Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA

Production and Operations Management

Quiz 2: Version C

N:_____________________________________Student no.:________

THIS QUIZ IS TO BE DONE WITHOUT THE CONSULTATION OF FURTHER MATERIAL AND HAS THE EXACT DURATION OF ONE HOUR AND THIRTY MINUTES.

Clearly mark your answer with the symbol "X" in the designated column. Wrong or misplaced answers receive 0 points. Pages 8 and 9 have been intentionally left blank and are to be used for ancillary computations.

Group (I)

1. A new customer arrives Mrs Bina Grocery store every 3 minutes. Clients wait for their turn in a single line. Two employees work at the grocery store helping each other: one as a cashier (register the purchases) and other in the packaging of the groceries. This process allows for a service of 25 customers per hour. Assume arrivals follow a *Poisson* distribution and that service follows a negative exponential distribution.

[2 val.] What is the average number of customers waiting in queue to pay for their groceries?		
1		4 clients
2	x	0.15 clients
3		3.2 clients
4		0.016 clients

2. Six students arrive, on average, every hour to the reception desk of S. Bernard's high school administrative office in accordance with a *Poisson* process. Only one clerk works at administrative office, which led to complaints that the average time students spend in the office, which is 5 minutes, is excessive. Please assume that service time follows a negative exponential distribution.

[1 val.] How long does, on average, a student wait in the office before being served by the office clerk?		
1		5 minutes
2		18 minutes
3		3.33 minutes
4	x	1,67 minutes

[2 val.] Assuming the average number of students served in one hour is μ=8 students, what is the probability of finding more than 2 students in line at any given moment?		
1		10.55%
2	x	31.64%
3		14.06%
4		42.19%

3. On average, a client arrives at the COMSAUDE reception desk every 5 minutes. Currently there are 2 service desks operating. On average, a client waits 53 seconds to be served. Assume the inter-arrival interval and the service times follow a generic distribution where coefficients of variation are 1 in both cases.

[1 val.] What is the average number of clients waiting to be served?		
1		10.6 clients
2	x	0.177 clients
3		5 clients
4		0.086 clients

Group (II)

1. The following table describes the client orders received in the preceding weeks by a home furniture factory. The Operations Manager decided to start the processing of the orders on **day 260** according to the following sequence: SD-SA-SB-SE-SF-SC.

Order of arrival of the order	Due date	Processing time (days)
SA	310	18
SB	350	28
SC	380	25
SD	300	15
SE	375	26
SF	378	22

[1 val.] Which of the following sequencing rule did the Operations Manager use?		
1		LPT
2		FCFS
3	x	EDD
4		SPT

[2 val.] Assuming the processing sequence decided by the Operations Manager was SD-SA-SB-SE-SF-SC, what is the average number of orders in the system?		
1		2.15
2	x	3.27
3		6
4		0.31

2. SCREWUP, an antique renovation company has received six orders last week. Antique renovation is a two-stage process in which the antiques are first processed on an abrasing machine and then lacquered on a second machine. The table below describes the processing hours on each machine:

	Jobs (processing hours)					
	A	B	C	D	E	F
Abrasing (M1)	2	5	8	1	5	7
Lacquering (M2)	6	2	4	4	9	3

[2 val.] Which of the following sequences minimises the total processing time?		
1		D-B-A-F-E-C
2		D-C-A-B-F-E
3		D-A-B-E-F-C
4	x	D-A-E-C-F-B

[1 val.] If the followed processing sequence was: F-E-D-C-A-B, what is the waiting time for job C on machine 2 (lacquering)?		
1		25 hours
2	x	4 hours
3		21 hours
4		0 hours

[1 val.] Assuming the processing sequence was: F-E-D-C-A-B, what is the inactivity time on machine 2 after 15 hours?		
1	x	9 hours
2		2 hours
3		7 hours
4		4 hours

3. The production director of METALINOX needs to decide how to assign 4 jobs to 4 available machines. From his past experience, the director estimated the following table depicting job-processing times (in hours) on each machine:

