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57:022 Principles of Design II

Quizzes Spring '96

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<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #1** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

Write the <u>number</u> corresponding to the correct probability distribution in each blank below. Note that some distributions may apply in more than one case, while others may not apply at all!

A telephone exchange (for ticket reservations, for example) contains 10 lines. A line can be busy or available for calls and all lines act independently. Each line is busy 75% of the noon period (so that the probability that a specified line will be busy at any given time during the noon period is 75%). When I call the exchanges number, I will be connected to a free line if available, or else obtain a busy signal if all ten lines are busy. *What probability distribution does each of the following random variables have?*

___ a. number of free lines are available when I call at 12:15.
___ b. number of times I must attempt a call before receiving a free line.

Cars arrive at a toll booth on the freeway at the average rate of 8/minute in a completely random fashion. The arrival times are recorded, beginning at 8:00 am. *What probability distribution does each of the following random variables have?*

___ c. time of arrival of first car
___ d. time of arrival of car #2
___ e. time between arrival of car #1 and car #2
___ f. number of cars arriving during the first minute (between 8:00 and 8:01)

A certain production process has a fraction defective of 8%. Four good pieces are required. All items are routinely inspected as soon as they are produced. *Which probability distributions would best be used to compute the probability that...*

___ g. the second item is the first good item to be produced.
___ h. the number of items required in order to obtain the fourth good item is 6.

Suppose that instead of inspecting each item before producing the next, a batch of size 6 is produced, and then the items are inspected. *Which probability distributions would best be used to compute the probability that...*

___ i. four or more good items are found in the batch

A pair of dice is thrown, with a desire of achieving a value of either "7" or "11". *Which probability distributions would best be used to compute the probability that...*

___ j. number of throws of the dice required in order to obtain a "7" or "11" is exactly 3.
___ k. in six throws of the dice, a "7" or "11" is obtained at least twice.

<u>Probability distributions</u>:

1. Binomial
2. Poisson
3. Pascal
4. Bernouilli
5. Exponential
6. Erlang
7. Normal
8. Geometric

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I. Along highway I-80 in Iowa, the probability that each passing car stops to pick up a hitchhiker is p=2%, i.e, an average of one in fifty drivers will stop; different drivers, of course, make their decisions whether to stop or not independently of each other.

___ 1. Consider a stochastic process in which X_n=1 if car n stops to pick up the hitchhiker, and X_n=0 otherwise. Then $\{X_n: n=1,2,3,...\}$ is a

a. Binomial process b. Bernouilli process c. Poisson process
d. Markov process e. Exponential process f. None of the above

___ 2. P{Xn=1} =

a. 0.50 b. 0.98 c. 0.025
d. 0.02 e. 0.2 f. None of the above

___ 3. If 25 cars pass the hitchhiker, the probability that *none* of them stop is

a. 25x(0.02) b. $(0.02)^{25}$ c. $(0.98)^{25}$
d. $(0.98)^{24}(0.02)$ e. $(0.02)^{24}(0.98)$ f. None of the above

___ 4. Given that a hitchhiker has counted 25 cars passing him without stopping, what is the probability that he will be picked up by the 40^{th} car *or before?*

a. $(0.98)^{40}$ b. $1-(0.98)^{15}$ c. $1-(0.02)^{40}$
d. $1-(0.02)^{15}$ e. $(0.98)^{15}$ f. None of the above

___ 5. If 25 cars pass the hitchhiker, the probability that two of them stop is

a. $\binom{25}{2}(0.98)^{23}(0.02)^2$ b. $1-\binom{25}{2}(0.02)^{23}(0.98)^2$ c. $(0.02)^2$
d. $\binom{25}{2}(0.02)^{23}(0.98)^2$ e. $1-\binom{25}{2}(0.98)^{23}(0.02)^2$ f. None of the above

Suppose that the arrivals of the cars form a Poisson process, at the average rate of 15 per minute. Define "success" for the hitchhiker to occur at time t provided that *both* an arrival occurs at t *and* that car stops to pick him up. Let T_1 be the time (in seconds) of the first "success", i.e., the time that he finally gets a ride, when he begins his wait at time T_1=0.

___ 6. The arrival rate of "successes" is

a. 1/minute b. 3/minute c. 2/minute
d. 0.3/minute e. 0.2/minute f. None of the above

___ 7. The random variable T_1 has what distribution?

a. Poisson b. Geometric c. Exponential
d. Pascal e. Erlang f. None of the above

___ 8. What is $E(T_1)$, the expected (mean) value of T_1?

a. 10/3 minutes b. 3 minutes c. 4 minutes
d. 3/2 minutes e. 1/3 minute f. None of the above

___ 9. What's the probability that his waiting time is less than or equal to 5 min. ($P\{T_1 \leq 5\}$?

a. $1 - e^{-4.5}$ b. $1 - e^{-1.5}$ c. $e^{-1.5}$
d. $e^{-4.5}$ e. $1 - e^{1.5}$ f. None of the above

___ 10. What is the probability that he must wait *exactly* 5 minutes for a ride ($P\{T_1= 5\}$?

a. $1 - e^{-1.5}$ b. $e^{-1.5}$ c. $e^{4.5}$
d. $1 - e^{-4.5}$ e. 0.0 f. None of the above

___ 11. Suppose that after 3 minutes (during which 42 cars have passed by) he is still there waiting for a ride. What is the *conditional* expected value of T_1 (expected *total* waiting time, i.e., since time 0, given that he has already waited 3 minutes).

a. 10/3 minutes b. 3/10 minutes c. 15 minutes
d. 40/3 minutes e. 3/40 minutes f. None of the above

II. A bearing in a Grass Chopper mower's PTO mechanism fails randomly, with an expected lifetime of 250 hours. Assume that the lifetime of the bearing has an exponential distribution.

