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UNIVERSITY EXAMINATIONS 2023/2024

THIRD YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE, BACHELOR OF SCIENCE IN MATHEMATICS, BACHELOR OF EDUCATION SCIENCE, BACHELOR OF COMPUTER TECHNOLOGY AND BACHELOR OF COMPUTER SCIENCE

SMS 3350: OPERATIONS RESEARCH

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Discuss the origin of operations research (3 Marks)

b) The annual demand per item is 6400 units. The unit cost is £ 12 and the inventory carrying charges 25% per annum. If the cost of procurement is £ 300 determine:

i. EOQ (2 Marks)

ii. No. of orders per year (2 Marks)

iii. Time between 2 consecutive orders (2 Marks)

iv. Optimal cost (2 Marks)

c) State the Queuing Theory and give examples where it is used (2 Marks)

d) Find the dual of the LPP

$Min\ W = 3y_1 + 2y_2$

subject to $y_1 + 3y_2 \geq 6$

$2y_1 + y_2 \geq 3$

$\boldsymbol{y_1 \geq 0, y_2 \geq 0}$ (3 Marks)

c) Find the initial basic feasible solution of the following transportation problem using North West corner rule (5 Marks)

Factory					Supply
	W1	W2	W3	W4	
F1	21	16	25	13	11
F2	17	18	14	23	13
F3	32	27	18	41	19
Demand	6	10	12		

The following are the time estimates and the precedence relationships of the activities in a project network.

Activity	Predecessor Activity	Duration weeks
A	-	3
B	A	5
C	A	7
D	B	9
E	C	6
F	D,E	4

i. Draw the network diagram. (2 Marks)

ii. Determine the critical path. (2 Marks)

g) Three machine shops A, B, C produces three types of products X, Y, Z respectively.

Each product involves operation of each of the machine shops. The time required for each operation on various products is given below. Formulate the linear programming problem that will maximize the profit. (5 Marks)

	A	B	C	Profit per unit
X	10	7	2	12
Y	6	3	4	30
Z	2	5	7	10
Available hours	15	77	88	

QUESTION TWO (20 MARKS)

a) The table below gives network relationship and their time estimates.

i. Identify the critical path and time required to complete the project. (8 Marks)

ii. What is the probability that the project will be completed in 20 days? (6 Marks)

Activity	T_0	t_m	t_p
1 to 2	2	2	8
2 to 4	0.5	2.5	7.5
2 to 3	1	1.5	11
3 to 4	0	0	0
4 to 5	6	7	8
3 to 5	1	2.5	7
4 to 6	3	4	11
5 to 6	4	6	8
3 to 6	1	2	3

A manufacturer has to supply his customers with 1200 units of his product per annum. The inventory carrying cost amounts to £ 1.2 per unit. The set-up cost per run is £ 160. Find:

i. EOQ (2 Marks)

ii. Minimum average yearly cost (2 Marks)

iii. Optimum no of orders per year (1 Marks)

iv. The optimum time between orders (optimum period of supply per optimum order) (1 Mark)

QUESTION THREE (20 MARKS)

a) Use graphical method to solve the following linear programming problem.

Minimize $Z=-x_1+2x_2$

Subject to: $-X_1+3X_2 \leq 10$

$X_1+X_2 \leq 6$

$X_1-X_2 \leq 2$

$X_1 \geq 0, X_2 \geq 0$ (10 Marks)

b) A company is producing a single product and is selling it through five agencies situated in different cities. All of a sudden there is a 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 traveling distances is minimized. The distance (in kms) between the surplus and deficit cities are given in the following distance — matrix.

Surplus programs					
programmers	I	11	111	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	35	70	80	105

Required:

Determine the optimum assignment schedule. (10 Marks)

QUESTION FOUR (20 MARKS)

a) At a service station, vehicles arrive at the rate of 24 per hour and the arrival rate follows poisson distribution. The servicing time of the vehicles follows exponential distribution and the servicing rate is 18 vehicles per hour. There are 4 servicing station. Find

i. The server idle time (4 Marks)

ii. Find the probability of having three vehicles in the system (2 Marks)

b) Find the initial solution of the problem below using north west corner rule and find the optimal solution using MODI. (14 Marks)

	City 1	City 2	City 3	City4	City 5	Supply
Factory 1	1	9	13	35	51	50
Factory 2	24	12	16	20	1	100
Factory 3	14	33	1	23	26	150
Demand	100	70	50	40	40	

QUESTION FIVE (20 MARKS)

Use simplex method to solve

Max $z = 4x_1 + 8x_2 + 5x_3$

Subject to; $x_1 + 2x_2 + 3x_3 \leq 18$

$2x_1 + 6x_2 + 4x_3 \leq 15$

$x_1, +4x_2, x_3 \geq 6$

$x_1, x_2, x_3 \geq 0$