



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 510: LOGISTICS AND SYSTEM ANALYSIS IN TRANSPORTATION

DATE: 20TH JANUARY, 2025

TIME: 11.00 AM – 1.00 PM

INSTRUCTIONS:

Answer question ONE (Compulsory) and any other TWO questions

QUESTION ONE (COMPULSORY) 30 MARKS

- a) Define the term Logistic as used in transportation planning (2mks)
- b) Outline the main components of s transportation system (3mks)
- c) Describe the four modes of transportation, providing advantages in each case. (5mks)
- d) Explain the main reason for recent focus on using Electric Vehicles (5mks)
- e) Describe the challenges facing Electric vehicles (5mks)
- f) Describe factors affecting elasticities of demand for a transport service (10mks)

QUESTION TWO - 20 MARKS

- a) Discuss the factors to consider when undertaking a financial feasibility analysis for a transportation project (5mks)
- b) Define the term sustainable transport system (3mks)
- c) Explain the three sustainable transport goals (6mks)
- d) Three alternative road projects all integrated with non-motorized

transportation were selected for a neighborhood to improve mobility of people. The transport planner has to select the best alternative based on increased safety and reduced emissions resulting to improved health quality. The economic life for the project is considered to be 10 years with interest rate of 3%. (All monetary value is in thousands (“1000”).

Determine the best alternative for the neighborhood using these two economic analysis techniques

i) Use of Net Present worth analysis Method (3mks)

ii) Benefit to cost (B/C) ratio method (3mks)

<i>Alternatives</i>	<i>Initial cost of construction</i>	<i>Annual savings in Accidents</i>	<i>Annual emission savings</i>	<i>Annual health savings</i>	<i>Annual maintenance cost</i>
A=Road constructed and Street provided with proper foot path	60000	5000	3000	500	1500
B= Road constructed with Public Bicycles sharing System	40000	5000	6500	1000	2500
C= Road Constructed with Public bicycles Sharing Integration with public transport	90000	7000	6000	1000	3000

Table Qn.2d. Road design financial data:

QUESTION THREE - 20 MARKS

a) Discuss the distribution of transportation Networks in Kenya at the national level (6mks)

b) Describe the main types of transportation carrier network types (6mks)

c) (i) Calculate the change in consumer surplus and the price elasticity of demand for Citi Hopper bus operating in Nairobi CBD given the following field data:

(ii) Explain whether the company lose income

- Assume all existing buses had a load factor of 90% and it is expected that the improvement will result in a 95% load factor.
- Assume that all the busses in the fleet are being used during the peak hour

- The vehicle load factor is a measure of seat availability and a load factor of 1.0 means that every seat is occupied.
- Citi Hopa Bus Company with an existing fleet of 40 seater capacity buses increases its fleet size by 20% and reduces its fare from Kshs.100 to 90 per ride.

(8mks)

QUESTION FOUR - 20 MARKS

- Explain by using appropriate examples the purpose of undertaking inventory studies on transportation systems (10mks)
- Determine the price elasticity of demand for a transportation mode given the following field data;
 - An aggregate demand function is represented by equation $q = 200 - 10p$
 - Where q is the number of trips made and p is the price per trip.

Table Qn4b. Trips Vs price per trip

Trips (q)	0	50	100	150	200
Price per trip, p (KShs.)	20	15	10	5	0

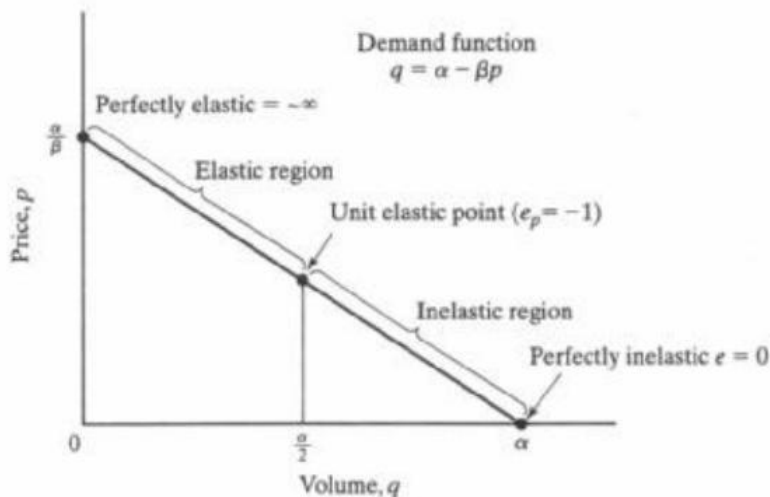


Fig. Qn.4b. General Linear demand function showing elasticities

(10mks)

QUESTION FIVE - 20 MARKS

- a) Define the term system operation design for a public transport (6mks)
- b) Determine the number of passenger carried by a train.