___ 12. What is the probability that the bearing lasts *longer than* 250 hours?

a. e^{-1} b. $1 - e^{-1}$ c. e^{250}
d. e^{-250} e. $1 - e^{-250}$ f. None of the above

___ 13. If the mower has already operated without failure, for 150 hours, what is the probability that the bearing will last a total of *at least* 250 hours?

a. e^{-250} b. $1 - e^{-100}$ c. e^{-100}
d. $1 - e^{-250}$ e. e^{-150} f. None of the above

___ 14. If, when the bearing fails, it is replaced (with an identical bearing), what is the probability distribution of the time of the second failure (T_2)?
a. Poisson b. Geometric c. Exponential
d. Pascal e. Erlang f. None of the above

___ 15. What is the probability that the bearing will fail (& be replaced)three or more times in 750 hours of mowing?
a. $\sum_{x=0}^{3} e^{-3}\frac{(3)^x}{x!}$ b. $e^{-3}\frac{(3)^3}{3!}$ c. $1 - \sum_{x=0}^{2} e^{-3}\frac{(3)^x}{x!}$
d. $1 - \sum_{x=0}^{3} e^{-3}\frac{(3)^x}{x!}$ e. $1 - e^{-3}\frac{(3)^2}{2!}$ f. None of the above

(Possibly) Useful Formulas:

Binomial distribution $P\{\text{x successes in n trials}\} = \binom{n}{x} p^x (1-p)^{n-x}$

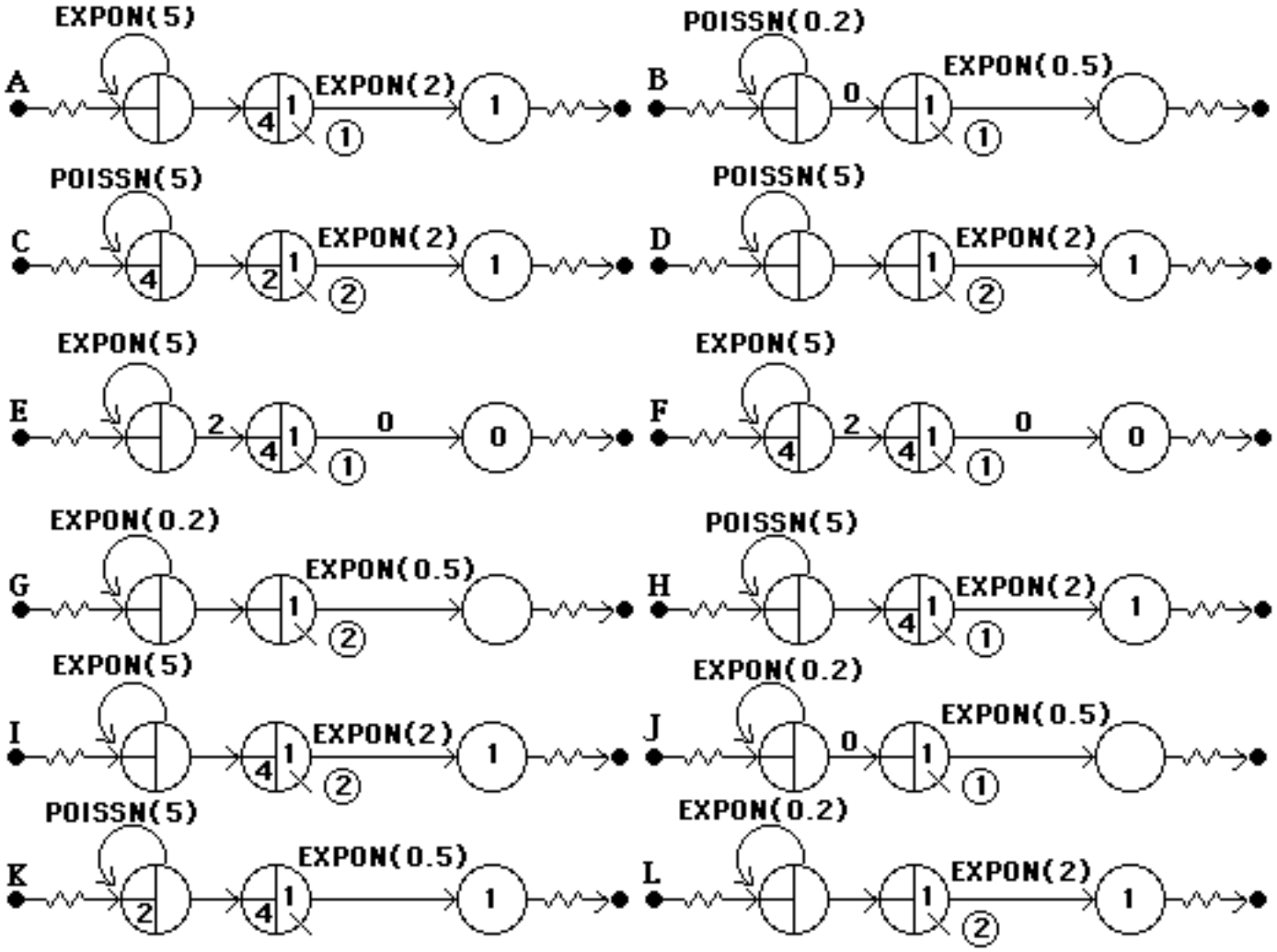
Exponential distribution $P\{T \le t\} = 1 - e^{-\lambda t}$

Poisson distribution $P\{N_t = x\} = e^{-\lambda t}\frac{(\lambda t)^x}{x!}$

<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #3** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

Homework #3 dealt with the proposed drive-up teller window (with a single teller). The arrival of customers (a Poisson process) occurs an average of one every five minutes, and customer service (exponentially distributed) requires an average of two minutes. Space will be provided for at most four autos, plus the one at the teller window.

