57:022 Principles of Design II
Midterm Exam - Spring 1993

Part:	I	II	III	IV	Total
Possible Pts:	15	15	15	15	60
Your score:	_____	_____	_____	_____	_____

PART I

We wish to simulate persons arriving at an elevator on the first floor of the Engineering Building at the average rate of 5/minute in a completely random fashion, starting at time t=0. Eighty percent of the persons are engineering students.

Write the alphabetic letter corresponding to the name of the probability distribution which each of the following random variables has. Warning: some distributions may apply in more than one case, while others not at all!

___ 1. the time of arrival of first person
___ 2. the number of persons arriving during the first minute
___ 3. the time between arrival of first and second persons
___ 4. the sequence number of the first non-engineering student.
___ 5. the number of engineers among the first 10 persons to arrive
___ 6. the total weight of the passengers when the elevator is full
___ 7. the weight of the heaviest passenger when the elevator is full
___ 8. the time of arrival of the fourth passenger

a. uniform b. geometric c. Bernouilli d. binomial
e. normal f. Weibull g. Gumbel h. exponential
i. Poisson j. Erlang k. chi-square
m. none of the above

Write the alphabetic letter below corresponding to the numerical value of the following probabilities:

___ 9. probability that the first passenger has already arrived at time t=0.1
___ 10. probability that exactly 5 passengers arrive during the first minute.
___ 11. probability that four of the first five passengers are engineers.
___ 12. probability that the first non-engineer is the fifth person to arrive.

n. $\frac{(0.8)^5}{4!} e^{-5}$ o. $1 - e^{-0.5}$ p. e^{-5} q. $\frac{5^5}{5!} e^{-5}$
r. $\binom{5}{4}\left(\frac{4}{5}\right)^4\left(\frac{1}{5}\right)$ s. $\left(\frac{1}{5}\right)^4\left(\frac{4}{5}\right)$ t. $1 - e^{-5}$ u. $e^{-0.5}$
v. $\binom{5}{4}\left(\frac{1}{5}\right)^4\left(\frac{4}{5}\right)$ w. $\left(\frac{4}{5}\right)^4\left(\frac{1}{5}\right)$ x. none of the above

PART II

A system consists of five components (A,B,C,D, & E). The probability that each component *survives* the first year of operation is 80% for A, B, & C, and 90% for D & E. For each alternative of (1) through (4), indicate:

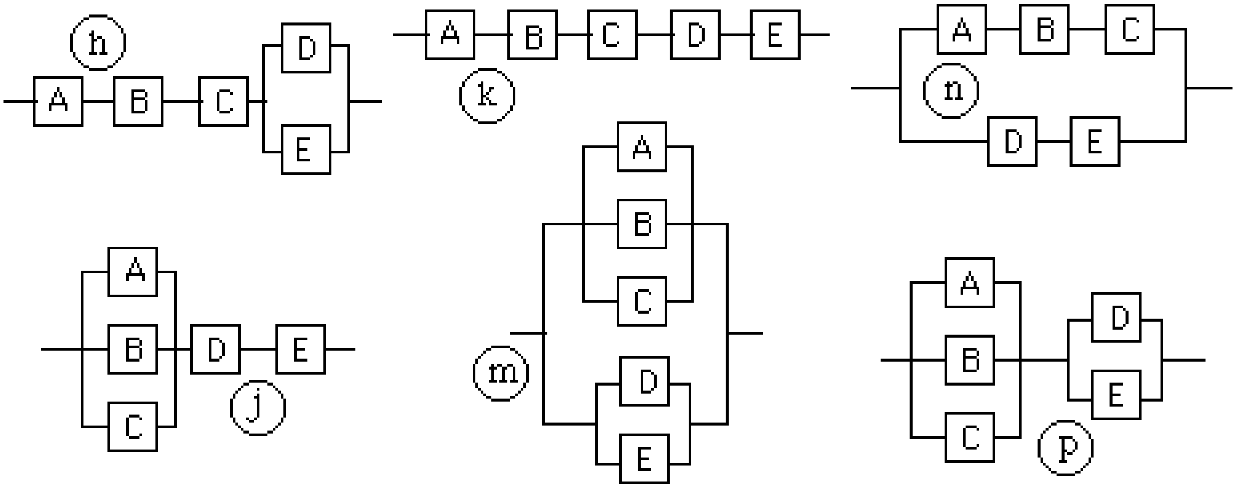
(i) the letter of the reliability diagram below which represents the system
(ii) the letter of the SLAM network model which represents the system
(iii) the letter with the computation of the 1-year reliability (i.e., survival probability)

i.	ii.	iii.	
___	___	___	1. The system can function only if A, B, & C all function or if D & E both function.
___	___	___	2. The system requires at least one of A, B, & C, and at least one of D & E.
___	___	___	3. The system requires at least one of A ,B, & C, and both of D & E .
___	___	___	4. The system requires all of A, B, & C, and at least one of D & E.

