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MAIN EXAMINATION

MAY – JULY 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

REGULAR PROGRAMME

ACS 203: OPERATIONS RESEARCH II

Date: JULY 2019	Duration: 2 Hours
INSTRUCTIONS: Answer Question ONE and any other TWO Questions	

Q1. a) Define the following terms as used in Operations Research

i. Feasible solution **(1mark)**

ii. Queuing system **(2marks)**

iii. Network **(2mark)**

iv. Dummy activity **(1mark)**

b) Give the mathematical formulation of an Assignment Problem **(4marks)**

c) Explain three common errors which may occur in operations research, illustrate each with an example from a real life situation **(5marks)**

d) Distinguish the terms Earliest start time(EST) and Latest start time (LST) **(2marks)**

e) Construct a network for the project whose activities and their precedence relationships are given below; Tasks A, B,..., K constitute a project. The notation $P < Q$ means that the task P must be completed before Q is started. With the notation,

$A < D, I; B < G, F; D < G, F; C < E; E < H, K; F < H, K; G, H < J$

(4marks)

f) A Television repairman finds that the time spent on his jobs has an exponential distribution with mean 30 minutes. If he repairs sets in the order in which they come in and the arrival is approximately Poisson with an average rate of 10 per 8-hour day, what is the repairman's expected idle time each day?

(5marks)

g) Consider the queuing model $(M/M/S):(N/FCFS)$
Explain clearly the meaning of each symbol in the model

(4marks)

Q2. a) The following table shows the jobs of a network along with their time estimates. The time estimates are in days:

Job	1-2	1-6	2-3	2-4	3-5	4-5	5-8	6-7	7-8
a	3	2	6	2	5	3	1	3	4
m	6	5	12	5	11	6	4	9	19
b	15	14	30	8	17	15	7	27	28

i. Draw the project network **(5marks)**

ii. Find the critical path **(3marks)**

iii. Find the probability that the project is completed in 31 days. **(3marks)**

a) Solve the following assignment problem in order to minimize the cost $(KES\ '000)$. The cost matrix given below gives the assignment cost when different operators are assigned to various machines.

(9marks)

Operators

Machines	I	II	III	IV	V
A	30	25	33	35	36
B	23	29	38	23	26
C	30	27	22	22	22
D	25	31	29	27	32
E	27	29	30	24	32

Q3. a) Find the initial basic feasible solution for the following transportation problem using the Vogel's Approximation Method

Destination

Origin		D_1	D_2	D_3	D_4	**Supply**
	O_1	11	13	17	14	250
	0_2	16	18	14	10	300
	O_3	21	24	13	10	400
	Demand	200	225	275	250	950

(10 marks)

b) Arrivals in a telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and the next. The length of a telephone call is assumed to be distributed exponentially with mean 3 minutes.

i. What is the probability that a person arriving at the booth will have to wait? **(3marks)**

ii. What is the average length of the queue that forms from time to time? **(3marks)**

iii. The telephone department will install a second booth when convinced that an arrival would except to have to wait at least three minutes for the phone. By how much must the flow of arrivals be increased in order to justify second booth? (**4marks)**

Q4. a) A company is producing a single product and is selling it through fire agencies situated in different cities. All of a sudden there is demand for the product in another five cities not having any agency of the company. The company is faced with the problem of deciding on how to assign the existing agencies to dispatch the product to needy cities in such a way that the travelling distances is minimized. The distance (in km's) between the surplus and the deficit cities are given in the following distance matrix.

Surplus cities/Deficit cities	**Programmes**				
Programmers	**I**	**II**	**III**	**IV**	**V**
A	160	130	175	190	200
B	135	120	130	160	175
C	140	110	155	170	185
D	50	50	80	80	110
E	55	55	70	80	105

Determine the optimum assignment schedule. **(8 marks)**

b) Define the following terms as used in Queuing Theory; Reneging, Jockeying, Balking

(6marks)

c) In $(M/M/1):(\infty/FCFS)$ Queuing model, $p_n = (1-\rho)\rho^n$ where $\rho = \lambda/\mu < 1, n = 1,2,...$. Show that $L_s = \frac{\rho}{1-\rho}$ where L_s is the expected number of units in the system.

(6marks)

Q5. a) Tasks A,B,...,H ,I constitute a project with the notations;

$A < D, A < E, B < F, D < F, C < G, C < H, F < I, G < I$

Draw a graph to represent the sequence of tasks and find the minimum time of completion of the project, when the time (in days) of completion of each task is as follows.

The above constraints can be given in the following table

Task	A	B	C	D	E	F	G	H	I
Time (days)	8	10	8	10	16	17	18	14	9

(10marks)

b) Use dynamic programming to solve the LPP

$Max.Z = x_1 + 9x_2$

Subject to the constraints

$2x_1 + x_2 \leq 25$

$x_2 \leq 11$

$x_1, x_2 \geq 0$

(10marks)

END