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M.A./M.Sc. (Fourth Semester)
EXAMINATION, MAY-JUNE, 2022
STATISTICS
Paper Third
(Operations Research–II)

Time : Three Hours] *[Maximum Marks : 80*

Note : Attempt all sections as directed.

(Section-A)

(Objective/Multiple Choice Questions)

(1 mark each)

Note - Attempt all questions.

Choose the most appropriate answer.

1. The problem of replacement is felt when job performing units fail -
   (A) Suddenly
   (B) Gradually
   (C) Both (A) and (B)
   (D) (B) but not (A)

2. The probability of survival to an age t is given by
   (A) $P_s(t) = \frac{1}{N}$
   (B) $P_s(t) = \frac{M(t+1)}{N+1}$
   (C) $P_s(t) = \frac{M(t)}{N}$
   (D) None of these
3. While dealing with replacement situations, total cost of an item over a given period of n years would be given by
   (A) (Purchase Price) - (Maintenance cost of n year)
   (B) (Purchase Price) + (Maintenance cost of n years)
   (C) (Purchase Price) + (Maintenance cost of n years) - (Value of item after n years)
   (D) (Purchase Price) + (Maintenance cost of n years) + (Value of item after n years)
4. A group replacement policy at the end of each month is most profitable when
   (A) $C_1 > \frac{q^2}{1+q} C_2$ and $C_2 > \frac{1+q}{q^2} C_1$
   (B) $N C_1 + N\, pC_2 < \frac{N C_2}{(1+q)^2}$
   (C) Both (A) and (B)
   (D) None of these

5. If C is the initial cost of an item, then the discounted value (d) of all future costs associated with the policy of replacing the item after n years is given by:

(A) $D_n = \frac{C}{1+d^n}$

(B) $D_n = \frac{C}{(1-d)^n}$

(C) $D_n = \frac{C}{(1+d)^n}$

(D) None of these

6. If an activity has zero slack, it implies that :

(A) It lies on the critical path

(B) Total float > free float > Independent float

(C) Both (A) and (B)

(D) None of these

7. In PERT network, each activity assumes a β -distribution, because:

(A) It is not be symmetrical about modal value

(B) It is a uni-modal distribution that provides information regarding the uncertainty of time estimates of activities

(C) It has got finite non-negative error

(D) All of the above

8. In critical path analysis, CPM is -

(A) Event oriented

(B) Probabilistic in nature

(C) Deterministic in nature

(D) Dynamic in nature

9. In Dijkstra's algorithm, the starting node is labelled as -

(A) $(0, -)$

(B) $(1, -)$

(C) $(\infty, -)$

(D) None of these

10. The slack for an activity in network is equal to :

(A) LS - ES

(B) LF - ES

(C) EF - ES

(D) None of these

11. The 0 - 1 integer programming problem -

(A) Requires the decision variables to have values either 0 or 1

(B) Requires that all the constraints have coefficients between zero and one

(C) Requires that the decision variables have coefficients between zero and one

(D) None of these

12. For Branch and Bound method the additional constraint to the new subproblem is given by -

(A) $x_j \leq [x_j^*] \ \ and \ \ x_j \geq [x_j^*] + 1$

(B) $x_j \geq [x_j^*] \ \ and \ \ x_j \leq [x_j^*] + 1$

(C) $x_j \leq [x_j^*] \ \ and \ \ x_j \geq [x_j^*] - 1$

(D) None of these

Where $[x_j^*]$ is the largest integer contained in x_j^*

13. Which of the following is not correct?

(A) An IPP where all the variables must be equal to zero or one is called a "0 - 1" IPP

(B) An LPP in which all the decision variables are non-negative integers is called a pure IPP

(C) Both (A) and (B)

(D) None of these

14. Dynamic programming approach -

(A) Helps in reducing the computational effort in sequential decision making

(B) Is based an the principle of optimality due to Bellman

(C) Divides the given problem into a sequence of smaller sub-problems called the stages