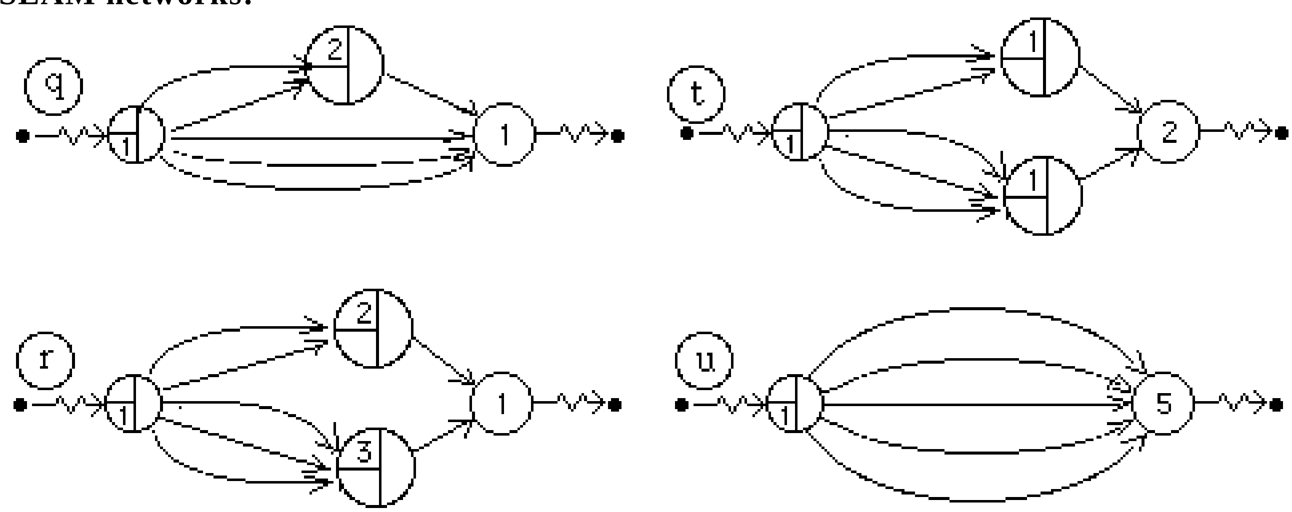
Reliabilities:

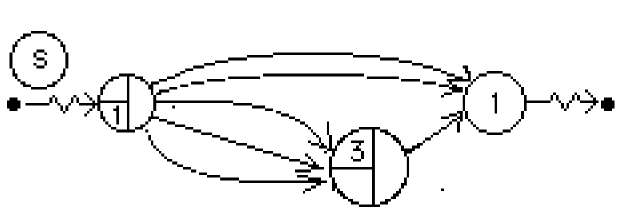
a. $1 - (0.2)^3(0.1)^2$ c. $(0.8)^3[1-(0.1)^2]$ e. $[1-(0.2)^3](0.9)^2$
b. $[1-(0.2)^3]\ [1-(0.1)^2]$ d. $(0.8)^3(0.9)^2$ f. $1- [1-(0.8)^3][1-(0.9)^2]$
g. None of the above

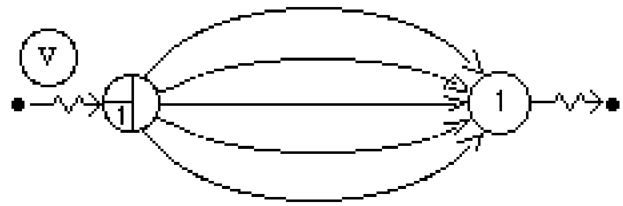
Diagrams:



SLAM networks:



