



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

Department of BUILDING & Civil engineering

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 4413 : TRAFFIC ENGINEERING III

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** questions.

Attempt question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

QUESTION ONE (Compulsory)

- a) Explain clearly the following aspects of a service system:
- i) The configuration of the service system and
 - ii) The speed of the service (8 marks)
- b) Describe the **TWO** main categories of queue discipline (6 marks)
- c) Briefly describe the 'Poisson distribution' and its relevance in queuing analysis. (4 marks)
- d) Using diagrams, describe a deterministic queuing analysis method for signalized road intersection. (6 marks)
- e) Explain why queues form and give **FOUR** clear examples of how queuing problems can be addressed in various places where they occur. (6 marks)

QUESTION TWO

- a) Describe the factors that characterize the input source of a queue. (10 marks)
- b) Differentiate between saturation and under saturation as used in queuing systems. (4 marks)
- c) Vehicles arrivals at a national park main gate are assumed poisson distributed with an average arrival rate of 1 vehicle every 5 minutes. What is the probability of the following:
 - i) Exactly two vehicles arrive in a 15 minutes interval
 - ii) Less than 2 vehicles arrive in a 15 minutes interval
 - iii) More two vehicles arrive in a 15 minutes interval (6 marks)

QUESTION THREE

- a) Using diagrams of cumulative customers vs time, illustrate the following special situations frequently encountered in transportation queuing analysis giving one example for each case.
 - i) Constant arrival rate vs constant service rate
 - i) Constant arrival rate vs varying service rate
 - ii) varying arrival rate vs varying service rate
 - iii) varying arrival rate vs constant service rate (8 marks)
- b) With the aid of queuing diagrams, explain queuing patterns when service rates vary over time while arrival rates are constant for incident situation on a highway (5 marks)
- c) An observer counts 360 vehicles/h at a specific highway location. Assuming that the arrivals of vehicles at this highway location is poisson distributed, estimate the probabilities of having 0, 1, 2, 3, 4, and 5 or more vehicles arriving over a 20-second time interval (7 marks)

QUESTION FOUR

a) Briefly explain the 'Little Law' as used in queuing analysis. (3 marks)

b) **Why is examination of queuing important in traffic engineering?** (3 marks)

c) You are now in line to get into the Arena. There are 3 operating turnstiles with one ticket-taker each. On average it takes 3 seconds for a ticket-taker to process your ticket and allow entry. The average arrival rate is 40 persons/minute.

Find the:

- i) average length of queue,
- ii) average waiting time in queue assuming M/M/N queuing.

d) At a roundabout, if the arrival rate is 1 vehicle every minute and the service rate is 1 vehicle every 45 seconds, find:

- i) the average queue size,
- ii) the average waiting time, and
- iii) average total delay. Assume an M/M/1 process.

(7 marks)

QUESTION FIVE

a) With the aid of a flow chart briefly describe the stochastic queuing analysis method. (6 marks)

b) Explain the **THREE** 'human behavior' encountered in queues (6 marks)

c) **At the exit of a toll gate with a single booth, vehicle arrive at random at a rate of 20 vehicles per minute. The service has an average rate of 22 vehicles per minute.**

Estimate the following:

(i) Average length of queue formed at the toll gate.

(ii) Average waiting time of vehicles.

(iii) Average time vehicles spent in the system. (8 marks)