

The Open University of Sri Lanka
Faculty of Engineering Technology
Department Electrical and Computer Engineering



Study Programme	: Bachelor of Software Engineering (Hons)
Name of the Examination	: Final Examination
Course Code and Title	: EEX5362 Performance Modelling
Academic Year	: 2024/2025
Date	: 17 th February 2026
Time	: 13:30 – 16:30 hrs
Duration	: Three (3) hours

General Instructions

- Read all instructions carefully before answering the questions.
- This paper consists of Five (5) questions in Four (4) pages.
- Answer **ALL** Questions. All questions carry equal marks.
- Answers for each question should commence from a new page.
- Try to write answers in point form.
- This is a **Closed Book Test (CBT)**.
- Answers should be in clear handwriting.
- Do not use any colour pen other than blue/black.
- General Examination Guidelines of the OUSL are applicable.

Question 01

- A. What is meant by “performance modeling” in computer systems? (05 Marks)
- B. Mr. ABC is an undergraduate student at OUSL. He believes that learning Performance Modeling is **not important** for software engineering students. Explain why a software engineering student needs to have a good understanding of Performance Modeling. (05 Marks)
- C. Customers arrive at a service desk at an average rate of 4 customers per hour. Moreover, an average rate of 3 customers per hour was served by the service desk.
- a. Write down 3 assumptions that you need to solve this problem. (05 Marks)
 - b. What is the probability that exactly 2 customers arrived and served in one hour? (05 Marks)

Question 02

- A. What is meant by capacity planning? (05 Marks)
- B. A company hosts a cloud-based web application on virtual machines (VMs). During peak hours:

- Each user sends 3 requests per minute.
- 5,000 users access the application
- Each VM can process 200 requests per second.
- The cloud provider recommends keeping VM utilization below 65% to ensure good performance.

By considering above information, answer the following questions. You could get suitable assumptions. Please write clearly the assumptions that you have made.

- I. Calculate the total number of requests per second generated by users during peak time. (05 Marks)
- II. Determine the minimum number of VMs required to handle the peak load. (05 Marks)
- III. Explain one advantage of using cloud resources for capacity planning in this situation. (05 Marks)

Question 03

- A. Explain Poisson distribution using a suitable example. (05 Marks)
- B. A student registration queue is analyzed and modelled as an M/M/1 queue.

Measurements shown below:

- a. Average arrival rate, $\lambda = 9$ students/hour
- b. Average service rate, $\mu = 10$ students/hour
- c. Queue utilization $\approx 90\%$

Using the standard M/M/1 formulas, the analyst concludes the system is *stable and acceptable*.

However, in practice:

- During peak periods, queues grow rapidly and users experience timeouts.
- After peaks, the system takes a long time to recover.
- Average response time over a day remains within service level agreement.

By considering the above information, answer the following questions. You can make suitable assumptions. Please write clearly the assumptions that you have made.

- I. Explain why M/M/1 results are misleading in this real system. (05 Marks)
- II. Write down two real-world assumptions of the M/M/1 model that are likely violated. (05 Marks)
- III. Propose a more realistic queueing model or analysis approach and justify how it better explains the observed behavior. (05 Marks)

Question 04

- A. Explain "Mean-value analysis" using a suitable real-world example. (05 Marks)
- B. A closed network model of an LMS (Learning Management System) backend is analyzed using Mean-Value Analysis (MVA).

The system consists of:

- A Central Processing Unit (CPU) (Considered as a single server)
- A Database (single server)
- A Logging service (infinite server)

The number of concurrent users (N) is gradually increased. Then, MVA results show:

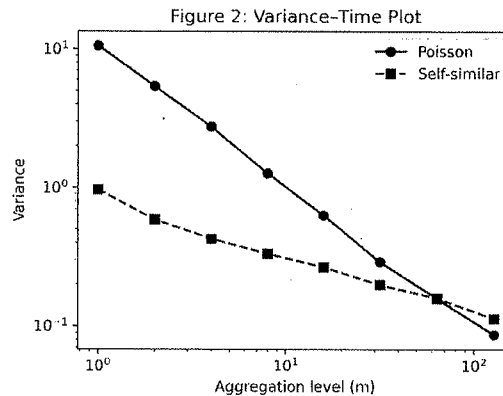
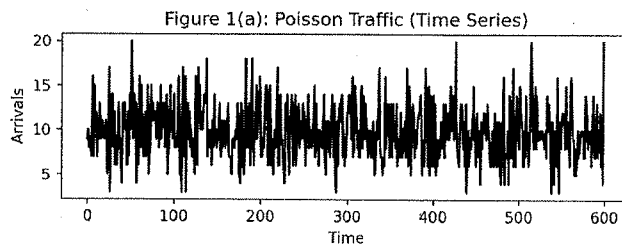
- System throughput increases linearly for small N
- CPU utilization approaches 95% as N grows to 75%
- Average response time increases non-linearly after a certain N
- Database queue length remains small compared to CPU

By considering the above information, answer the following questions. Students can make suitable assumptions. Please write clearly the assumptions that you have made.

- I. Explain why response time increases sharply even though only one device appears highly utilized. (05 Marks)
- II. Using MVA reasoning, explain how the CPU becomes the system bottleneck and dominates end-to-end performance. (05 Marks)
- III. Explain why optimizing the database will have negligible impact on system throughput at high N , even if database service time is reduced. (05 Marks)

Question 05

- A. What is a stochastic process? Give a simple real-life example to explain it. (05 Marks)
- B. Consider the scenario below related to network traffic modeling. Figures 1(a), 1(b) and 2 show characteristics of two different network traffic models.
- Figure 1(a) shows the time-series of the arrivals of network packets using a Poisson process.
 - Figure 1(b) shows the time-series of arrivals network packets using a self-similar traffic model.
 - Figure 2 shows the variance–time plot for both traffic types.



By considering the above information, answer the following questions. You could get suitable assumptions. Please write clearly the assumptions that you have made.

- a. State one clearly visible difference between the two time-series plots. (07 Marks)
- b. Explain one reason why self-similar traffic is more challenging than Poisson traffic when designing network buffers or planning system capacity. (08 Marks)

----- END OF THE PAPER -----