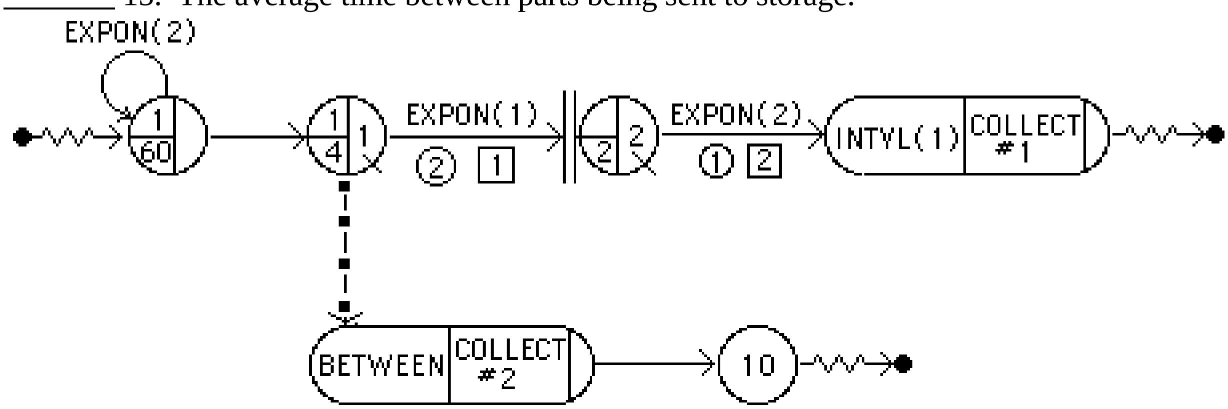




PART III

Consider the SLAM II network and its output below. Arriving parts must be processed at two machine centers. Each machine center has limited storage space for waiting parts. Parts which arrive and cannot be stored at the first machine center are sent elsewhere for storage, to be processed at a later time.

________ 1. The average time between arrivals.
________ 2. The total number of servers in the system.
________ 3. The number of entities in the system initially.
________ 4. The capacity of the first queue.
________ 5. The fraction of the time that the first server(s) is/are busy.
________ 6. The fraction of the time that the second server(s) is/are idle.
________ 7. The average time which entities spend in the system.
________ 8. The average time which entities spend in the queues.
________ 9. The number of entities which are created during the simulation.
________ 10. The longest time that any entity spent in the system.
________ 11. The average number of entities waiting in the system.
________ 12. The longest stretch of time which the second server(s) worked without a break.
________ 13. The time at which the simulation ended.
________ 14. The number of parts sent to storage.
________ 15. The average time between parts being sent to storage.



SLAM II SUMMARY REPORT

RUN NUMBER 1 OF 1

CURRENT TIME 0.1021E+03
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF.OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NO.OF OBS
COLLECT#1	0.133E+02	0.461E+01	0.347E+00	0.369E+00	0.208E+02	43
COLLECT#2	0.823E+01	0.111E+02	0.134E+01	0.607E+00	0.331E+02	9

FILE STATISTICS

FILE NO.	LABEL/TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	QUEUE	1.935	1.453	4	4	3.952
2	QUEUE	1.901	0.383	2	2	4.220
3	CALENDAR	2.372	0.581	5	2	0.868

**SERVICE ACTIVITY STATISTICS

ACTACT NUM	LABEL OR START NODE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
1	QUEUE	2	0.377	0.59	0	1.39	2.00	2.00	46
2	QUEUE	1	0.995	0.07	1	0.00	0.45	101.31	43

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Fortran STOP
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PART IV

Complete the SLAM network below which could be used to model the following system (or draw your own network "from scratch"):

- Widgets come off an assembly line at a constant rate of 2/minute to be inspected, adjusted if necessary, and packaged for shipment.
- There are two inspectors, and inspection time is normally distributed with mean 1 minute, and standard deviation 0.25 minute.
- An average of 5% of the widgets will fail inspection and must be sent to be adjusted by a single worker. Adjustment time is normally distributed with mean 2 minutes and standard deviation 0.5 minute.
- After adjustments, the widgets are sent to be packaged (without reinspection).
- A maximum of 12 widgets can await inspection; any arriving widgets while 12 widgets already await inspection are sent directly to be packaged, without inspection.
- Widgets are packaged in cartons, with 6 widgets/carton. After the carton is filled, it is prepared by a single shipping clerk for shipping, requiring between 1 and 2 minutes (uniformly distributed).