Avinashilingam Institute for Home Science and Higher Education for Women

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Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Master's Degree Examination – May 2025
II Semester

Class : I M.C.A./2023 Batch/2022 Batch **Time: 3 Hours**
Major : Computer Applications **Max. Marks: 100**

23MCAC08 Optimization Techniques

Course Outcomes:
CO1: Formulate a real-world problem as a mathematical programming model with application software.
CO2: Solve the Linear Problems and analyze the simplex and dual simplex principles.
CO3: Apply optimality and allocation methods for resources.
CO4: Demonstrate network scheduling concepts and apply critical path analysis and time estimate forreal time project completion.
CO5: Apply sequencing algorithm for job scheduling.

Part A **10 x 1 = 10**
Choose the Correct Answer

1. A basic feasible solution is called non-degenerate basic feasible solution if it has exactly m positive X_i (i-1, 2, …m), and, none of the basic variable is CO1K1

   a. Infinity b. One c. Zero d. None of the above

2. In the Dual Simplex Method, what condition must be satisfied for a basic variable to be eligible for leaving the basis? CO1K1
   a. The corresponding coefficient in the objective row must be negative
   b. The corresponding value in the right-hand side (RHS) must be negative
   c. The pivot column must have all positive entries
   d. The reduced cost must be zero

3. The solution to a transportation problem with m supplies and n destinations is feasible if the number of positive allocations are CO2K2

   a. m + n b. m x n c. m + n – 1 d. m + n + 1

4. In the MODI (Modified Distribution) Method for solving transportation problems, what is the primary purpose of computing the u_i and v_j values? CO2K2

   a. To determine the optimality of the current solution
   b. To find the feasibility of the initial basic feasible solution
   c. To maximize the total transportation cost
   d. To check whether the supply and demand constraints are satisfied

5. In marking assignments, which of the following should be used? CO3K1
   a. Only row having single zero b. Only column having single zero
   c. Only row/ column having single zero d. Column having more than one zero

6. In the Hungarian Method, what is the first step in solving an assignment problem? CO3K1
   a. Assign tasks randomly to workers
   b. Subtract the smallest element in each row from all elements in that row
   c. Check if all assignments are optimal
   d. Convert the problem into a transportation problem

7. The shortest possible time in which an activity can be achieved under ideal circumstances is known as CO4K1
   a. Pessimistic time estimate b. Optimistic time estimate
   c. Expected time estimate d. Most likely time estimate

8. Which of the following statements is true about slack time in CPM? CO4K1
   a. Slack time is the extra time that a critical activity can be delayed without delaying the project
   b. Slack time is the time difference between the latest and earliest start times of an activity
   c. Slack time is always zero for non-critical activities
   d. Activities on the critical path always have positive slack

9. In Replacement Theory, which factor is most commonly considered when deciding to replace an asset? CO5K2
   a. The colour and design of the asset
   b. The initial cost of the asset only
   c. The trade-off between maintenance costs and the cost of a new asset
   d. The number of employees using the asset

10. Which of the following sequencing rules is commonly used to minimize the total completion time in a single-machine scheduling problem? CO5K2
   a. Shortest Processing Time (SPT) rule b. First Come, First Served (FCFS) rule
   c. Earliest Due Date (EDD) rule d. Longest Processing Time (LPT) rule

Part B **5 x 6 = 30**

Answer ALL questions

Each answer should not exceed 400 words or two pages

11.a. A manufacturing company is engaged in producing three types of products: CO1K3
A, B and C. The production department produces, each day, components sufficient to make 50 units of A, 25 units of B and30 units of C. The management is confronted with the problem of optimizing the daily production of the products in the assembly department, where only 100 man-hours are available daily for assembling the products. The following additional information is available:

Type of Product	*Profit Contribution per Unit of Product* (*Rs*)	*Assembly Time per Product* (*hrs*)
A	12	0.8
B	20	1.7
C	45	2.5

The company has a daily order commitment for 20 units of products A and a total of 15 units of products B and C. Formulate this problem as an LP model so as to maximize the total profit.

(or)

11.b. Use the graphical method to solve the following LP problem. CO1K3

Maximize $Z = 7x1 + 3x2$
subject to the constraints
(i) $x1 + 2x2 \geq 3$ (ii) $x1 + x2 \leq 4$
(iii) $0 \leq x1 \leq 5/2$ (iv) $0 \leq x2 \leq 3/2$
and $x1, x2 \geq 0$.