	Machine			
Job	SOLD	PIC	PENT	LAS
T1	27	25	28	23
T2	27	24	26	25
T3	30	30	26	29
T4	28	25	27	24

The director asked a new intern to find the most efficient assignment of jobs to the machines. The intern decided to use the optimal assignment method, but stopped her work on the third step of the method:

1st step

	SOLD	PIC	PENT	LAS
T1	4	2	5	0
T2	3	0	2	1
T3	4	4	0	3
T4	4	1	3	0

2nd step

	SOLD	PIC	PENT	LAS
T1	1	2	5	0
T2	0	0	2	1
T3	1	4	0	3
T4	1	1	3	0

3rd step

	SOLD	PIC	PENT	LAS
T1	1	2	5	0
T2	0	0	2	1
T3	1	4	0	3
T4	1	1	3	0

[2 val.] Continuing to follow the optimal assignment method, the next step in finding the optimal assignment matrix is:

1

3rd step matrix:

	SOLD	PIC	PENT	LAS
T1	1	2	5	0
T2	0	0	2	1
T3	1	4	0	3
T4	1	1	3	0

2 x

	SOLD	PIC	PENT	LAS
T1	0	1	5	0
T2	0	0	3	2
T3	0	3	0	3
T4	0	0	3	0

3

	SOLD	PIC	PENT	LAS
T1	0	1	5	0
T2	0	0	2	1
T3	0	3	0	3
T4	0	0	3	0

4

	SOLD	PIC	PENT	LAS
T1	0	1	4	0
T2	0	0	1	0
T3	0	3	0	2
T4	0	0	2	0

Name ____ [7]

4. The manager of the production line of WAYNE.INC, a television set maker, needs to minimise the assembling time of the model BTM1. In order to do so she needs to allocate four employees to four assembly line jobs centres.

The following table describes the times (in minutes) each worker takes to perform each task on each job centre.

	Job Centres			
Worker	Centre 1	Centre 2	Centre 3	Centre 4
Alfred	40	30	35	20
Bruce	35	15	20	40
Harvey	25	20	30	25
Jack	30	20	40	30

After following all the steps of the optimal assignment method, the matrix below was determined (optimal assignment matrix):

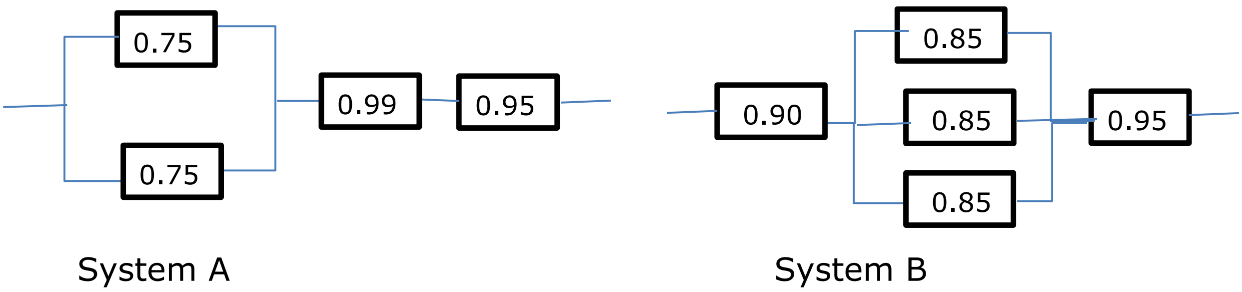
	Centre 1	Centre 2	Centre 3	Centre 4
Alfred	15	10	10	0
Bruce	15	0	0	25
Harvey	0	0	5	5
Jack	5	0	15	10

[1 val.] Determine the minimum necessary time required to assemble the BTM1 model		
1		100 minutes
2		75 minutes
3		80 minutes
4	x	85 minutes

Name ____ [8]

Group (III)

1. João is an electrician who needs to chose the one of the following electrical systems:



[2 val.] Should you have to tell João what is the reliability of each system, you would say that the reliability of systems A and B are, respectively:		
1	x	0.882 and 0.852
2		0.705 and 0.836
3		0.529 and 0.525
4		0.411 and 0.180

