RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Sciences Honours in Industrial Mathematics
Fourth Year - Semester II Examination – February 2023

MAT 4304 – OPERATIONAL RESEARCH II

Time allowed: Three (03) hours

Answer all (05) questions

1. The World Health Council has five medical teams available to allocate among three countries to improve health conditions. The council needs to determine how many teams to allocate to each of these countries to maximize the total effectiveness of the five teams. The measure of performance being used is additional person-years of life. Following table gives the estimated additional person-years of life (in thousands):

Medical Teams	Thousands of Additional Person-Years of Life		
	Country		
	1	2	3
0	0	0	0
1	45	20	50
2	70	45	70
3	90	75	80
4	105	110	100
5	120	150	130

Using dynamic programming determine how many teams to allocate to countries to maximize the measure of performance.

(100 marks)

2. A manufacturer has order to supply goods at a uniform rate of r per unit time. No shortages are allowed. He starts a production run every t time units, where t is fixed and the set up cost

per production run is C_3. Replacement is instantaneous. C_1 is the cost of holding one unit in inventory for a unit time.

Determine the optimum

i. production run. **(20 marks)**

ii. production quantity. **(20 marks)**

A particular item has a demand of 9,000 units per year. The setup cost is Rs. 100 per production cycle and the holding cost per unit is Rs. 2.40 per year. The replacement is instantaneous and no shortages are allowed. Determine

i. the economic lot size. **(20 marks)**

ii. the number of orders per year. **(20 marks)**

iii. the time between orders. **(20 marks)**

3. Consider the manufacturing model with no shortages. It is assumed that the run sizes are constant and that a new run will be started whenever inventory is zero. Let

r = number of items required per unit time

k = number of items produced per unit time

C_1 = cost of holding per item per unit time

C_3 = cost of setting up a production run

Q = number of items produced per run

t = time interval between runs

Determine the optimum:

i. lot size. **(20 marks)**

ii. time interval. **(20 marks)**

An item is produced at the rate of 50 items per day. The demand occurs at the rate of 25 items per day. The setup cost is Rs. 100 per production run and holding cost is 1 cent per unit of item per day. Assuming shortages are not permitted, determine

iii. economic lot size for one run. **(20 marks)**

iv. optimum time of production cycle. **(20 marks)**

v. minimum total cost for one run. **(20 marks)**

4. a) *Consider the following activities of a certain project:*

Activity	Days Required	Predecessor Activities
A	10	---
B	20	A
C	15	A
D	5	B
E	5	C
F	3	D, E
G	4	F
H	2	F
I	2	G, H

i. Draw a network for this problem and identify the critical path by applying the Critical Path Method (CPM). **(20 marks)**

ii. What is earliest time that the project can be completed? **(05 marks)**

iii. Construct linear programming models to determine the earliest and latest start times for each activity. **(10 marks)**

iv. Solve the models in part (iii) using MS Excel solver. **(15 marks)**

b) Suppose completion time of each activity of the project given in a) is uncertain and follow triangular distribution as given below:

Activity	Predecessor Activities	t_o	t_m	t_p
A	---	8	10	12
B	A	16	20	23
C	A	14	15	18
D	B	4	5	7
E	C	3	5	8
F	D, E	2	3	4
G	F	2	4	6
H	F	1	2	4
I	G, H	1	2	3

t_o: Optimistic time t_m : Most likely time t_p : Pessimistic time

i. Use mean and variance formulas used in PERT to identify the expected time and variance of each activity. **(30 marks)**

ii. What is the critical path? What is the expected time and variance of the critical path? **(10 marks)**

iii. Construct a 95% confidence interval for the expected time of the critical path. **(10 marks)**

5. A sample of 100 arrivals of customers at a retail sales depot is according to the following distribution:

Time between arrivals (minutes)	Frequency
0.5	2
1.0	6
1.5	10
2.0	25
2.5	20
3.0	14
3.5	10
4.0	7
4.5	4
5.0	2

A study of the time required to service customers by adding up the bills, receiving payments and placing packages yields the following distribution:

Time between service (minutes)	*Frequency*
0.5	12
1.0	21
1.5	36
2.0	19
2.5	7
3.0	5

Estimate the average customer waiting time and average percentage idle time of the server by simulating in MS Excel spreadsheet for the next 100 arrivals. **(100 marks)**

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