(D) All of above

15. Dynamic programming -

(A) Deals with multi-stage decision making problems

(B) Can be solved using "Recursive equation approach"

(C) Both (A) and (B)

(D) None of these

16. The technique of goal programming-

(A) allows to have multiple goals with or without priorities

(B) is an approach to achieve goal of a solution to all-integer programming problems

(C) is an attempt to minimize deviations from targets

(D) is used when goals are not satisfied in an ordinal sequence

17. Deviational variable in GP model must satisfy the following conditions -

(A) $di^+ \times di^- = 0$

(B) $di^+ - di^- = 0$

(C) $di^+ + di^- = 0$

(D) None of these

18. If $X^T Q X$ is negative-semi-definite, then it is :

(A) Strictly Convex

(B) Strictly Concave

(C) Convex

(D) Concave

19. Quadratic programming is concerned with the NLPP of optimizing the quadratic objective function subject to :

    (A) Linear inequality constraints

    (B) Non-linear inequality constraints

    (C) Non-linear equality constraints

    (D) None of these

20. Which of the following methods of solving a quadratic programming problem is based on modified simplex method.

    (A) Wolfe's Method

    (B) Beale's Method

    (C) Fletcher's Method

    (D) None of these

(Section- B)

(Very Short Answer Type Questions)

(2 marks each)

Note : Attempt all questions.

1. What is replacement problem in OR?

2. Give difference between individual and group replacement.

3. Explain reasons for incorporating dummy activities in a network diagram.

4. Explain the following terms used in PERT:

    (i) Pessimistic time

    (ii) Optimistic time

    (iii) Most likely time

5. Distinguish between pure and mixed IPP.

6. State Bellman's principle of optimality.

7. Define Goal Programming.

8. When a NLPP is called Quadratic programming problem?

(Section - C)

(Short Answer Type Questions)

(3 marks each)

Note : Attempt all questions.

1. Explain types of failure in the context of replacement decisions.

2. Suppose the cost of maintenance of a machine increases with time and its scrap value is constant, if time is measured in continuous units, then the average annual cost will be minimized by replacing the machine when

the average cost till date becomes equal to the current maintenance cost.

3. List some real-life applications of network flow problem, clearly pointing out the nodes, links and flows in each case.

4. Explain advantages of network analysis.

5. Explain characteristics of Dynamic programming problem.

6. Describe a method of solving an all-integer linear programming problem.

7. Explain steps in formulation of linear goal programming problem.

8. What is meant by quadratic programming? Write the application of QPP?

Section D

(Long Answer Type Questions)

(5 marks each)

Note:- Attempt all questions.

1. Develop a model for the replacement of equipment whose maintenance cost are incurred in the beginning of the different time periods and value of money changes with time.

OR

At time zero all items in a system are new. Each item has a probability p of failing immediately before the end of the first month of life, and a probability q = (1 - p) of failing immediately before the end of the second month (ie., all items fail by the end of the second month). If all items are replaced as they fail. Show that the expected number of failures $f(x)$ at the end of month x is given by

$$f(x) = \frac{N}{1+q}\left[1-(-q)^{x+1}\right]$$

where N is the number of items in the system.

2. Briefly explain an algorithm to solve shortest Path problem.

OR

A small project consist of seven activities for which the relevant data are given below :

Activity	Preceeding Activities	Activity Duration (Days)
A	—	4
B	—	7
C	—	6
D	A, B	5
E	A, B	7
F	C, D, E	6
G	C, D, E	5

(i) Draw the network and find the project completion time.

(ii) Calculate total float for each of the activities and highlight the critical path.

3. Describe the branch and bound method for the solution of integer programming problem.

OR

Describe recursive equation approach to solve dynamic programming problem.

4. Describe briefly the Beale's Method for solving Quadratic Programming Problem.

OR

Mention briefly the Wolfe's algorithm for solving a quadratic programming problem given in the usual notation :

Maximize $Z = CX + \frac{1}{2} X^T Q X$

such that $AX \leq b \ \ and \ \ X \geq 0$.