1. Which of the twelve SLAM networks below best models this system? _____
2. Which of the twelve SLAM networks below best models the alternative proposal with two teller windows? _____



True(+) or False (0)?

___ 3. A service activity is represented in SLAM by an arrow rather than a node.

___ 4. The output of the "TRACE" option on the "MONITOR" control statement includes separate lines indicating (i) the time of arrival of each car, (ii) the waiting time in the queue for each car, (iii) the time at the teller window for each car, and (iv) the time of departure of each car.

___ 5. In order to simulate the SLAM model several times, a modification is required for the GEN control statement but none to the NETWORK statements in the input file.

___ 6. Because of the random arrival times and service times, no two students in the class should have obtained exactly the same results of the simulation.

___ 7. In the SLAM model of the bank teller window, when a car arrives and finds that the queue is filled, an error message is printed and the simulation is immediately terminated.

___ 8. In the model of the system with two teller windows, each teller is represented by a service activity.

___ 9. A "regular" activity, even if the duration is zero, requires an ACTIVITY statement in the SLAM input file.

Use the SLAM output below to answer the questions which follow. (Note that this output is for a slightly different SLAM model of the bank teller window than that used in the homework assignment, in that the overflow of the queue causes immediate termination of the simulation.)

```
**FILE STATISTICS**
```

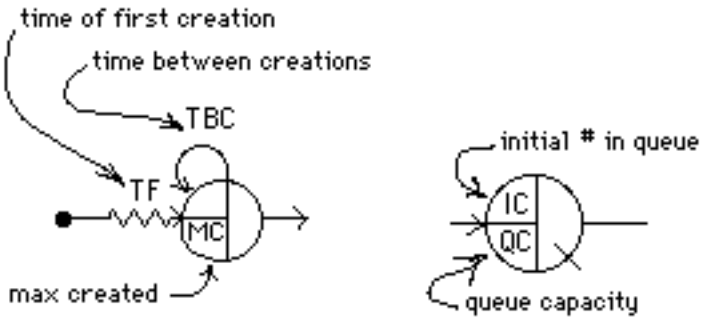
```
FILE                    AVERAGE   STANDARD    MAXIMUM   CURRENT AVERAGE
NUMBER   LABEL/TYPE     LENGTH    DEVIATION   LENGTH    LENGTH  WAIT TIME

   1         QUEUE        0.300      0.724        4         4       1.317
   2         CALENDAR     1.439      0.496        3         2       2.669

            **SERVICE ACTIVITY STATISTICS**

ACT ACT LABEL OR  SER AVERAGE     STD   CUR AVERAGE MAX IDL MAX BSY   ENT
NUM START NODE    CAP   UTIL      DEV   UTIL BLOCK   TME/SER TME/SER   CNT
 1      QUEUE      1   0.439    0.50     1    0.00    17.35   29.23    88
```

10. What is the average total time that a customer spent at the bank? _____
11. What is the maximum time that any customer spent at the bank? _____
12. What is the average time that a customer spent waiting to be served? _____
13. What is the average number of cars in the waiting line? _____
14. How many customers were served during this simulation? _____
15. What percent of the time was the bank teller busy serving customers? _____



<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #4** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

Indicate "+" for true, "o" for false:

___ 1. If you use the Cricket Graph program to fit a line, it will find the straight line which minimizes the sum of the squares of the errors, i.e., the sum of the squares of the vertical distances between each data point and the line.

___ 2. If F(t) is the CDF of the interarrival time for a Poisson process, the expected number of arrivals E_i which fail in the time interval $[t_{i-1},t_i]$ is $F(t_i) - F(t_{i-1})$

___ 3. In the chi-square goodness-of-fit test, the number of degrees of freedom is never more than the number of "cells" of the histogram.

___ 4. In a Poisson process, the time between arrivals has a Poisson distribution.

___ 5. The inverse transformation method to generate a random number can be used to simulate interarrival times for a Poisson process.

___ 6. In a Poisson process with arrival rate λ/minute, the number of arrivals in one minute is random, with a Poisson distribution having mean λ.

___ 7. The exponential distribution is a special case of the Erlang distribution.

___ 8. The "Cumulative Distribution Function" (CDF) of any random variable X is defined as

a. $f(x) = P\{x \mid X\}$
b. $f(x) = P\{x\}$
c. $F(x) = P\{X=x\}$
d. $F(x) = P\{X \geq x\}$
e. $f(x) = P\{X|x\}$
f. $F(x) = P\{X \leq x\}$

The time *between* arrivals of forty vehicles are measured. The number of observations O_i falling within each half-minute interval is shown in the table below. The average is computed by weighting the midpoint of each interval by its number of observations: 0.25x9 + 0.75x4 + 1.25x5

+ ... = 2.225 minutes. We wish to test the "goodness of fit" of the exponential distribution having mean 2.225 minutes.

i	Interval	O_i	p_i	E_i	$(E_i-O_i)^2/E_i$
1	0.0 - 0.5	9	0.2015	8.0594	0.1098
2	0.5 - 1.0	4	0.1609	6.4355	0.9217
3	1.0 - 1.5	5	0.1285	5.1389	0.0038
4	1.5 - 2.0	3	0.1026	4.1035	0.2967
5	2.0 - 2.5	7	0.0819	3.2767	4.2308
6	2.5 - 3.0	3	0.0654	2.6165	0.0562
7	> 3.0	9	0.2592	10.3696	0.1809

The sum of the values in the last column is D = 5.8.