12.a. A company has three production facilities *S*1, *S*2 and *S*3 with production capacity of 7,9 and 18 units (in 100s) per week of a product, respectively. These units are to be shipped to four warehouses *D*1, *D*2, *D*3 and *D*4 with requirement of 5, 6, 7 and 14 units (in 100s) per week, respectively.The transportation costs (in rupees) per unit between factories to warehouses are given in the table below:

	*D*1	*D*2	*D*3	*D*4	*Supply(Availability)*
*S*1	19	30	50	10	7
*S*2	70	30	40	60	9
*S*3	40	8	70	20	18
Demand	5	8	7	14	34

(Requirement)

Formulate this transportation problem as an LP model to minimize the total transportation cost. CO2K3

(or)

12.b. A dairy firm has three plants located in a state. The daily milk production at each plant is as follows: Plant 1 : 6 million litres, Plant 2 : 1 million litres, and Plant 3 : 10 million litres. Each day, the firm must fulfil the needs of its four distribution centres. The minimum requirement of each centre is as follows: CO2K3

Distribution centre 1 : 7 million litres, Distribution centre 2 : 5 million litres,
Distribution centre 3 : 3 million litres, and Distribution centre 4 : 2 million litres

Cost (in hundreds of rupees) of shipping one million litre from each plant to each distribution centre is given in the following table:

		Distribution Centre			
		*D*1	*D*2	*D*3	*D*4
	*P*1	2	3	11	7
Plant	*P*2	1	0	6	1
	*P*3	5	8	15	9

Find the initial basic feasible solution for the given problem by using North-west corner rule method.

13.a. A computer centre has three expert programmers. The centre wants three application programmes to be developed. The head of the computer centre, after carefully studying the programmes to be developed, estimates the computer time in minutes required by the experts for the application programmes as follows: CO3K4

		Programmers		
		A	*B*	*C*
	1	120	100	180
Programmes	*2*	180	190	110
	3	110	140	120

Assign the programmers to the programmes in such a way that the total computer time is minimum.

(or)

13.b. Five men are available to do five different jobs. From past records, the time (in hours) that each man takes to do each job is known and is given in the following table:

		Jobs				
		I	*II*	*III*	*IV*	*V*
	A	2	9	2	7	1
	B	6	8	7	6	1
Men	*C*	4	6	5	3	1
	D	4	2	7	3	1
	E	5	3	9	5	1

Find out how men should be assigned the jobs in way that will minimize the total time taken. CO3K5

14.a. Explain in detail about major difference between PERT and CPM with the neat diagram and example. CO4K3

(or)

14.b. Discuss in detail about the rules for the construction of networks and labelling the nodes with the relevant examples and diagram. CO4K3

15.a. The data on the operating cost per year and resale price of equipment A whose purchase price is Rs 10,000 are given below: CO5K4

Year :	1	2	3	4	5	6	7
Operating cost (Rs) :	1,500	1,990	2,300	2,900	3,600	4,500	5,500
Resale value (Rs) :	5,000	2,500	1,250	600	400	400	400

i. What is the optimum period for replacement?

ii. When equipment A is two years old, equipment B, which is a new model for the same usage, is available. The optimum period for replacement is four years with an average cost of Rs 3,600. should we change equipment A with equipment B? If so, when?

(or)

15.b. There are seven jobs, each of which has to go through the machines A and B in the order AB. Processing times in hours are as follows: CO5K4

Job :	1	2	3	4	5	6	7
Machine A :	3	12	15	6	10	11	9
Machine B :	8	10	10	6	12	1	3

Determine a sequence of these jobs that will minimize the total elapsed time T. Also find T and idle time for machines A and B.

Part C 5 x 12 = 60

Answer ALL questions

Each answer should not exceed 800 words or four pages

16.a. A firm produces two products A and B. Each product must be processed through two departments namely 1 and 2. Department 1 has 30 hours of production capacity per day, and department 2 has 60 hours. Each unit of product A requires 2 hours in department 1 and 6 hours in department 2. Each unit of product B requires 3 hours in department 1 and 4 hours in department 2. Management has rank ordered the following goals it would like to achieve in determining the daily product mix: CO1K5

$P1$: Minimize the under achievement of joint total production of 10 units.

$P2$: Minimize the under achievement of producing 7 units of product B.

$P3$: Minimize the under achievement of producing 8 units of product A.

Formulate this problem as a GP model and then solve it by using the graphical method.

