UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BTECH *CIVIL ENGINEERING TECHNOLOGY*
SUBJECT	:	**TRANSPORTATION PLANNING 4**
CODE	:	**TPP 411**
DATE	:	SUMMER EXAMINATION 2017 15 NOVEMBER 2017
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	60:40
TOTAL MARKS	:	**100 MARKS**

EXAMINER	:	DR HA QUAINOO
MODERATOR	:	MR MED B. KWESIGA
NUMBER OF PAGES	:	PAGES 7

INSTRUCTIONS	:	PLEASE ANSWER ALL THE QUESTIONS.
REQUIREMENTS	:	NONE

DEPARTMENT OF CIVIL ENGINEERING TECHNOLOGY

TPP411: TRANSPORTATION PLANNING 4

NOVEMBER EXAMINATION – 2017

Answer All Questions Time Allowance: 3 Hours

QUESTION 1

(a) Briefly discuss the importance of integrating land-use planning and transportation planning in the development of provinces. **[5 marks]**

(b) A demand analysis for Trip, T, is given by the function of fare, P, as follows:

$$T = 1000 * P^{-2.0}$$

Suppose the fare changed from R150 to R200, what is the approximate arc elasticity of demand? Comment on the significance of your answer.

NB: $e_{arc} = \dfrac{\Delta X / X}{\Delta v / v}$, whereby v = price or income

X = quantity demanded

This may be approximated as $e_{arc} = \dfrac{(X_1 - X_0) / (X_1 + X_0)}{(v_1 - v_0) / (v_1 + v_0)}$

[5 marks]

(c) Use a Logit (Modal Split) model to determine the modal distribution of a group of 12 000 work commuters choosing between four modes of travel (Private car, Rail, Bus and Bike) during the morning peak hour.

The utility functions for the four modes are estimated as follows:

$U_{Car} = 2.4 - 0.2\,C - 0.03T$

$U_{Rail} = 0.4 - 0.2\,C - 0.03T$

$U_{Bus} = 0.0 - 0.2\,C - 0.03T$

$U_{Bike} = 0.0 - 0.2\,C - 0.03T$

Where

C = Cost of travel (R) per kilometre

T = Travel Time in minutes

Table 1 provides the cost of travel per kilometre with associated for all workers.

Table 1: Cost of travel per kilometre and Travel Time (minutes)

Mode	C (R/km)	Travel Time (mins)
Private Car	4	30
Rail	1	20
Bus	0.5	45
Bike	0.2	90

The Multimodal Logit model is given as

$$P_i = e^{U(i)} / \sum_{r=1}^{n} e^{U(r)}$$

Where: U(i) = utility of mode i

U(r) = utility of mode r

n = number of modes available

[15 marks]

Question 2

Table 2.1 gives statistics of trip productions for a Municipality demarcated into seven (7) zones.

Table 2.1 Annual Trip Productions

Zone	Populations	Numbers employed	Trip Productions
A	7 500	775	22 000
B	4 000	3 500	11 500
C	6 000	700	17 500
D	5 000	4 000	14 500
E	9 000	1 000	26 500
F	6 000	3 000	17 500
G	4 000	800	11 500

(i) Develop a Trip Generation relationship between X_1, X_2 and Y. Comment on the significance of your equation.

(ii) What is the expected Trip to be generated if the population is 3600 with 580 employed in the formal sector of the economy?

(iii) Calculate the Standard error of the regression model in (i) and interpret its significance with respect to the answer in (ii) above.

(iv) Estimate the Coefficient of Determination, and briefly discuss the significance of your answer.

[25 marks]

[Hint: important formulae:

$$\Sigma Y = na + b_1\Sigma X_1 + b_2\Sigma X_2$$

$$\Sigma X_1 Y = a\Sigma X_1 + b_1\Sigma X_1^2 + b_2\Sigma X_1 X_2$$

$$\Sigma X_2 Y = a\Sigma X_2 + b_1\Sigma X_1 X_2 + b_2\Sigma X_2^2$$

Se = Square root of $\{\Sigma (Y - \hat{Y})^2 / (n-k-1)\}$

Where Se = Standard error

Y = Sample values of the dependent variable

Y = Corresponding estimated values from the regression

n = number of zones

k = number of independent variables

$$R^2 = 1 - \frac{\Sigma (Y - \hat{Y})^2 / (n-k-1)}{\Sigma (Y - \bar{Y})^2 / (n-1)}$$

Question 3

A transport study is being undertaken incorporating three zones 1, 2 and 3. The estimated future work trip production and attractions are presented in Table 3.1 The travel costs between these zones in generalised time units as well as the disincentive to travel (in the form of friction factors) are given in Tables 3.2 and 3.3 respectively. Table 3.4 provides the socio-economic adjustment factors. Compute the expected zonal trips (up to the 2nd iteration only). State the adjustment values for the 3rd iteration.

Table 3.1: Annual Trip Generation data

Zone	1	2	3
Trip Productions	11 500	17 500	14 500
Trip Attractions	10 300	13 200	20 000

Table 3.2: Travel times (minutes)

i \ j	1	2	3
1	1	6	11
2	7	3	12
3	15	13	4

Table 3.3: Friction factors

i \ j	1	2	3
1	0.876	1.554	0.77
2	1.554	0.876	0.77
3	0.77	0.77	0.876

Table 3.4 Socio-economic activities adjustment factors

i \ j	1	2	3
1	1.04	1.15	0.66
2	1.06	0.79	1.14
3	0.76	0.94	1.16

[Hint: use this variant of the Gravity model equation:

$$T^{m}_{i-j} = \left[\frac{P_i * (A_j F_{ij}^{m} * K_{ij})}{\sum_{j=1}^{n} (A_j F_{ij}^{m} * K_{ij})} \right]_p$$

Adjustment factor: $A_{jk} = A_j * \frac{A_{j(k-1)}}{C_{j(k-1)}}$

where each symbol has its usual meaning.

[25 marks]

Question 4

Five warehouses are supplied weekly by four factories manufacturing tyres. The supply available from each factory, demand at each warehouse and the cost (Rand) per unit of transporting tyres from the factories to the warehouses are summarised in Table 4.1.

Table 4.1

	W1	W2	W3	W4	W5	Supply
F1	13	9	15	10	12	***400***
F2	11	10	12	12	9	***100***
F3	12	9	11	12	9	***200***
F4	13	12	13	12	10	***100***
Demand	***120***	***150***	***200***	***150***	***180***	

If X_{ij} is the quantity of tyres transported from Factory i to Warehouse j at a unit cost of C_{ij},

(i) Formulate the transportation problem as a linear programming model

(ii) Use (a) the North-West Corner method and (b) The least Cost method to determine the initial basic feasible solution of the transportation problem; comment on the significance of the two solutions

(iii) Hence find the optimum solution using the Stepping Stone Method based on the initial basic feasible solution obtained from the **North-West Corner method.**

[25 marks]