Indicate "+" for true, "o" for false:

____ 9. The parameter of the exponential distribution is assumed to be λ = 1/2.225min. = 0.45/min.
____ 10. The probability p_i that a car arrives in an interval #i, $[t_1, t_2]$, is $F(t_1) - F(t_2)$
____ 11. The CDF of the distribution of interarrival times is assumed to be $F(t) = 1 - \lambda e^{-\lambda t}$
____ 12. The number of observations, O_i, in an interval should have a binomial distribution, with n=40.
____ 13. The quantity D is assumed to have the chi-square distribution.
____ 14. The quantity $(E_i-O_i)^2/E_i$ is assumed to have the normal N(0,1) distribution.
____ 15. The chi-square distribution for this test will have 7 "degrees of freedom".
____ 16. The number of observations O_i in interval #i is a random variable with approximately Poisson distribution.
____ 17. If it is true that T has the exponential distribution with mean 2.225 minutes, the probability that D exceeds 5.8 is less than 10%.
____ 18. The exponential distribution with mean 2.225 minutes should be rejected as a model for the interarrival times of the vehicles.
____ 19. The quantity E_i is a random variable with approximately Poisson distribution.
____ 20. The quantity D is assumed to have approximately a Normal distribution.
____ 21. The degrees of freedom is reduced by 2 because (i) the total number of observations is fixed, and (ii) the data was used to estimate one parameter for the distribution being tested.
____ 22. The smaller the value of D, the worse the fit for the distribution being tested.
____ 23. The quantity E_i is the expected number of observations in interval #i
____ 24. The sum of several N(0,1) random variables has chi-square distribution.
____ 25. The chi-square distribution for this test will have 6 "degrees of freedom".

deg.of	Chi-square Dist'n $P\{D \geq \chi^2\}$					
freedom	99%	95%	90%	10%	5%	1%
2	0.0201	0.103	0.211	4.605	5.991	9.210
3	0.115	0.352	0.584	6.251	7.815	11.341
4	0.297	0.711	1.064	7.779	9.488	13.277
5	0.554	1.145	1.610	9.236	11.070	15.086
6	0.872	1.635	2.204	10.645	12.592	16.812
7	1.239	2.167	2.833	12.017	14.067	18.475

<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #5** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

Statements below refer to today's homework assignment (HW#5). *Indicate "+" for true, "o" for false:*

___ 1. The Weibull CDF, i.e., F(t), gives, for each unit of the device, the probability that it has failed at or before time t.

___ 2. The method used in HW#5 to estimate the Weibull parameters u & k does *not* require that the units of the device be tested until *all* have failed.
___ 3. The exponential distribution is a special case of the Weibull distribution, with a constant failure rate.
___ 4. We assumed in this HW that the number of failures at time t , $N_f(t)$, has a Weibull distribution.
___ 5. We assumed in this HW that the lifetime of the device has a Weibull distribution.
___ 6. The Weibull distribution is often an appropriate distribution for the minimum of a large number of nonnegative random variables.
___ 7. A positive value of k indicates an increasing failure rate, and negative k indicates a decreasing failure rate.
___ 8. According to the results of this homework exercise, the failure rate of the electronic device is decreasing rather than increasing.
___ 9. If 10 units of this device are installed in a computer system, the number still functioning after 500 hours has a Weibull distribution.
___ 10. The Cricket Graph program fits a line which minimizes the sum of the errors, i.e., the vertical distance between each data point and the line.
___ 11. To estimate the time at which 90% of the units will have failed, evaluate 1 - F(0.90).
___ 12. The quantity R_t is the fraction of the devices which have failed at time t (or earlier).
___ 13. If the failure rate is increasing, it may be more appropriate to use the Gumbel distribution than the Weibull.
___ 14. Given a coefficient of variation for the Weibull distribution (the ratio σ/μ), the parameter k can be determined.
___ 15. We assumed in this HW that the number of failures at time t , $N_f(t)$, has a Weibull distribution.
___ 16. If the assumption of Weibull distribution were correct, a plot of the data points (t, $N_f(t)$) for t=100, 200, ...800 should lie approximately on a straight line.

In order to estimate k & u in this HW exercise, Cricket Graph was used to fit a straight line to some plotted data points. Select the letter below which indicates each correct answer:

___ 17. The slope of the line fit by Cricket Graph should be approximately ...
___ 18. The label on the vertical axis should be ...
___ 19. The label on the horizontal axis should be ...
___ 20. The vertical intercept of the line fit by Cricker Graph should be approximately ...

a. $\ln 1/t$	g. $\ln 1/R_t$	m. mean value μ
b. ln ln t	h. ln ln R_t	n. standard deviation σ
c. t	i. R_t	o. shape parameter k
d. ln t	j. ln R_t	p. scale parameter u
e. k ln u	k. u ln k	q. ln k
f. $\ln \ln 1/t$	l. $\ln \ln 1/R_t$	r. ln u

___ 21. The "Cumulative Distribution Function" (CDF) of any random variable X is defined as

a. $f(x) = P\{x\}$ c. $f(x) = P\{X|x\}$ e. $F(x) = P\{X=x\}$
b. $f(x) = P\{x \mid X\}$ d. $F(x) = P\{X \geq x\}$ f. $F(x) = P\{X \leq x\}$