The following data was obtained from the field:

- Assume 170 passengers sit in each car compartment).
 - Train clearance time is 50 seconds
 - A three –car light rail transit line operates on city streets through signalized intersections.
 - The $g/C = 0.45$ and the passenger dwell time is 90 seconds. (4mks)
- c) Thus the cost of transportation can be thought of as consisting of costs incurred by two parties, namely the agency cost and the user cost.
- Explain the difference between agency costs and user costs by giving appropriate examples (6mks)
- d) Outline any four major emerging transportation technologies (4mks)

APPENDICES

Capacity of Urban Transit

$$c_p = f'O_1 + [(1800 - 1.5f')O_2]$$

where

f' = number of buses per hour

O_1 = bus occupancy

O_2 = car occupancy

c_p = person capacity (persons/hr)

The capacity of a transit line can be estimated from the following equations:

$$c_v = \frac{3600R}{h} = \frac{3600R}{D + t_c}$$

$$c_p = nSc_v = \frac{3600nSR}{D + t_c}$$

where

c_v = vehicles/hr per channel (maximum)

c_p = people/hr per channel (maximum)

h = headway between successive vehicles (sec)

t_c = clearance between successive vehicles (sec)

D = dwell time at major stops (sec)

S = passengers per vehicle

n = vehicles per unit ($n = 1$ for buses; $n = 1$ to 11 for rail)

R = reduction factor for dwell time and arrival variation

= 0.833 for bus operation on city streets

If g = green time (sec) and C = cycle time (sec) for transit running on signalized streets, then

$$c_p = \frac{(g/C)3600nSR}{(g/C)D + t_c}$$

$$D = \frac{P_d t_{pf}}{N_{cd}} + t_{oc}$$

where

D = dwell time, s

N_{cd} = number of channels per door for moving passengers

t_{oc} = door opening and closing time, s

P_d = alighting passengers per rail through busiest door (p), and

t_{pf} = passenger flow time, (seconds per person),

Rail Transit Average passenger Flow Times (single streams)

Car Entry	Passenger Flow Time t_{pf} for Flow Type (s/p)		
	Mainly Boarding	Mainly Alighting	Mixed Flow
Level	2.0	1.5	2.5
Steps	3.2	3.7	5.2

Note: Add 1 sec to mixed flow and either boarding or alighting times if fares are collected on board.

Source: TRB, 2000.

Rail Operation Design

Volume is related to headway given by

$$V = \frac{3600}{h}$$

V is traffic Volume and h is time in hours

capacity

$$c_v = \frac{3600}{h_m}$$

where c_v is the theoretical vehicular capacity or maximum volume (veh/hr), and h_m is the minimum headway (sec). Theoretical passenger capacity is given by

$$c_p = pNc_v = \frac{3600pN}{h_m}$$

where

c_p = theoretical passenger line capacity (number of passengers)

p = vehicles/train

N = maximum passenger per vehicle

actual vehicle capacity is given by

$$c_a = \frac{3600\alpha}{h_m}$$

$$\text{Actual passenger capacity} = \frac{3600 \times \sigma \times \alpha \times p \times N}{h_m}$$

Bus Operation Design

headway of a bus stop

$$h_m = 2t_d/60$$

where h_m is the minimum headway between buses (minutes), and t_d is the average dwell time in seconds.

compute dwell time.

$$t_d = P_a t_a + P_b t_b + t_{oc}$$

Where:

t_d = dwell time, s

P_a = alighting passengers per bus through the busiest door during peak 15-min (p)

t_a = passenger alighting time, sec/person (s/p)

P_b = boarding passengers per bus through busiest door during peak 15-min (p)

t_b = passenger boarding time (s/p)

t_{oc} = door opening and closing time (s)

$$P_{15} = \frac{P}{4(\text{PHF})}$$

Where:

PHF = peak-hour factor

P = passenger volume during peak hour (p)

P_{15} = passenger volume during peak 15 min (p).

The passenger capacity of a bus is given by

$$c_t = c_a + \alpha c_b$$

Where:

c_t = total passenger capacity per vehicle

c_a = vehicle seating capacity

c_b = vehicle standing capacity

α = fraction of c_b allowed

capacity R_c of a bus routing during any time period is

$$R_c = \frac{60c_t}{h_m} = \frac{60(c_a + \alpha c_b)}{h_m}$$

The number of vehicles needed (fleet size)

$$N_f = St_R = \frac{t_R}{h}$$

where N_f is the fleet size, and S is the service frequency, which equal 1/headway.