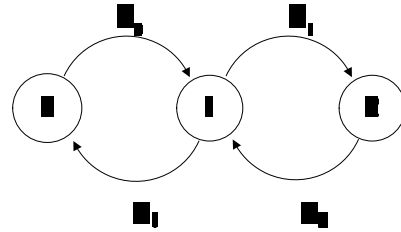


■■■■ 57:022 Principles of Design II ■■■■
 Quiz #10 – 3 May 2002

A total of 10,000,000 cu ft of dirt is needed to construct a dam. The dirt is moved via dumpers to the dam site. Only one loader and two dumpers are available. Each dumper can hold 1000 cu ft of dirt. It takes an average of *six* minutes to load a dumper with dirt, and it takes each dumper an average of *ten* minutes to deliver the dirt to the dam and return to the loader. Making appropriate assumptions about exponentiality so as to obtain a birth/death model, we wish to determine the total expected time required to move the dirt needed to build the dam.

Letting the state be the number of dumpers at the loading site, we model this as a birth-death process, as in the diagram on the right.



1. Match the values

- | | | | |
|-----------------|----------|-----------------------------|----------|
| ___ λ_1 | a. 1/hr | b. 2/hr | c. 3/hr |
| ___ λ_0 | d. 5/hr | e. 6/hr | f. 10/hr |
| ___ μ_1 | g. 12/hr | h. 15/hr | i. 20/hr |
| ___ μ_2 | j. 30/hr | k. <i>None of the above</i> | |

2. If the loader were fully utilized, the length of time required to complete moving the dirt would be (*choose nearest value*):

- | | | | |
|---------------|---------------|----------------|-----------------------|
| a. 100 hr. | b. 500 hr. | c. 1000 hr. | d. 5000 hr. |
| e. 10,000 hr. | f. 50,000 hr. | g. 100,000 hr. | h. $\geq 500,000$ hr. |

___ 3. Indicate the equation used to compute the probability that the loading area is idle:

- | | | |
|---|---|--|
| a. $\frac{1}{\pi_0} = 1 + \frac{12}{10} + \left(\frac{6}{10}\right)^2 = 2.56$ | b. $\frac{1}{\pi_0} = 1 + \frac{10}{6} + \left(\frac{10}{6}\right)^2 = 5.44$ | c. $\frac{1}{\pi_0} = 1 + \frac{6}{10} + \left(\frac{6}{10}\right)^2 = 1.96$ |
| d. $\frac{1}{\pi_0} = 1 + \frac{12}{10} + \frac{12}{10} \times \frac{6}{10} = 2.92$ | e. $\frac{1}{\pi_0} = 1 + \frac{20}{6} + \frac{20}{6} \times \frac{10}{6} = 9.88$ | f. <i>None of the above</i> |

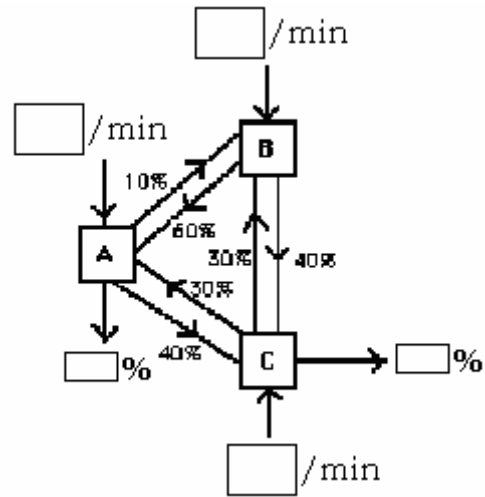
___ 4. The utilization of the loader (fraction of time it is busy) is (*select nearest value*)

- | | | | | | |
|--------|--------|--------|--------|--------|----------------|
| a. 15% | b. 20% | c. 25% | d. 30% | e. 35% | f. 40% |
| g. 45% | h. 50% | i. 55% | j. 60% | k. 65% | l. $\geq 70\%$ |

___ 5. The fraction of the time that both dumpers are at the loading site is (*select nearest value*)

- | | | | | | |
|--------|--------|--------|--------|--------|----------------|
| a. 15% | b. 20% | c. 25% | d. 30% | e. 35% | f. 40% |
| g. 45% | h. 50% | i. 55% | j. 60% | k. 65% | l. $\geq 70\%$ |

A network of three computer centers (A, B, & C) each receive messages from outside, as shown. The messages may then be routed to another computer in the network for further processing, also as shown, or a reply sent to the sender of the message. Each center has two computers, processing messages at the rate of 8/minute.



Consult the RAQS model output below to answer the questions.

- ___ 1. Which is the busiest computer center?
 a. A b. B c. C

- ___ 2. What is the average time to respond to a message? (Choose nearest value)
 a. 0.2 minute b. 0.3 minute c. 0.4 minute
 d. 0.5 minute e. 0.6 minute f. 0.7 minute
 g. 0.8 minute h. 0.9 minute i. 1 minute

3. Complete the three arrival rates and the two fractions of messages routed back to sender in the diagram above. (Five boxes to fill.)

Input information
 This model has been developed in the Basic Mode
 Type of network-Open Network
 Number of nodes = 3

Node #	Number of servers	Arrival Rate	Arrival SCV	Mean Serv Time	Service time SCV
1	2	1.000	1.000	0.125	1.00
2	2	4.000	1.000	0.125	1.00
3	2	3.000	1.000	0.125	1.00

Routing (Pij) Matrix

0.000	0.100	0.400
0.600	0.000	0.400
0.300	0.300	0.000

Output Report
 This Model has been developed in the Basic Mode
 Type of Network - Open Network

Network Measures
 Average Number in the Network = 4.523
 Average time spent in the Network = 0.565

Node Measures

Node	Util	AvTIQ	VarTIQ	AvNIQ	AvTAN	VarTAN	AvNAN	VarNAN
1	0.528	0.048	0.006	0.407	0.173	0.022	1.462	1.675
2	0.480	0.037	0.004	0.287	0.162	0.020	1.247	1.259
3	0.591	0.067	0.011	0.632	0.192	0.026	1.813	2.526

Util - the Utilization at a Node
 AvTIQ, VarTIQ - Mean and Variance of the waiting time in queue at a node
 AvNIQ - Mean queue length at a node
 AvTAN, VarTAN - Mean and Variance of time spent at a node
 AvNAN, VarNAN - Mean and Variance of the number of customers at a node