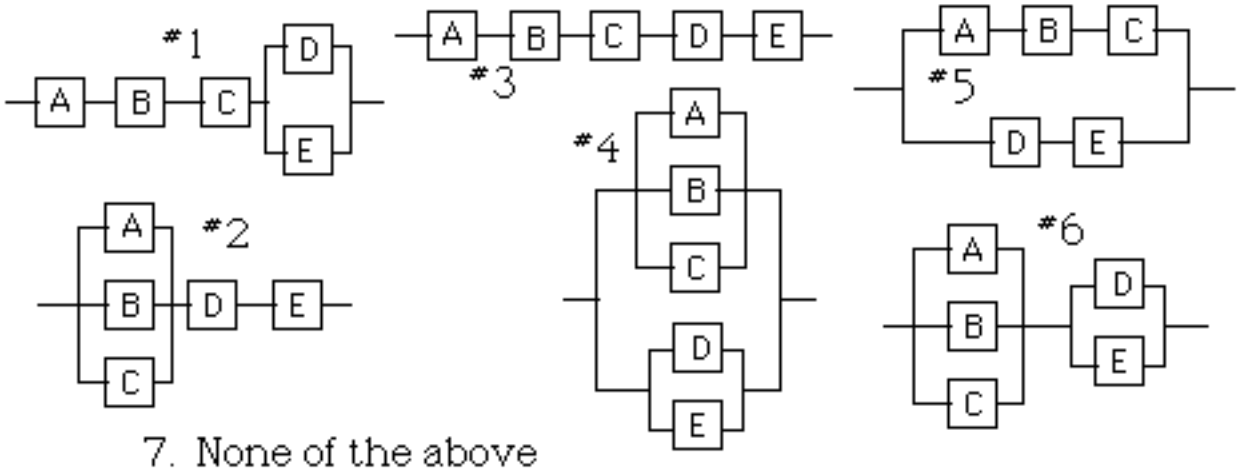
<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #6** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

Part One: A system consists of five components (A,B,C,D, &E). The probability that each component *fails during the first year* of operation is 10% for A, B, and C, and 20% for D and E. For each alternative of (a) through (e), indicate:

- the number of the reliability diagram below which represents the system.
- the computation of the 1-year reliability (i.e., survival probability)
- the SLAM network which would simulate the system lifetime

Diagram	Reliability	SLAM network	
___	___	___	a. The system requires that D & E both function, and at least one of A, B, & C function.
___	___	___	b. The system can function if all of A, B, and C function *or* if both D and E function.
___	___	___	c. The system requires all of A, B, & C, and at least one of D & E.
___	___	___	d. The system requires at least one of A ,B, &C, and at least one of D & E .

Diagrams:

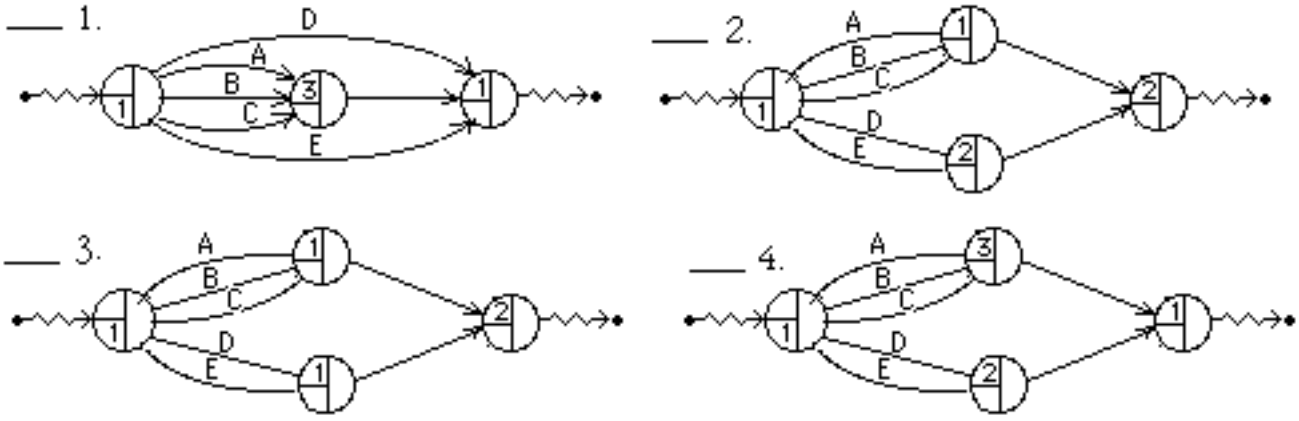


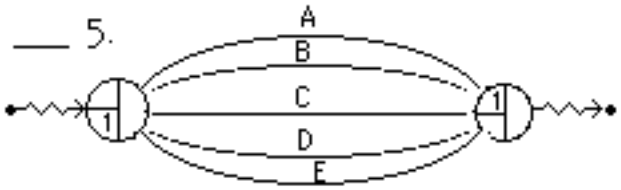
7. None of the above

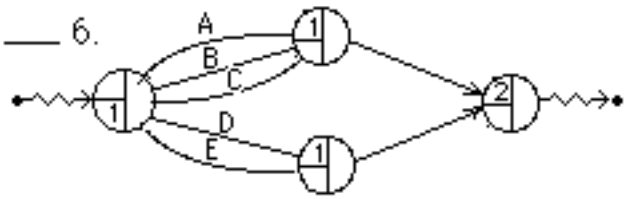
Reliabilities:

1. $1-[1-0.1^3]\,[1-0.2^2]$
2. $[1-0.1^3]\,[1-0.2^2]$
3. $1-\,[1-0.9^3]\,[1-0.8^2]$
4. $1-(0.1)^3(0.2)^2$
5. $0.9^3[1-0.2^2]$
6. $[1-0.1^3]\,(0.8)^2$
7. *None of the above*

SLAM networks:



