Enroll. No._____

MARWADI UNIVERSITY

Faculty of Technology

Information and Communication Technology **B.Tech**

SEM: VI **MU FINAL EXAM** **April: 2023**

Subject: - Optimization Technique (01CT0614) **Date:- 28/04/2023**

Total Marks:-100 **Time: - 03:00 hours**

Instructions:

1. **All Questions are Compulsory.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **You must be able to provide the optimal solution to each question**

Question-1 Answer the Following Questions:

(a) Multiple Choice Questions [10]

1 Operations research practitioners do not
   a. Predict future operations
   b. Build more than one model
   c. Collect relevant data
   d. Build mathematical models

2 If two constraints do not intersect in a graph, then
   a. The problem is infeasible
   b. The solution is unbounded
   c. One of the constraint is redundant
   d. None of the above

3 Graphical method of Linear Programming uses
   a. Objective function equation
   b. Constraint equations
   c. Linear equations
   d. All of the above

4 Which of the following method is used to verify the optimality of the current solution of the transportation problem?
   a. North West Method
   b. Modified Distribution Method
   c. Least Cost Method
   d. All of the above

5 If a non-redundant constraint is removed from a LP problem then
   a. Solution will become always infeasible
   b. Feasible region will always become smaller
   c. Feasible region will always become larger
   d. None of the above

6 While solving an assignment problem, an activity is assigned to a resource through a square with zero opportunity cost because the objective is to
   a. Minimize the total assignment cost to zero
   b. Minimize the value of cost for that assignment as zero
   c. Minimize the total cost of the assignment
   d. None of the above

7 The Optimal solution for an assignment problem is obtained only if
   a. Each row and column has only one zero element
   b. Each row and column has at most two zero element
   c. The data are arranged in a square matrix
   d. None of the above

8 While drawing a network diagram, for each activity project, we must look for the
   a. Which activity precede the current activity
   b. Which activity follow the current activity
   c. Which activity can concurrently take place with the current activity
   d. All of the above

9 In any time cost trade off analysis,
   a. Cost increases as the time decreases
   b. Cost at the normal time is zero
   c. Cost increases as the time increases
   d. None of the above

10 If an opportunity cost value is used for an unused cell to test optimality, it should be
   a. Equal to Zero
   b. Most Negative Number
   c. Most Positive number
   d. Any value depending on experience

(b) Answer the Following Questions in short [10]

1 Give one real life example with mathematical model that resembles to linear programming model.

2 Enlist two points of difference between Linear and Non Linear Programming model.

3 What is meant by feasible solution of an LP problem?

4 What is the use of slack variables in Simplex method of LP problem?

5 Can transportation problem be applied to the triangular matrix?

6 What is the purpose of selecting the highest negative opportunity cost for MODI method in transportation problem?

7 There are N paths from source to destination in any network diagram. If for any non-critical random path, the time taken for reaching the destination from source is 52 hours, what will be the estimated time taken for the critical path?

8 Let SI and DJ (I=1,2,….., m; J=1,2,…..,n) be the supply and demand available, respectively, for a commodity at M godowns and N shopping malls. Let CIJ be the cost of transporting one unit of commodity from godown I to shopping mall J. Assume that

$$\sum_{I=1}^{M} S_I = \sum_{J=1}^{N} D_J$$

Then, for the calculation of the minimum cost using the optimality test MODI method, let NOU denote the number of unknown variables.
If NOU = f(M,N) i.e. NOU is an arbitrary function in form of variables M and N, then what could be the value of NOU?

9 Explain in short about any simulation model that you have developed in your real life.

10 Give an example of mathematical model satisfying unbounded region feasible solution using graphical representation.

Question-2 Answer the Following Questions:

(a) Define Operational Research. State and explain in brief the applications of Operational Research in four different sectors/fields. **[08]**

(b) Consider a mathematical model M with 1 objective function, 3 functional constraints and non-negative constraints. Let F denote the feasible solution pertaining to intersection of **all the constraints** defined for the model M. On removing one functional constraint, the feasible region becomes F' (F-DASH). Design such model M such that F=F' and represent in the graphical format. **[08]**

OR

(b) How PERT method helps a business manager in decision making? Compare and contrast CPM and PERT techniques. Under which conditions, would you recommend the scheduling of PERT technique. Justify your answer with appropriate reasons. Mention one limitation of the PERT technique. **[08]**

Question-3 Answer the Following Questions:

(a) A television company has three major departments for manufacturing two of its models- A and B. The monthly capacities of the departments are given below: **[08]**

	Per unit time requirement (hours)		Hours available this month
	Model A	Model B	
Department I	4	2.0	1600
Department II	2.5	1.0	1200
Department III	4.5	1.5	1600

The marginal profit per unit from model A is Rs 400 and from model B it is Rs. 100. Assuming that the company can sell any quantity of either product due to favourable market conditions, determine the optimum output for both the models and the highest possible profit for this month. Use Simplex method solve the problem.

