RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B. Sc. (Four Year) Degree in Industrial Mathematics

Fourth Year - Semester II Examination – July 2020

MAT 4304 – OPERATIONAL RESEARCH II

Time allowed: Three (03) hours

Answer all questions

1. (a) Linda Madison owns a business that provides hair and nail care services in a small town. Recently, Linda has decided to expand her business to include tanning and massage services for her clients. In order to accommodate these new services, Linda is relocating her business to a large facility. However, the new location will require some renovation before she relocates there. Linda has identified the following activities that must be performed before she can open at her new location:

Activity	***Description***	***Days Required***	***Predecessor Activities***
A	Install new plumbing	10	---
B	Order and receive furniture	20	---
C	Order and receive flooring	15	---
D	Construct partitions	5	---
E	Paint and wallpaper	5	A,D
F	Install furniture	3	E,B
G	Install flooring	4	E,C
H	Move inventory and record	2	F,G
I	Clean old shop	2	H

(i) Draw a network for this problem. **(20 marks)**

Answer to the following questions using MS Excel:

(ii) Use a linear programming model to identify the earliest start time for each activity. **(20 marks)**

(iii) What is earliest time the renovation can be completed? **(05 marks)**

(iv) Use a linear programming model to identify the latest start time for each activity. **(20 marks)**

(v) Summarize the earliest and latest start and finish times, the slack for each activity, and the critical activities. **(10 marks)**

(b) Refer to the part (a). Suppose that Linda's lease on her current facility expires in 20 days. The normal and crash times and costs for each activity in her moving project are summarized below. By what amount should each activity be crashed in order for her to complete the move within 20 days?

(25 marks)

	Normal		*Crash*	
Activity	***Time***	***Cost($)***	***Time***	***Cost***
A	10	11,000	7	15,000
B	20	5,000	18	6,000
C	15	3,000	12	3,500
D	5	1,500	3	2,000
E	5	750	2	1,200
F	3	600	1	1,200
G	4	1,000	2	1,500
H	2	250	1	450
I	2	200	1	300

2. At a small store of readymade garments, there is one clerk at the counter who is to check the bills, receive payments and place the packed garments into bags. The customers' arrival at the check counter is a random phenomenon and the time between the arrivals from one minute to five minutes. The service time varies from one minute to three minutes. Frequency distributions of arrival and service rates are given in the following table:

Time between arrivals (minutes)	***Frequency (%)***	***Service time (minutes)***	***Frequency (%)***
1	35	1.0	20
2	25	1.5	35
3	20	2.0	25
4	12	2.5	15
5	8	3.0	5

The Manger feels that the clerk at the counter is not sufficiently loaded with work and wants to assign him some additional work. But before taking a decision, Manager wants to know precisely by what percentage of time the clerk is idle.

(i) Using **MS Excel** and **simtools add-in**, perform 100 replications and find the percentage that the clerk is idle.

(60 marks)

(ii) Redo Part (i), assuming that the customer arrival and service times are Poisson distributed with arrival and service rates are 0.4 and 0.6 per minute respectively.

(40 marks)

3. 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. **(10 marks)**

(ii) production quantity. **(10 marks)**

The annual demand for an item is 3200 units. The unit cost is Rs. 6.00 and inventory carrying charges 25% per annum. If the cost of one procurement is Rs. 150.00, then determine:

(i) economic order quantity. **(20 marks)**

(ii) the time between two consecutive orders. **(20 marks)**

(iii) number of orders per year. **(20 marks)**

(iv) the optimal total cost. **(20 marks)**

4. 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. If the setup cost is Rs. 100.00 per setup and holding cost is Rs. 0.01 per unit of item per day, then find the economic lot size for one run, assuming that shortages are not permitted. Also, find

(i) the time of cycle. **(30 marks)**

(ii) minimum total cost per run. **(30 marks)**

5. A firm has just hired eight new employees and would like to determine how to allocate their time to four activities. The firm has just prepared the following table, which gives the estimated profit for each activity as a function of the number of new employees allocated to it:

	Number of New Employees								
Activities	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
1	22	30	37	44	49	54	58	60	61
2	30	40	48	55	59	62	64	66	67
3	46	52	56	59	62	65	67	68	69
4	5	22	36	48	52	55	58	60	61

Use Dynamic Programming method to determine the optimal allocation of new employees to the activities. **(100 marks)**

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