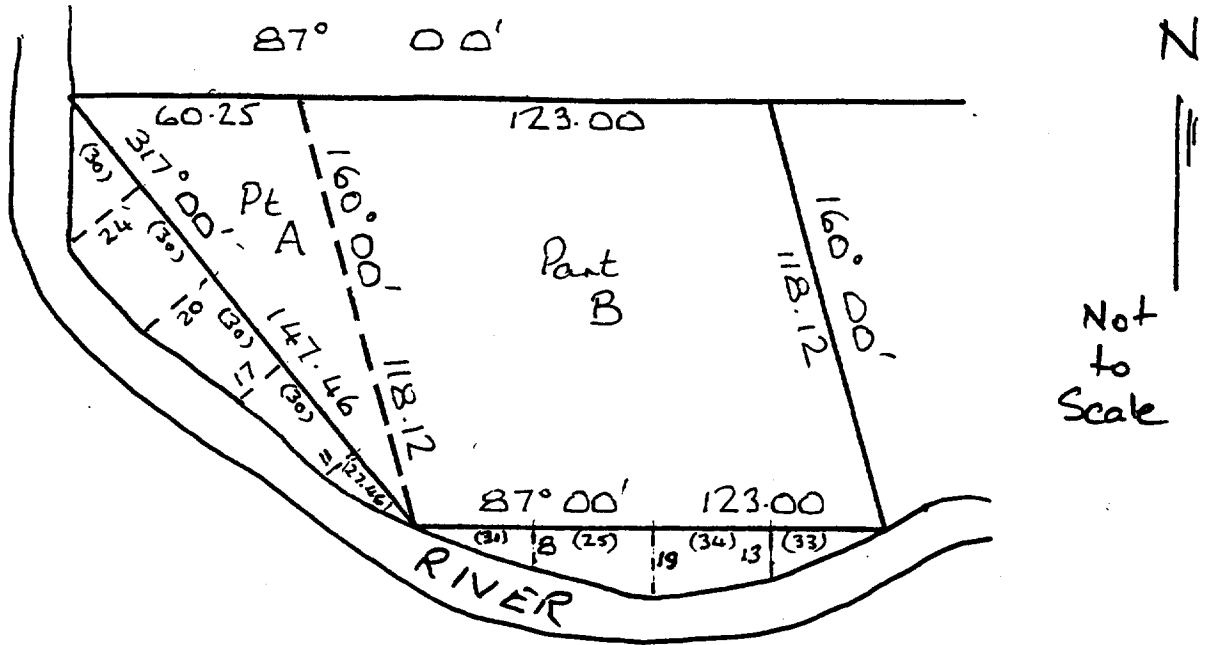
LENGTH OF VERTICAL CURVE REQUIRED

QUESTION 6 (12 Marks)

The diagram below shows a block of land which is bounded by a river, a road and an adjacent block of land.

Calculate the area of the block of land.

You may use any method to calculate the area, but explain the method you adopt. While you do not need to show every step of the calculations, show intermediate answers as you progress.

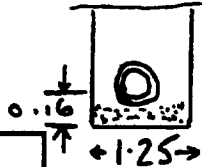


QUESTION 7 (10 Marks)

A trench has to be dug for a pipe which has its invert level at chainage 00 at 25.430m

From 00, the pipe will rise at a constant grade of 1.75% over a horizontal distance of 57.9m. A longsection was run and the levels found for the existing natural surface are tabulated below.

Using the end area method, calculate the volume of material to be removed from the trench given the following conditions. The trench has to be 1.25m wide and needs to always be 0.16m below the pipe's invert level to allow for the thickness of the pipe and a layer of bedding material to support the pipe.