[1 val.] 65 thermometers were tested during 400 hours each. Three thermometers failed during the test: the first after 10 hours, the second after 200 hours, and the third after 250 hours. The MTBF is:		
1		8450 hours
2		8513.33 hours
3		8666.67 hours
4	x	8420 hours

[1 val.] Which of the following two are techniques used to improve the reliability of a system?		
1		Create redundancy in individual components and shorten the repair time
2	x	Increase the reliability of individual components and add parallel components to the existing ones in the system
3		Reduce the number of components and shorten the repair time
4		Increase the number of components in the system and implement a preventive maintenance

Name ____ [9]

ANCILIARY COMPUTATIONS

Name ____ [10]

Name ____ [11]

Formulas Sheet_2nd PART

Waiting Line Models

$$L_q = \lambda \times W_q \;;\quad L_S = \lambda \times W_S \;;\quad L_S = L_q + \lambda/\mu \;;\quad W_S = W_q + 1/\mu$$

M/M/1

$$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} \;;\; L_S = \frac{\lambda}{\mu-\lambda}$$

$$W_q = \frac{\lambda}{\mu(\mu-\lambda)} \;;\; W_S = \frac{1}{\mu-\lambda}$$

$$\rho = \frac{\lambda}{\mu} \;; \qquad P_0 = 1 - \rho \qquad P_n = P_0 \times \left(\frac{\lambda}{\mu}\right)^n$$

$$P(n > k) = \rho^{k+1}$$

M/M/S

$$P_0 = \frac{1}{\left[\sum_{n=0}^{S-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n\right] + \frac{(\lambda/\mu)^S}{S!} \times \frac{S\mu}{S\mu-\lambda}} \; (S\mu>\lambda)$$

$$Lq = \frac{\lambda \times \mu \times \left(\frac{\lambda}{\mu}\right)^S}{(S-1)!(S\mu-\lambda)^2} P_0 \qquad \rho = \frac{\lambda}{S\mu}$$

$$P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} P_0 \;\; (n \le S)$$

$$P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{S!\, S^{n-S}} P_0 \;\; (n > S)$$

M/D/1

$$L_q = \frac{\lambda^2}{2\mu(\mu-\lambda)} \;;$$

$$W_q = \frac{\lambda}{2\mu(\mu-\lambda)} \qquad \rho = \frac{\lambda}{\mu}$$

M/G/1

$$Lq = \frac{\lambda^2 \sigma_{te}^2 + \rho^2}{2(1-\rho)} \qquad \rho = \frac{\lambda}{r_e}$$

$$Po = 1 - \rho$$

G/G/1

$$Lq = \frac{\rho^2}{1-\rho} \times \left(\frac{CV_{ta}^2 + CV_{te}^2}{2}\right) \qquad CV_{ta} = \frac{\sigma_{ta}}{t_a} \qquad CV_{te} = \frac{\sigma_{te}}{t_e}$$

$$\rho = \frac{r_a}{r_e} \qquad r_a = \frac{1}{t_a} \quad r_e = \frac{1}{t_e} \qquad Po = 1 - \rho$$

G/G/S

$$\rho = \frac{r_a}{Sr_e} \qquad Lq = \frac{1}{S} \times \left(\frac{r_a}{r_e}\right) \frac{\rho^{\sqrt{2(S+1)}-1}}{1-\rho} \times \left(\frac{CV_{ta}^2 + CV_{te}^2}{2}\right)$$

Scheduling

CR = $\frac{Due\ Date - Today's\ date}{Work(lead)\ time\ remaining}$

Average completion time = $\frac{Total\ Flow\ Time}{Number\ of\ jobs}$

Utilization = $\frac{Total\ job\ work\ time}{Total\ flow\ time}$

Average job lateness = $\frac{Total\ late\ days}{Number\ of\ jobs}$

Average number of jobs in the system = $\frac{Total\ flow\ time}{Total\ job\ work\ time}$