(b) Use the graphical method to solve the following LP problem **[04]**
Minimize $Z= 2X_2 - X_1$ subject to the constraints
$3X_2 - X_1 \leq 10$ (ii) $X_1 + X_2 \leq 6$ (iii) $X_1 - X_2 \leq 2$
$X_1, X_2 \geq 0$

(c) What is meant by the term 'feasible region'? Why must this be a well-defined boundary for the maximization problem? What is meant by the term 'infeasible region' **[04]**

OR

(a) Use the Simplex method to solve the following LP problem: **[08]**
Maximize $Z= 3X_1 + 5X_2 + 4X_3$ subject to the constraints
$3X_2 + 2X_1 \leq 8$ (ii) $2X_2 + 5X_3 \leq 10$ (iii) $3X_1 + 2X_2 + 4X_3 \leq 15$
$X_1, X_2, X_3 \geq 0$

(b) A diet for sick person must contain minimum requirement units of the contents and given cost per unit (in Rs.) as shown in the table below. Formulate this problem as an LP model and solve it by graphical method to find combination of foods to be used to have least cost. **[04]**

Food	Unit Content of			Cost per Unit (in Rs.)
	Vitamin	Mineral	Calories	
A	200	1	40	4
B	100	2	40	3
Minimum Requirement	4000	50	1400	

(c) What is an 'unbounded region'? Explain how the unbounded region can be represented using the graphical method. Give an example for unbounded region using mathematical model. **[04]**

Question-4 Answer the Following Questions:

(a) The following table gives the cost of transporting material from supply points A,B,C and D to demand points E,F,G,H and I. **[08]**

	TO					
		E	F	G	H	I
FROM	A	8	10	12	17	15
	B	15	13	18	11	9
	C	14	20	6	10	13
	D	13	19	7	5	12

The present allocation is as follows: A to E is 90; A to F is 10; B to F is 150; C to F is 10; C to G is 50; C to I is 120; D to H is 210; D to I is 70.
Check if this allocation is optimum. If not, find an optimum schedule.
If in the above problem, the transportation cost from A to G is reduced to 10, what will be the new optimum schedule?

(b) Determine the percentage reduction of the initial basic feasible solution for the given transportation problem for North-West Corner Method and Least Cost Method, where O_i and D_j represents the ith origin and jth destination, respectively. **[08]**

	Destination					
		D1	D2	D3	D4	Supply
Source	O1	6	4	1	5	14
	O2	8	9	2	7	16
	O3	4	3	6	2	5
	Demand	6	10	15	4	

Also, obtain the final optimal solution to the given problem.
Explain why least cost method gives reduced cost as compared to North West Corner Rule.

OR

(a) A company has received a contract to supply gravel to three new construction projects located in towns A,B and C. The construction engineers have estimated that the required amounts of gravel which will be needed at these construction projects are given in the table: **[08]**

Project Location	Weekly Requirement (Truckloads)
A	72
B	102
C	41

The company has 3 gravel pits located in towns X,Y and Z. The gravel required by the construction projects can be supplied by three pits. The amount of gravel that can be supplied by three pits. The amount of gravel that can be supplied by each pit is as follows:

Plant	X	Y	Z
Amount available (truckloads)	76	82	77

The company has computed the delivery cost from each pit to each project site. These costs (in Rs.) are shown in the following table:

	Project Location			
PITS		A	B	C
	X	4	8	8
	Y	16	24	16
	Z	8	16	24

Schedule the shipment from each pit to each project in such a manner that it minimizes the total transportation cost within the constraints imposed by pit capacities and project requirements. Also find the minimum cost.

(b) Determine the percentage reduction of the initial basic feasible solution for the given transportation problem for North-West Corner Method and Least Cost Method, where O_i and D_j represents the ith origin and jth destination, respectively. **[08]**

	Destination					
Source		D1	D2	D3	D4	Supply
	O1	11	13	17	14	250
	O2	16	18	14	10	300
	O3	21	24	13	10	400
	Demand	200	225	275	250	

Also, obtain the final optimal solution to the given problem.
Explain why least cost method gives reduced cost as compared to North West Corner Rule.

Question-5 Answer the Following Questions:

(a) A leads draftsman has five drafting tasks to accomplish and five idle draftsmen. Each draftsman is estimated to require the following number of hours for each task. **[06]**

		Tasks				
		1	2	3	4	5
Employees	A	60	50	100	85	95
	B	65	45	100	75	90
	C	70	60	110	97	85
	D	70	55	105	90	93
	E	60	40	120	85	97

If each draftsman costs the company Rs. 15.80 per hour, including overhead, find the assignment of draftsmen to tasks that will result in the minimum total cost. What would be the total cost?

(b) We have 5 jobs, each of which must go through the machines A, B and C in an order. Processing time (in hours) is as follows: **[06]**

Job	**1**	**2**	**3**	**4**	**5**
Machine A	5	7	6	9	5
Machine B	2	1	4	5	3
Machine C	3	7	5	6	7

Determine the sequence for the jobs that will minimize the total elapsed time. Calculate the idle time for each machine.