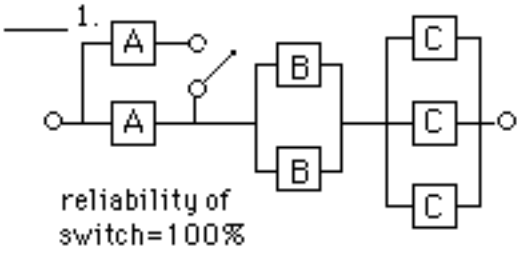


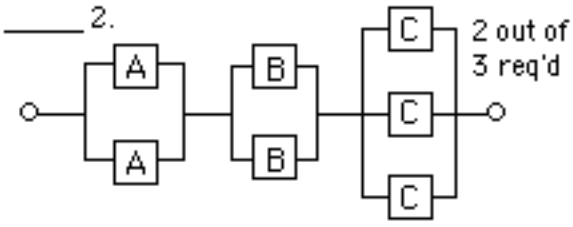


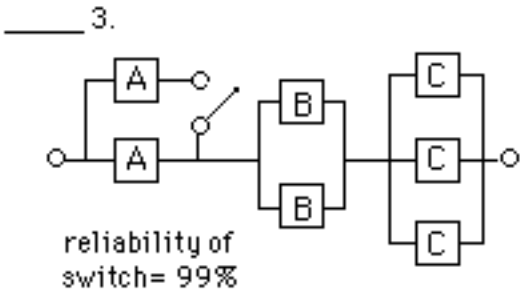
7. None of the above

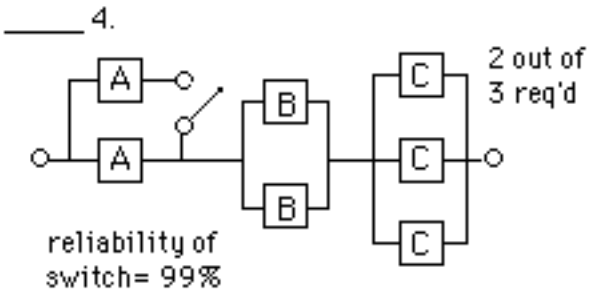
Part Two.

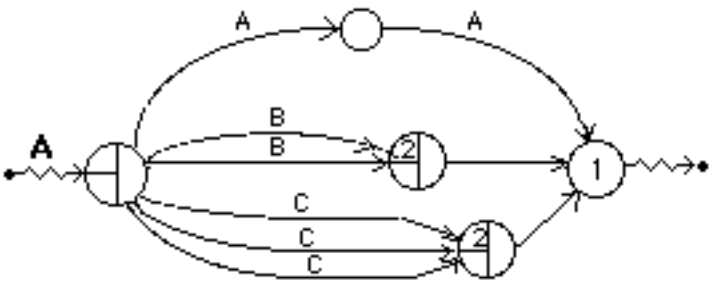
For each system 1-4 below, write the letter (A-H) of the SLAM model which simulates the system lifetime. The switch in the diagram indicates that the back-up copy of A is switched into the system (possibly with less than 100% reliability) when the first copy of A fails. Assume that A, B, C, etc. in the SLAM network represent the lifetime distributions of devices A, B, C, etc.

