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

Study Programme	: Bachelor of Software Engineering in Honours
Name of the Examination	: Final Examination
Course Code and Title	: **EEX5362 Performance Modelling**
Academic Year	: 2021/22
Date	: 14th February 2023
Time	: 13:30 – 16:30 hrs.
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Five (5)** pages.
3. Answer **all** questions in **Part I** and **any two (2)** questions in **Part II**.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test **(CBT).**
6. Answers should be in clear handwriting.
7. Do not use red colour pen.
8. Clearly state your assumptions, if any.

Part I: Answer all questions [60 Marks]

Q1 [40 Marks]

Figure Q1 shows a software performance modelling (SPM) approach that can be used to performance study of any software system. The subprocesses are denoted from **A** to **J**.

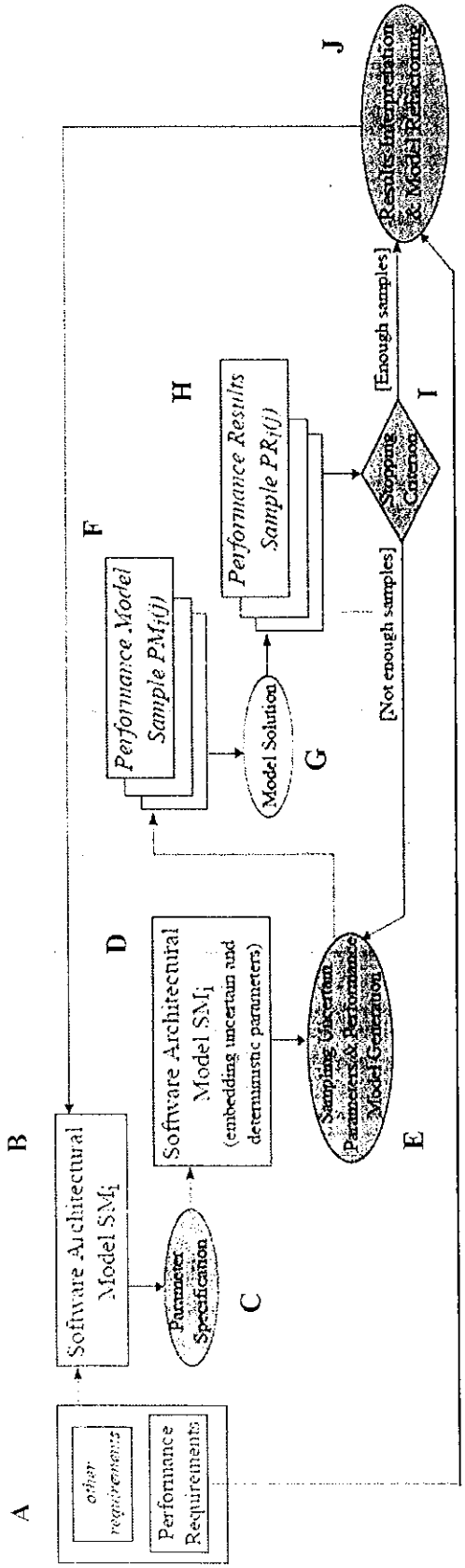


Figure Q1: Software performance modelling (SPM) approach.

Answer to the following:

(a) The given SPM approach can be break down into four phases, explain each phase. [16]

(b) What is the crucial step among above four phases, explain why it is the crucial. [04]

(c) Suggest any real-world application for analyze the performance by using this SPM approach and briefly describe your selected system. [04]

(d) Describe three performance requirements for your selected application. [06]

(e) Briefly describe three uncertain parameters that occur in your application. [06]

(f) Describe two methods that you can use to interpret your results. [04]

Q2 [20 Marks]

(a) Describe two types of queuing networks with an example for each type. [04]

(b) Explain the below characteristics in a queuing system [04]

i) Queue discipline ii) Service mechanism

(c) Quick Suppliers is a distribution centre for hardware material and items needed for building construction work. Trucks loaded with bricks arrives to be unloaded at the Quick Suppliers. It is noted that trucks arrive at an average rate of two trucks per hour, following the Poisson distribution. A worker can unload one truck in two hours' time. Consider this as a single channel queuing system answer the below questions.

