**D 143202** **(Pages : 4)** **Name.....**

**Reg. No.....**

**FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2026**

(CBCSS)

Mathematics

MTH4C16—OPTIMIZATION TECHNIQUES IN OPERATIONS RESEARCH

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**Part A**

*Answer* **all** *the questions.*
*Each question carries a weightage of* 1.

1. Explain Critical Path Method.
2. Differentiate between FF limit method and Stepping step method.
3. What is a sequencing problem. Give an example.
4. Give a brief account of Bellman's Optimal Principle.
5. Decide the definiteness of the function

   $f(X) = -3x_1^2 + 2x_2^2 - 3x_3^2 - 10x_1x_2 + 4x_2x_3 + 6x_1x_3$.
6. Define unimodal function. Give an example.
7. Find the lower bound for $f(x) = x^{-4} + 4x^3 + 4x, x > 0$.
8. Write Arithmetic-Geometric mean inequality.

(8 × 1 = 8 weightage)

**Part B**

*Answer any* **two** *questions from each module.*
*Each question carries a weightage of* 2.

MODULE I

9. Construct a network where the activities satisfy the requirements : (i) A and B are the first activities of the project to start simultaneously ; (ii) A and B precede C ; (iii) B precedes D and E ; (iv) A and B precede F ; (v) F and D precede G and H ; (vi) C and G precede I ; and (vii) E, H and I are the terminal activities.

**Turn over**

10. There are six jobs each of which is to be processed through the machines $M_1$ and $M_2$ in order $M_1M_2$. The processing time is given in hours. Determine the sequence of these jobs which minimizes the total elapsed time.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Job number | : | 1 | 2 | 3 | 4 | 5 | 6 |
| Processing time on $M_1$ | : | 5 | 9 | 4 | 7 | 8 | 5 |
| Processing time on $M_2$ | : | 8 | 4 | 8 | 3 | 6 | 6 |

11. Consider the data :

| *Activity* | | $t_0$ | $t_p$ | $t_m$ |
|---|---|---|---|---|
| (1, 2) | ... | 2 | 8 | 5 |
| (1, 3) | ... | 1 | 7 | 4 |
| (2, 3) | ... | 0 | 0 | 0 |
| (2, 4) | ... | 2 | 6 | 4 |
| (2, 6) | ... | 5 | 12 | 7 |
| (3, 4) | ... | 3 | 10 | 7 |
| (3, 5) | ... | 3 | 3 | 6 |
| (4, 5) | ... | 2 | 8 | 5 |
| (4, 6) | ... | 4 | 10 | 6 |
| (5, 6) | ... | 2 | 6 | 4 |

(a) Find the probability that the earliest (starting) occurrence time of event 4 is less than or equal to 13 days ;

(b) Find the probability that the project is completed in 23 days.

MODULE II

12. Find the maximum of sum of cubes of three positive value integers whose product does not exceed 5.

13. Solve the following nonlinear programming problem by Lagrange multiplier method,

$$\text{Max : } f(X) = 4x_1^2 + 2x_2^2 + x_3^2 - 4x_1x_2$$

$$\text{subject to } x_1 + x_2 + x_3 = 15$$

$$2x_1 - x_2 + 2x_3 = 20$$

$$x_1, x_2, x_3 \geq 0.$$

14. Formulate the approximate LPP for the following separable programming problem and find its solution: $\max f(X) = \sin(\pi x_1 / 4) + x_2$ subject to $x_1^2 - 3x_2 \leq 4$, $x_1, x_2 \geq 0$.

MODULE III

15. Find the minimum of $f(x) = x(1.5 - x)$ in the interval [0, 1] to within 10 % of the exact value. Take $\delta = 0.001$.

16. Explain Fibonacci search method.

17. Use conjugate gradient method to optimize the non-linear function min $x_1^2 - x_1x_2 + 3x_2^2$, initial approximation $X_i = (1, 2)^T$.

(6 × 2 = 12 weightage)

## Part C

*Answer any* **two** *questions.*

*Each question carries a weightage of* 5.

18. (a) Write an algorithm for the sequencing problem of two jobs on ordered $m$ machines.

(b) Use the graphical methods minimize the time required to process the following jobs on two machines. Find the job which should be processed first. Also, calculate the total elapsed time to complete both jobs.

| Job 1 | | | | | | |
|---|---|---|---|---|---|---|
| | Order | A | B | C | D | E |
| | Time | 3 | 4 | 2 | 6 | 2 |

| Job 2 | | | | | | |
|---|---|---|---|---|---|---|
| | Order | B | C | A | D | E |
| | Time | 5 | 4 | 3 | 2 | 6. |

19. Solve the following LPP using dynamic programming :

$$\text{Max } y_0 = 28y_1 + 7y_2$$

$$\text{subject to } 4y_1 + 3y_2 \leq 12$$

$$2y_1 + 5y_2 \leq 10$$

$$y_1, y_2 \geq 0.$$

**Turn over**

20. (a) What is a convex quadratic programming problems (CQPP).

(b) Use Wolfe's method to solve the following nonlinear programming problem :

$$\text{Max } f(X) = -2x_1^2 - 3x_2^2 - 4x_1x_2 + 6x_1 + 3x_2$$

$$\text{subject to } x_1 + x_2 \leq 1$$

$$2x_1 + 3x_2 \leq 4$$

$$x_1, x_2 \geq 0.$$

21. (a) Minimize the following function [$m = k + 1$, $m = 3$, $k = 2$]

$$f = 4x_1^2 - x_2^{-3} + 5x_1^{-3}x_2 + 7x_1x_2,\ x_1x_2 > 0.$$

(b) Define a posynomial.

