UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE FOUR

MODELLING AND SIMULATION

Tuesday 16 April 1996

16:00 to 17:30

Examiners:

A. D. McGettrick (External)

M. P. Fourman (Chairman)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

1. (a) Each of the paragraphs below describes a scenario in which someone needs to conduct performance analysis in order to derive information about a system. For each scenario explain which approach you think should be used for the analysis of the system and to find the required performance measure. Your answer should explain why the approach you suggest is appropriate for the problem to be solved.

   i. A system manager in a busy office where employees use a transaction processing system to answer telephone queries has just learned that 10 new employees will be starting work tomorrow. He needs to find out how the response time of the system will be affected.

   [5 marks]

   ii. A modeller is engaged in a detailed performance study, using a queueing network, of the disk subsystem of a complex system. She needs to find out how many "classes" of jobs use the existing disk subsystem and their average arrival rates.

   [5 marks]

   iii. The operations manager of the London Underground Computerised Control System has commissioned a performance analyst to undertake a nine month project. The objective of the project is to find out how quickly the system can be fully operational again after various forms of error and/or failure.

   [5 marks]

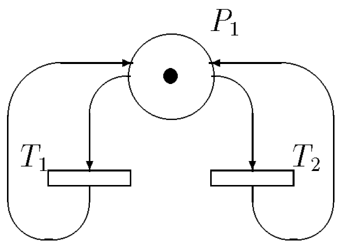
   iv. In a flexible manufacturing system a robotic arm needs to be replaced. In operation the robotic arm needs to have access simultaneously to a conveyor belt and a pallet. Two possible replacement robotic arms have been identified on the basis of cost. A performance modeller has been asked to compare the two and provide a recommendation in four weeks' time based on which robot will give the greater average throughput.

   [5 marks]

(b) Traditionally users have been modelled in interactive systems by "think time"—usually a considerable delay. Discuss the extent to which this model still applies to modern systems such as those run in the department, i.e. workstations running UNIX and X-windows.

[5 marks]

2. We consider variations of the simple GSPN shown below.



(a) Explain how the conflict between transition T_1 and transition T_2 is resolved in each of the following cases:

i. T_1 is a timed transition and T_2 is a timed transition (illustrated in the diagram).

ii. T_1 is an immediate transition and T_2 is an immediate transition.

iii. T_1 is a timed transition and T_2 is an immediate transition,

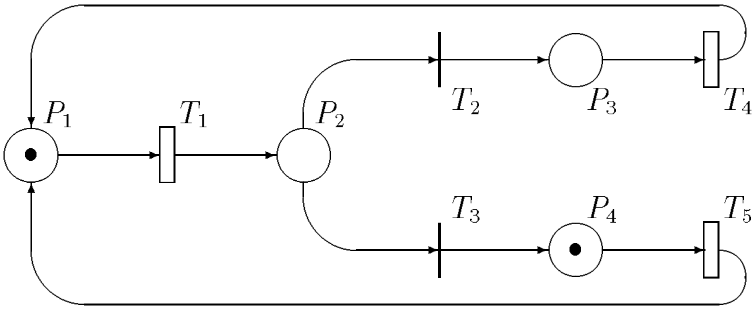
[6 marks]

(b) Assuming that T_1 is a timed transition with single server semantics and T_2 is a timed transition with infinite server semantics, what effect will increasing the initial marking of P_1 have on the throughput of T_1 and T_2? Justify your answer.

[5 marks]

Question continued on next page

The GSPN model shown below represents a system with two subsystems, S_1 and S_2, represented by P_3, T_4 and P_4, T_5 respectively. Each job is processed centrally (P_1,T_1) and then selects processing in subsystem S_1 by firing T_2 or processing in subsystem S_2 by firing T_3. 30% of jobs go to S_1 and 70% go to S_2. After processing in a subsystem, a job returns for central processing and then repeats the same cycle of behaviour, possibly selecting a different subsystem each time.



(c) List all the vanishing markings of the GSPN with the initial marking shown. Briefly explain how these would be eliminated from the reachability graph.

[6 marks]

(d) Explain how you would use the GSPN model to derive the average waiting time for a job in subsystem S_1.

[8 marks]

3. (a) Explain why it is sufficient to derive performance measures from a single solution of a GSPN model but it is necessary to run a simulation model several times.

[5 marks]

(b) When running a series of experiments on a simulation model, replication and regeneration can be important techniques. Give a definition of each of these techniques and explain how they are used.

[6 marks]

(c) A performance analyst has constructed a simulation model of a communication network. Describe two different methods which he can employ to validate the model before using it predictively. Include examples of how these methods are used in your description.

[8 marks]

(d) Preliminary experiments with the model (considered in part (c)) have generated the performance estimates shown in the table below. Each message in the system generates 10 packets at Node 1 and 10 packets at Node 2.

Throughput of System (in messages/second)	Utilisation of Node 1	Utilisation of Node 2	Transmission time at Node 1 (milliseconds/packet)	Transmission time at Node 2 (milliseconds/packet)
25	50%	95%	2	3

Based on the data in the table do you think that the model is correct? Explain your reasoning.

[6 marks]