i) Based on the condition that the utilization factor (λ/μ) must be less than one, calculate the minimum number of workers needed. [02]

ii) Calculate the probability that the queuing system is idle. [02]

iii) Calculate the average number of lorries in the queue. [02]

iv) Calculate the average time a lorry spends in the queue to get the service. [03]

(d) A worker who unloads a truck is being paid Rs. 20 per hour whether busy or idle. The cost of a truck being idle (waiting to be serviced) is Rs. 100 per hour. Assuming that there are 5 workers, calculate the total idling cost per hour. [03]

Part II: Answer any two questions [40 Marks]

Q3 [20 Marks]

(a) The Kendall notation is very useful to denote any queuing model. Describe the Kendall notation for queues. [05]

(b) If an M/M/1 queue has utilization of 80% and the arrival rate is 100 jobs per second, compute: [04]

i) its mean queue length, ii) the mean response time.

(c) If an M/D/1 queue has utilization of 80%, what do you expect its mean queue length and response time each to be: *less*, *same*, or *greater* than of an M/M/1? Explain your answer for both parameters. [06]

(d) Little's law is a practical theory for various queuing systems.

i) State the Little's law and explain its formula. [03]

ii) A monitor on a disk server showed that the average time to satisfy an I/O request is 100 milliseconds. The I/O rate is about 6000 requests per minute. What is the mean number of requests at the disk server? [02]

Q4 [20 Marks]

(a) Poisson distribution is one of the important topics in calculating the possibilities for an event with the average rate of value. Answers to the followings.

i) State the formula for the Poisson distribution function of a random variable X and write the meaning of each term. [04]

ii) State and proof the mean of the Poisson distribution formula you wrote in i). [06]

(b) A shop is selling a particular type of a cell phone which is very popular among customers due the quality, durability, and the reasonable price. The shop owner noted that on average he sells three (3) cell phones per week. Assume the weekly demand for the cell phone follows a Poisson distribution to answer the followings.

i) Find the probability that the shop sells at least 3 cell phones in a week, [03]

ii) Find the probability that the shop sells at most 5 cell phones in a week. [03]

iii) Based on the assumption that stocks are replenished only at the beginning of each month, find the minimum number of cell phones that should be in stock at the beginning of a month so that the shop can be at least 95% sure of being able to meet the demand during the month. [04]

Q5 [20 Marks]

(a) The probability theory is usually applied for performance modelling in software systems. Answer to the following questions:

i) Why we need to build models? [02]

ii) What is the performance measure of most interest in information systems? [02]

iii) Why is probability theory being interest to performance of software systems? [02]

iv) Consider an unfair six-sided die where the probability of rolling a "1" is three times the probability of rolling any other value. All other values have the same probability of occurring. Let X be the random variable that takes on values 1 through 6 for our unfair dic. Determine the mean of X. [04]

(b) A computer consists of three processors and main task is to execute jobs from users. These jobs arrive according to a Poisson process with rate 15 jobs per minute. The execution time is exponentially distributed with mean 10 seconds. When a processor completes a job and there are no other jobs waiting to be executed, the processor starts to execute maintenance jobs. These jobs are always available, and they take an exponential time with mean 5 seconds. But as soon as a job from a user arrives, the processor interrupts the execution of the maintenance job and starts to execute the new job. The execution of the maintenance job will be resumed later (at the point where it was interrupted). Answer to the followings:

i) What is the mean number of processors busy with executing jobs from users? [02]

ii) How many maintenance jobs are on average completed per minute? [02]

iii) What is the probability that a job from a user must wait? [03]

iv) Determine the mean waiting time of a job from a user. [03]

-- End --

Queuing theory formulas

A. The average number of customers or units in the system, L, that is, the number in line plus the number being served: $L = \lambda/(\mu-\lambda)$

B. The average time a customer spends in the system, W, that is, the time spent in line plus the time spent being served: $W = 1/(\mu-\lambda)$

C. The average number of customers in the queue $L_q = \lambda^2 / \mu\,(\mu-\lambda)$

D. The average time a customer spends waiting in the queue. $W_q = \lambda / \mu\,(\mu-\lambda)$