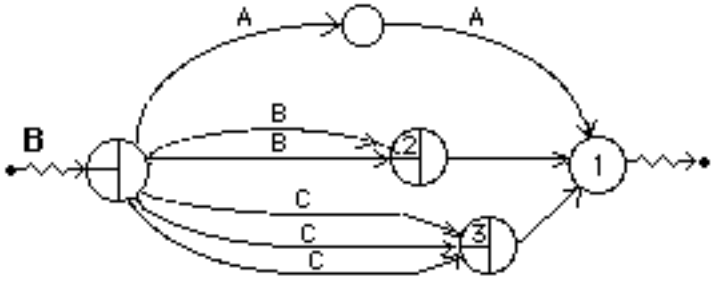


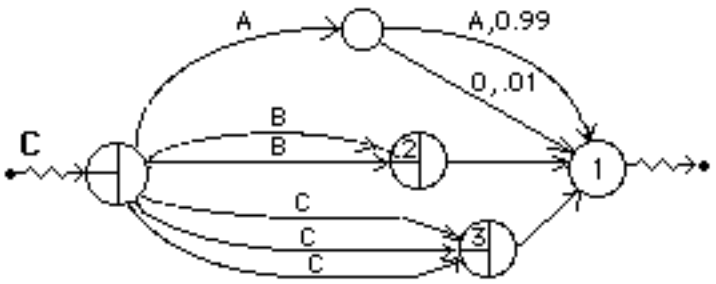


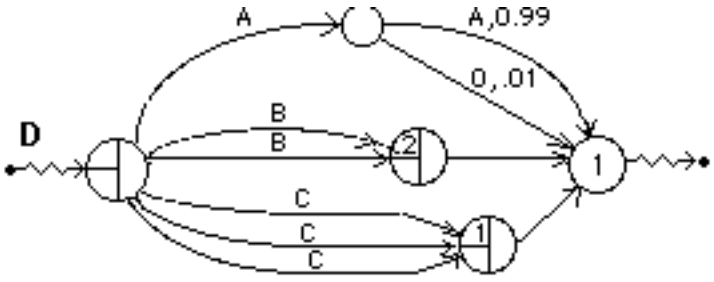


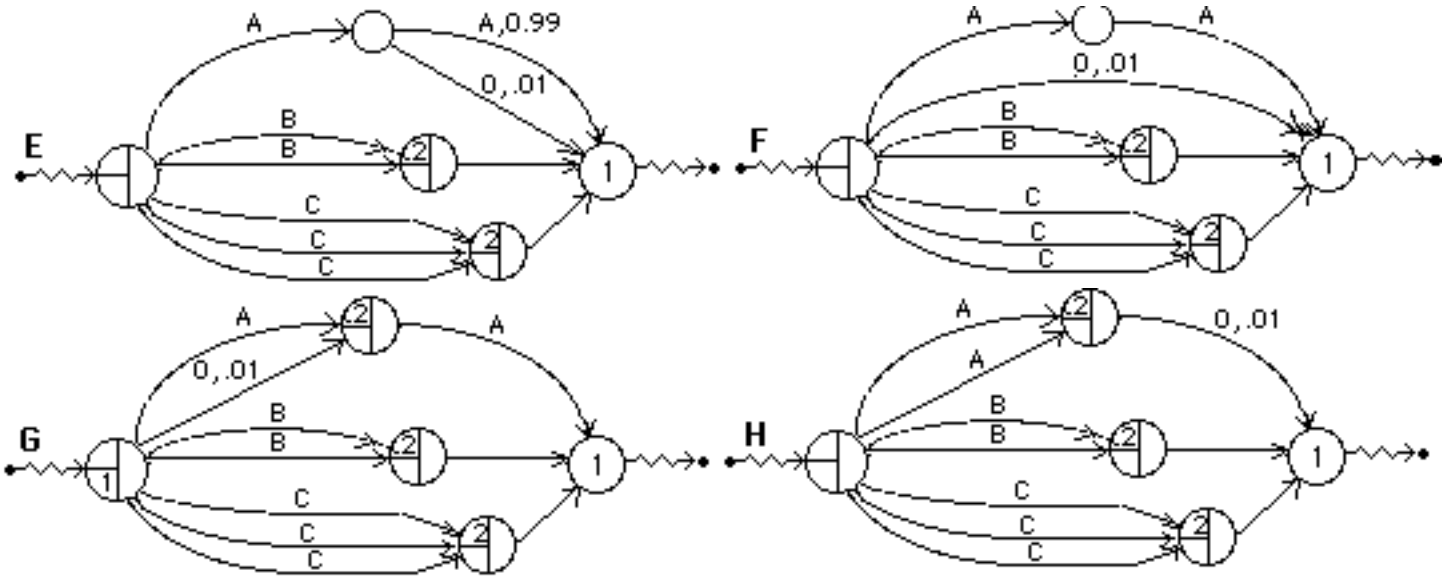










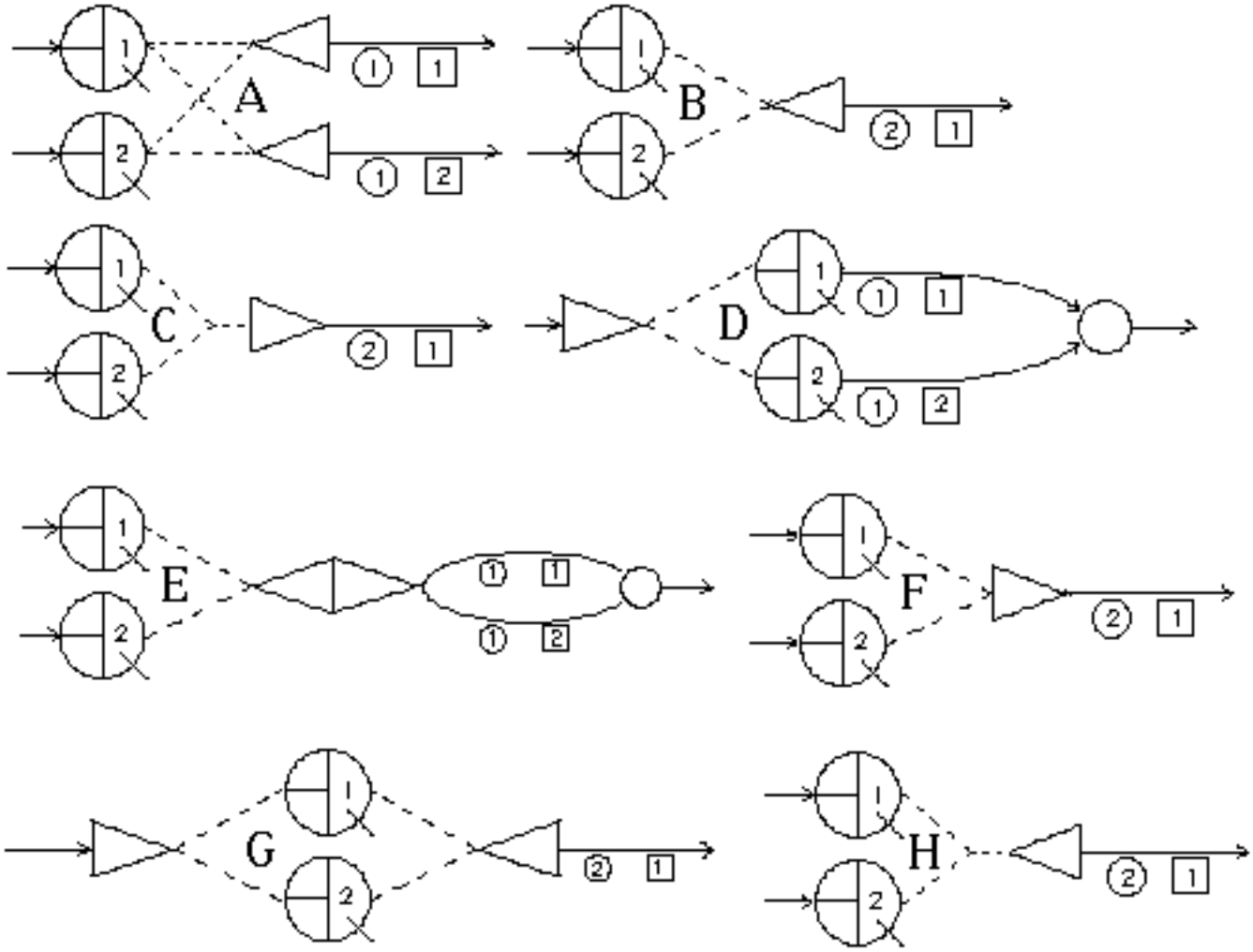


I. None of the above

<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #7** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

For each system described below, indicate the appropriate SLAM network setment (A through H) which might be used to model it for <u>some</u> choice of QSR (queue selection rule) and/or SSR (server selection rule). If no network segment shown could be used, indicate "N" (none).