(c) Explain the meaning of modelling in terms of Operational Research. Suppose you design a system using MPU6050 (Accelerometer-Gyroscope) Sensor. Let the values obtained by using the sensor be AX, AY, GX and GY corresponding to X,Y axes each for accelerometer and gyroscope respectively. **[04]**

Let $P = [AX \quad AY \quad GX \quad GY]^T$. Dimension of P is 4 x 1. But for some reason the sensor was placed at an angle Θ with X-Axis that generated the readings as AX', AY', GX' and GY' corresponding to X,Y axes each for accelerometer and gyroscope respectively.

Let $Q = [AX' \quad AY' \quad GX' \quad GY']^T$. Dimension of Q is 4 x 1. Design a mathematical model that maps P to Q. Give the justification for the same.

[Hint: Use the concept of AX=B, where X is the transformation matrix from A to B.]

OR

(a) An automobile dealer wishes to put four repairmen to four different jobs. The repairmen have somewhat different kinds of skills and they exhibit different levels of efficiency from one job to another. The dealer has estimated the number of man-hours that would be required for each job-man combination. This is given in matrix form in the following table: **[06]**

		Jobs			
		A	B	C	D
Men	1	5	3	2	8
	2	7	9	2	6
	3	6	4	5	7
	4	5	7	7	8

Find the optimal assignment that will result in minimum man-hours needed. What would be the total hours for completion of the tasks?

(b) We have 7 jobs, each of which must go through the machines A, B and C in an order. Processing time (in hours) is as follows: **[06]**

Job	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Machine A	3	8	7	4	9	8	7
Machine B	4	3	2	5	1	4	3
Machine C	6	7	5	11	5	6	12

Determine the sequence for the jobs that will minimize the total elapsed time. Calculate the idle time for each machine.

(c) Define Simulation. Being an ICT engineer, you are asked to design a **random number generator system**. Design a mathematical model for the same. Explain the model that you have designed. **[04]**

Question-6 Answer the Following Questions:

(a) A sociologist plans a questionnaire survey (activity), consisting of the following tasks: **[08]**

Activity	Immediate Predecessor	Duration (in days)		
		Likely	Minimum	Maximum
A	---	5	4	6
B	---	12	8	16

C	A	5	4	12
D	B	3	1	5
E	D, A	2	2	2
F	B	5	4	6
G	C, E, F	14	10	18
H	G	20	18	34

(i) Draw the network diagram for the set of activities given.
(ii) Calculate the earliest and latest completion times of each event
(iii) Determine the critical path and the time taken to complete the entire task

(b) Explain Ant Colony Optimization giving real life examples. **[04]**

(c) What is an assignment problem? Give two applications of an assignment problem. What is meant by unbalanced assignment problem? How is the Hungarian method applied for obtaining a solution if the matrix is rectangular? **[04]**

OR

(a) A nationalized bank wishes to plan and schedule the development of the new computerized system. The sequence of activities follows particular sequence of order. The time taken for the activity is as mentioned in the table below: **[08]**

Activity	Immediate Predecessor	Duration (in days)		
		Optimistic	Likely	Pessimistic
A	---	5	8	17
B	---	3	12	15
C	A	4	7	10
D	A	5	8	23
E	B, C	1	1	1
F	B, C	1	4	13
G	D, E	3	6	9
H	D, E	1	2.5	7
I	H	1	1	1
J	F, G	2	2	2
K	G, I	5	8	11

(i) Draw the network diagram for the set of activities given.
(ii) Calculate the earliest and latest completion times of each event
(iii) Determine the critical path and the time taken to complete the entire task

(b) What do you mean by Swarm Intelligence. Explain the requirement of Swarm Intelligence in the field of Artificial Intelligence. **[04]**

(c) Show that an assignment problem is a special case of transportation problem. **[04]**

---Best of Luck---

Course Outcome Wise Questions

Subject Code	**01CT0614**	Subject	**OPTIMIZATION TECHNIQUES**

CO No.	Course Outcome
CO1	Cast engineering minima/maxima problems into optimization framework.
	1(A), 1(B), 2(A)
CO2	Learn efficient computational procedures to solve optimization problems
	1(A), 1(B), 2(B), 2(B-Or), 3(C), 3(C-Or), 4(B), 4(B-Or), 6(B), 6(B-Or), 6(C), 6(C-Or)
CO3	Apply optimization concepts to deal with real world situations
	3(A), 3(A-Or), 3(B), 3(B-Or), 4(A), 4(A-Or), 5(A), 5(A-Or), 5(B), 5(B-Or), 6(A), 6(A-Or)
CO4	Design the simulation model for the given case study problem
	5(C), 5(C-Or)

Blooms Taxonomy	Question List
Remember / Knowledge	1(A), 1(B)
Understand	1(A), 1(B), 2(A), 2(B), 2(B-Or), 3(C)
Apply	1(B), 3(A), 3(A-Or), 3(B), 3(B-Or), 3(C-Or), 6(A), 6(A-Or), 6(B), 6(B-Or), 6(C), 6 (C-Or)
Analyze	4(A), 4(A-Or), 4(B), 4(B-Or)
Evaluate	5(A), 5(A-Or), 5(B), 5(B-Or)
Higher order Thinking / Creative	5(C), 5(C-Or)