(2 × 5 = 10 weightage)

**D 143202–A** **(Pages : 5)** **Name.....**

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Mathematics

MTH4C16—OPTIMIZATION TECHNIQUES IN OPERATIONS RESEARCH

(2019 Admission onwards)

(Multiple Choice Questions for SDE Candidates)

| **Time : 20 Minutes** | **Total No. of Questions : 20** | **Maximum : 5 Weightage** |
|---|---|---|

## INSTRUCTIONS TO THE CANDIDATE

1. This Question Paper carries Multiple Choice Questions from 1 to 20.
2. The candidate should check that the question paper supplied to him/her contains all the 20 questions in serial order.
3. Each question is provided with choices (A), (B), (C) and (D) having one correct answer. Choose the correct answer and enter it in the main answer-book.
4. The MCQ question paper will be supplied after the completion of the descriptive examination.

MTH4C16—OPTIMIZATION TECHNIQUES IN OPERATIONS RESEARCH

(Multiple Choice Questions for SDE Candidates)

1. The time required by each job on each machine is called ———— time.

   (A) Elapsed. (B) Idle.

   (C) Processing. (D) Average.

2. The points at which an activity starts or ends are called :

   (A) Node. (B) Network.

   (C) Project. (D) Path.

3. An activity $(i, j)$ is called critical activity if and only if :

   (A) $ES_i = LC_i$, $ES_j = LC_j$, $ES_j - ES_i = LC_j - LC_i = t_{ij}$.

   (B) $ES_j = LC_j$, $ES_j - ES_i = LC_j - LC_i = t_{ij}$.

   (C) $ES_i = LC_i$, $ES_j - ES_i = LC_j - LC_i = t_{ij}$.

   (D) $ES_i = LC_i$, $ES_j = LCj$.

4. In the network of the project for which the activities E precedes G and H means.

   (A) E $\rightarrow$ G $\rightarrow$ H. (B) H $\rightarrow$ G $\rightarrow$ E.

   (C) E $\rightarrow$ G, E $\rightarrow$ H. (D) G $\rightarrow$ E, H $\rightarrow$ E.

5. An optimal policy has the property that whatever the initial state and initial decision are the remaining decisions must constitute an optimal policy with regard to the state resulting from the preceding decision, is called :

   (A) Forward Recursion. (B) Backward Recursion.

   (C) Dynamic method. (D) Bellman's optimality.

6. A quadratic form $X^T AX$ is said to be positive definite if :

   (A) $X^T AX > 0 \ \forall X \neq 0$.

   (B) $X^T AX \geq 0 \ \forall X \neq 0$ at least one $X \neq 0$, $X^T AX = 0$.

   (C) $X^T AX < 0 \ \forall X \neq 0$.

   (D) $X^T AX \leq 0 \ \forall X \neq 0$ at least one $X \neq 0$, $X^T AX = 0$.

7. If $f(X) = x_1^2 - 2x_2^2$ then $f$ is :

(A) Positive definite. (B) Negative definite .

(C) Positive semi definite. (D) Indefinite.

8. The Assembly line scheduling and longest common subsequence problems are an example of :

(A) Greedy algorithm. (B) Branch and bound method.

(C) Geometric method. (D) Dynamic algorithm.

9. For the matrix $\begin{bmatrix} -3 & -5 & 3 \\ -5 & 2 & 2 \\ 3 & 2 & -3 \end{bmatrix}$ we have $D_2$ is :

(A) 32. (B) – 31.

(C) 16. (D) – 10.

10. For a quadratic $X^T AX$, $X^*$ is a point of relative maximum if A is :

(A) Node. (B) Negative definite.

(C) Saddle point. (D) Positive definite.

11. The function $L \equiv L(X, \lambda) = f(X) + \sum_{i=1}^{m} \lambda_i g_i(X)$ is called :

(A) Lagrange function. (B) Optimal function.

(C) Constraint function. (D) None of these.

12. Let $f(X) = X^T AX$. Then $f(X)$ is convex in $R^n$ if $X^T AX$ is :

(A) Convex. (B) Concave.

(C) Positive semi definite. (D) Negative semi definite.

**Turn over**

13. A mathematical programming problem in which the objective function and constraint are separable is called :

(A) Linear Programming problem. (B) Dynamic programming problem.

(C) Integer programming problem. (D) Separable programming problem.

14. Let $f(X)$ and G (X) be convex differentiable functions, and let $X_1 \in P_F$ and $(X_2, \lambda) \in S_D$. Then :

(A) $f(X_1) = 0$. (B) $\phi(X_2, \lambda) = 0$.

(C) $f(X_1) \geq \phi(X_2, \lambda)$. (D) $f(X_1) \leq \phi(X_2, C)$.

15. A function which has only one peak in a given interval is called :

(A) Unimodal function. (B) Maxima of a function.

(C) Lagrange function. (D) Minima of a function.

16. In this method two experiments are placed as close as possible to the centre of the interval of uncertainty.

(A) Newton-Raphson method. (B) Steepest decent method.

(C) Fibonacci search method. (D) Dichotomous search method.

17. Two vectors $s1$ and $s2$ in R $n$ are said to be conjugate vectors with respect to H if :

(A) $s_1^T Hs_2 > 0$. (B) $s_1^T Hs_2 = 0$.

(C) $s_1^T Hs_2 < 0$. (D) $s_1^T Hs_2 \neq 0$.

18. The technique used for solving problems involving posynomials is called :

(A) Dynamic programming. (B) Goal programming.

(C) Geometric programming. (D) Linear programming.

19. The geometric programming is cannot be applied in :

(A) Posynomial optimization. (B) Linear optimization.

(C) Oil tank design problem. (D) Gravel box design problem.

20. The direct cost of project increases and indirect cost decreases if the duration of the project is :

(A) No change. (B) Increased.

(C) Medium change. (D) Reduced.