___1. Customers select the check-out lane at the grocery store which has the shortest queue.
___2. Two (identical) servers select their next job from the longer of two queues.
___3. Widgets and boxes arrive on two different conveyors at the final station on an assembly line. Two (identical) workers have the task of selecting a widget and a box, packing it, and sealing the box.
___4. Two workers, who differ in the speed with which they work, select their next job from queue #1 if any jobs wait there, and queue #2 otherwise.
___5. Arriving customers select the waiting area (of two available) with the lesser number of people already waiting. Each of two identical clerks serves the person (in either queue #1 or queue #2) who has waited the longest.
___6. Customers in two different queues may be served by either of two non-identical clerks. If both clerks are idle, customers prefer clerk #1. If a clerk finishes serving a customer and both queues have persons waiting, he selects the customer at the head of the longest queue.


A
B
C
D
E
F
G
H

For each of the following statements about SLAM, **indicate "+" if True and "O" if False:**

___7. An activity which follows a queue node *must* be a service activity.
___8 . Consider 2 check-out lanes at a grocery store, where the arriving customer chooses the shorter queue but can freely switch at any time from one queue to the other if the other queue becomes shorter, the SLAM model should have a SELECT node to select the queue.
___9. A SLAM network requires at least one CREATE node.
___10. When an entity arrives at a terminate node, the simulation is immediately terminated.
___11. A SLAM network requires at least one TERMINATE node.
___12. The number of entities entering an ACCUMULATE node equals the number leaving the node.
___13. To model a vehicle trying to enter a busy street, an assembly node can be used to "assemble" a vehicle and an arriving "opportunity".
___14. INT(1) on a COLCT node means that you wish statistics collected on the interarrival times of entities at this node.
___15. The activity preceding a queue node with blocking must be a service activity.
___16. An ASSEMBLY node is a special case of a SELECT node.
___17. A GOON node in a SLAM network is used to eject unruly customers from a queue.
___18. A SLAM network may have more than one CREATE node.
___19. An activity which precedes a queue node *cannot* be a service activity.
___20. The length of time to be simulated by a SLAM model may be specified on the INIT control statement.
___21. The LIMITS control statement of SLAM includes a maximum number of entities to be created during the simulation run.
___22. To obtain statistics on the length of time which an entitiy spends in the system requires that you include a COLCT node in your SLAM network.
___23. To obtain statistics on the fraction of time that a server is busy requires that you include a COLCT node in your SLAM network.
___24. A SELECT node must include both a server selection rule (SSR) or a queue selection rule (QSR).
___25. A SELECT node *must* have a label.

<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•> **Quiz #8** <•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>

For each of the following statements about SLAM, **indicate "+" if True and "O" if False:**
___ 1. Entities may wait at a QUEUE node for a GATE to open.
___ 2. A resource which is assigned to an entity can only be freed again by that same entity's arrival at a FREE node.
___ 3. A SLAM network requires at least one CREATE node.
___ 4. When an entity arrives at a terminate node, the simulation is immediately terminated.
___ 5. Only an entity which closes a gate may open the gate.
___ 6. In the homework exercise involving the storage facility in the job shop, the jobs were modeled as entities and the workers as a "resource".
___ 7. The "1" in INT(1) on a COLCT node means that you wish statistics collected on the difference between TNOW and attribute #1 of entities arriving at this node.
___ 8. An unlimited number of entities may be in the same (regular) activity simultaneously.
___ 9. At an AWAIT node, entities may wait for either a gate to be opened or a resource to be assigned.
___ 10. When two entities are waiting at the same AWAIT node for a gate to open, and the gate then opens, both entities are allowed to proceed to the next node.
___ 11. An entity at an AWAIT node waiting for a gate must next open the gate (by means of an OPEN node) before proceeding.
___ 12. Entities may balk when arriving at either a QUEUE node or an AWAIT node with limited capacity.
___ 13. XX(1) refers to attribute #1 of an entity.

___ 14. The number of entities in an activity following an AWAIT node cannot exceed the number of units of resource available.
___ 15. An activity which follows a queue node *must* be a service activity.
___ 16. A SLAM network requires at least one TERMINATE node.
___ 17. When an entity arrives at a CLOSE node to close a gate, then any entities which follow it may not pass through that same node until the gate is opened again.
___ 18. A resource which is assigned to an entity must be freed before it can be reassigned to another entity.
___ 19. A SLAM network may have more than one CREATE node.
___ 20. An entity may request and be assigned more than one unit of a resource at the same AWAIT node.
___ 21. To obtain statistics on the length of time which an entitiy spends in the system requires that you include a COLCT node in your SLAM network.
___ 22. To obtain statistics on the fraction of time that a server is busy requires that you include a COLCT node in your SLAM network.
___ 23.An entity arriving at an AWAIT node must be assigned a resource before it may proceed.
___ 24. The mean of a SLAM distribution specified by ERLNG(2,2) is 2.
___ 25.The SLAM distribution ERLNG(2,1) is identical to the distribution EXPON(2).
___ 26.The node which follows an AWAIT node where entities are assigned a resource must be a FREE node.
___ 27. An entity may request and be assigned more than one unit of a resource at the same AWAIT node.

<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>-<•>