Chainage	Natural Surface R.L.	Invert Level	Depth of Trench		Volume
00	26.25	25.430			
10	26.30				
20	26.45				
27.8	26.62				
35.6	28.00				
40	28.02				
50	28.10				
57.9	28.27				

VOLUME OF MATERIAL TO BE REMOVED

QUESTION 8 (16 Marks)

a) (4 Marks)

The Global Positioning System is operated by the U.S. Department of Defence, who have deliberately introduced random errors into the system so that the position determined by civilian users will be accurate to only about 100m. **Explain** the system which has been developed to enable ships and cars to be able to use GPS for navigation purposes and be able to determine their position correct to a couple of metres instantaneously.

b) (2 Marks)

Explain exactly what is meant by the term "cadastral surveys".

c) (2 Marks)

In using a surveying package such as Landmark, it is necessary to create a mesh of triangles and to edit them. Why are the triangles needed and why must some care be used in selecting which points will create the triangles.

d) (2 Marks)

List and very briefly describe two advantages that occur from using a Total Station instrument with a data recorder to perform a detail and contour survey, when compared with the traditional stadia method.

e) (2 Marks)

What are the main advantages of an electronic level compared to the traditional automatic level and staff.

f) (2 Marks)

When using a level and staff for a traditional levelling run, describe the most important field procedure to be adopted to ensure errors are minimised.

g) (2 Marks)

When using a theodolite, name the most important field procedure to be adopted to ensure that errors are minimised.

$$C_{slope} = -L \times (1 - \cos \beta)$$

$$C_{slope} = -\left[\frac{\Delta h^2}{2L_m} + \frac{\Delta h^4}{8L_m^3} \right]$$

$$C_{temp} = \pm L \times \alpha \times (\Delta t)$$

$$\alpha_{steel} = 11.2 \times 10^{-6} / ^\circ C$$

$$C_{sag} = \frac{w^2 L^3}{24 \times T^2} \times \cos^2 \beta$$

$$Grade = \frac{\Delta h}{HorDist.} \times 100$$

$$OM = \frac{L \times (G_2 - G_1)}{800}$$

$$PQ = \frac{4 \times \alpha^2 \times OM}{L^2}$$

$$PQ = \left(\frac{G_2 - G_1}{200L} \right) \times x^2$$

$$d = \left(\frac{G_1}{G_1 - G_2} \right) \times L$$

$$H = 100 \times s \times \cos^2 \theta$$

$$V = 100 \times s \times \sin \theta \times \cos \theta$$

$$RL_S = RL_T + HI + V - m$$

$$Tangent Dist. = R \tan \frac{\Delta}{2}$$

$$Secant Dist. = R \sec \frac{\Delta}{2}$$

$$External Dist. = R \left(\sec \frac{\Delta}{2} - 1 \right)$$

$$Mid Ord = R \left(1 - \cos \frac{\Delta}{2} \right)$$

$$Chord = 2R \sin \frac{\Delta}{2}$$

$$Arc = R \theta^{rad.}$$

$$Arc = R \theta^{deg} \times \frac{\pi}{180}$$

$$\delta = \frac{arc}{2R} \times \frac{180}{\pi}$$

$$Chord = 2R \sin \delta$$

$$y_0 = R - \sqrt{R^2 - \left(\frac{c}{2} \right)^2}$$

$$y_1 = y_0 - \left[R - \sqrt{R^2 - x^2} \right]$$

$$Area = \pi R^2$$

$$Sector = \frac{1}{2} R^2 \theta$$

$$Segment = \frac{1}{2} R^2 (\theta - \sin \theta)$$

$$2 \times \text{area} = (N_1 E_2 + N_2 E_3 + N_3 E_4 + \dots + N_{N-1} E_N + N_N E_1) - (E_1 N_2 + E_2 N_3 + E_3 N_4 + \dots + E_{N-1} N_N + E_N N_1)$$

$$Volume = \frac{w}{2} (A_1 + 2A_2 + 2A_3 + \dots + 2A_{n-1} + A_n)$$

$$V = \frac{w}{3} (A_1 + 4 \sum \text{even areas} + 2 \sum \text{odd areas} + A_n)$$

$$Volume = \frac{Area}{4} (\sum d_1 + \sum 2d_2 + \sum 3d_3 + \sum 4d_4)$$