(or)

16.b. Use modified simplex method to solve the following GP problem. CO1K5

Minimize $z = P_1d_1^- + P_2d_4^+ + 5P_3d_2^- + 3P_3d_3^- + P_4d_1^+$

subject to

$$x_1 + x_2 + d_1^- - d_1^+ = 80$$
$$x_1 + d_2^- - d_2^+ = 70$$
$$x_2 + d_3^- - d_3^+ = 45$$
$$d_1^+ + d_4^- - d_4^+ = 10$$
$$x_1, x_2, d_1^-, d_2^-, d_3^-, d_1^+, d_4^-, d_4^+ \geq 0$$

17.a. Determine an initial basic feasible solution to the following transportation problem by using CO2K4

(i) LCM and (ii)VAM

	Destination				
	*D*1	*D*2	*D*3	*D*4	*Supply*
*S*1	21	16	15	3	11
S2	*17*	*18*	*14*	*23*	*13*
S3	*32*	*27*	*18*	*41*	*19*
Demand	6	6	8	23	

(or)

17.b. Apply MODI method to obtain optimal solution of transportation problem using the data given below: CO2K4

	*D*1	*D*2	*D*3	*D*4	*Supply*
*S*1	19	30	50	10	7
*S*2	70	30	40	60	9
*S*3	40	18	70	20	18
Demand	5	8	7	14	34

18.a. A lead 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. CO3K4

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

(or)

18.b. Five swimmers are eligible to compete in a relay team that is to consist of four swimmers swimming four different swimming styles. The styles are – back stroke, breast stroke, free style and butterfly. The time taken by the five swimmers – Anand, Bhasker, Chandru, Dorai and Easwar, to cover a distance of 100 metres in various swimming styles is given below, in minutes, seconds. CO3K4

- Anand swims the back stroke in 1 : 09, the breast stroke in 1 : 15 and has never competed in the free style or butterfly.
- Bhasker is a free style specialist averaging 1 : 01 for the 100 metres but can also swim the breast stroke in 1 : 16 and butterfly in 1 : 20.
  Chandru swims all styles: back 1 : 10, butterfly 1 : 12, free style 1 : 05 and breast stroke 1 : 20.
- Dorai swims only the butterfly 1 : 11, while Easwar swims the back stroke 1 : 20, breast stroke 1 : 16, free style 1: 06 and the butterfly 1 : 10.Which swimmer should be assigned which swimming style? Who will not be in the relay?

19.a. A research and development department is developing a newpower supply for a console television set. It has broken the job down into the following: CO4K5

Job	*Description*	*Immediate Predecessors*	*Time* (*days*)
A	Determine output voltages	–	5
B	Determine whether to use solid state rectifiers	*A*	7
C	Choose rectifier	B	2
D	Choose filters	*B*	3
E	Choose transformer	*C*	1
F	Choose chassis	*D*	2
G	Choose rectifier mounting	*C*	1
H	Layout chassis	*E, F*	3
I	Build and test	*G, H*	101

i. Draw the network diagram of activities involved in the project and indicate the critical path.

ii. What is the minimum completion time for the project?

(or)

19.b. The following network diagram represents activities associated with a project: CO4K5

Activities :	A	B	C	D	E	F	G	H	I
Optimistic time, *t*0 :	5	18	26	16	15	6	7	7	3
Pessimistic time, *tp*:	10	22	40	20	25	12	12	9	5
Most likely time, *tm* :	8	20	33	18	20	9	10	8	4

Determine the following:

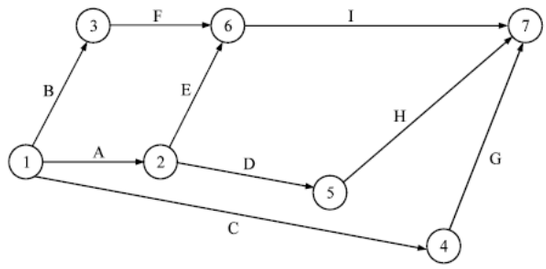
i. Expected completion time and variance of each activity

ii. The earliest and latest expected completion times of each event.

iii. The critical path.

iv. The probability of expected completion time of the project if the original scheduled time of Completing the project is 41.5 weeks.

v. The duration of the project that will have 95 per cent chance of being completed.



20.a. A computer contains 10,000 resistors. When any resistor fails, it is replaced. The cost of replacing a resistor individually is Re 1 only. If all the resistors are replaced at the same time, the cost per resistor would be reduced to 35 paise. The percentage of surviving resistors say *S*(*t*) at the end of month *t* and the probability of failure *P*(*t*) during the month *t* are as follows: CO5K4

t :	10	11	12	13	14	15	16
s(*t*) :	100	97	90	70	30	15	0
P(*t*) :	–	0.03	0.07	0.20	0.40	0.15	0.15

What is the optimal replacement plan?

(or)

20.b. Find an optimal sequence for the following sequencing problems of four jobs and five machines, when passing is not allowed. Its processing time (in hours) is given below: CO5K4

Job Machine	*M*1	*M*2	*M*3	*M*4	*M*5
A	7	5	2	3	19
B	6	6	4	5	10
C	5	4	5	6	18
D	8	3	3	2	16

Also find the total elapsed time.

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