Roll No. .....

D–1022

M. A./M. Sc. (Fourth Semester) (Main/ATKT) EXAMINATION, 2020

STATISTICS

Paper Third

(Operations Research—II)

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

Note : Attempt all Sections as directed.

Section—A 1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. When the efficiency of a machine deteriorates with 'age' due to constant use and required increased operating and maintenance costs. In such cases deterioration level is predictable and is represented by :
   (a) increased maintenance cost
   (b) increased operational costs
   (c) scrap value
   (d) All of the above

2. The operational efficiency of a machine deteriorates with time and the failure of items occurs gradually, which results in :

   (a) increased maintenance and operating cost

   (b) decrease in the salvage value

   (c) Both (a) and (b)

   (d) None of the above

3. If the time is measured continuously, then the replacement policy is 'replace the machine' when the average running cost R (n) is derived as :

   (a) $R(n) = \frac{1}{n}\left\{C - S + \int_0^n R(t)\,dt\right\}$

   (b) $R(n) = \frac{1}{n}\left\{C + S - \int_0^n R(t)\,dt\right\}$

   (c) $R(n) = \frac{1}{n+1}\left\{C - S + \int_0^n R(n)\,dt\right\}$

   (d) $R(n) = \frac{1}{n+1}\left\{C + S - \int_0^n R(n)\,dt\right\}$

4. If 'r' is the interest rate, then the present value of one rupee spent in 'n' years is given by :

   (a) $Pwf = (1 + r)^n$

   (b) $Pwf = (1 + r)^{-n}$

   (c) $Pwf = (1 - r)^n$

   (d) $Pwf = (1 - r)^{-n}$

5. For a group replacement policy at the end of each month is most profitable, when :

   (a) $C_1 > \frac{q^2}{1+q} C_2$

   (b) $C_2 > \frac{1+q}{q^2} C_1$

   (c) $NC_1 + N'_p C_2 < \frac{NC_2}{1+q}$

   (d) None of the above

6. The objective of network analysis is to :

   (a) minimize total project duration

   (b) minimize total project cost

   (c) minimize production delays, interruption and conflicts

   (d) All of the above

7. Activity-on-Arrow (AOA) diagram is preferred over Activity-on-Node (AON) diagram because :

   (a) AOA diagrams are simple to construct

   (b) AOA diagrams give a better sense of the flow of time throughout a project

   (c) AOA diagrams do not involve dummy activities

   (d) All of the above

8. The critical path satisfies the condition that :

   (a) $L_j - E_j = L_i - E_j = d$ (constt.)

   (b) $L_j - E_j = L_i - L_j$

   (c) $E_i = L_j$ and $E_j = L_j$

   (d) All of the above

9. A dummy activity is used in network diagram when :
   (a) two parallel activities have the same tail and head events.
   (b) The chain of activities may have a common event yet independent by themselves.
   (c) Both (a) and (b)
   (d) None of the above

10. The length of time by which an activity can be delayed if all its preceding activities are completed at their earliest possible time and all successor activities can be delayed until their latest possible time is called :
   (a) Free Float
   (b) Total Float
   (c) Independent Float
   (d) Slack of activities

11. A linear integer programming problem, in which some, but not all, of the decision variables are restricted to integer values is called :
   (a) Pure Integer Programming problem
   (b) Zero-one programming problem
   (c) Non-linear programming problem
   (d) Mixed-integer programming problem

12. The use of cutting plane method :
   (a) reduces the number of constraints in the given problem
   (b) gives the better value of objective function
   (c) requires that the use of standard LPP approach between each cutting plane application
   (d) All of the above

13. The part of the feasible solution space eliminated by plotting a cut contains :
   (a) Only non-integer solutions
   (b) Only integer solutions
   (c) Both (a) and (b)
   (d) None of the above

14. In a Branch-and-Bound approach to a maximization of ILPP, a node is terminated if :
   (a) a node has an infeasible solution
   (b) a node yields a solution that is feasible but not an integer
   (c) upper bound is less than the current subproblem's lower bound
   (d) All of the above

15. The corners of the reduced feasible region of ILPP contains :
   (a) only integer solution
   (b) optimal integer solution
   (c) only non-integer solution
   (d) All of the above

16. A stage in a dynamic programming problem represents :
   (a) number of decision alternatives
   (b) different time periods in the planning period
   (c) status of the system at a particular state
   (d) All of the above

17. Dynamic programming approach :
    (a) optimizes a sequence interrelated decision over a period of time
    (b) provides optimal solution to a single period decision-problem
    (c) provides optimal solution to long-term corporate planning problems
    (d) All of the above

18. Necessary Kuhn-Tucker condition to achieve relative maximum for an NLPP are :
    (a) $\lambda_i\, g_i(x) = 0, i = 1, 2,....., m;\ g_i(x) \leq 0$ and $\lambda_i \geq 0$
    (b) $\lambda_i\, g_i(x) \leq 0,\ i = 1, 2,....., m;\ g_i(x) \geq 0$ and $\lambda_i \geq 0$
    (c) $\lambda_i\, g_i(x) \geq 0,\ i = 1, 2,....., m;\ g_i(x) \leq 0$ and $\lambda_i \geq 0$
    (d) None of the above

19. The objective function of the quadratic programming problem is :
    (a) Strictly convex in case of minimization
    (b) Strictly concave in case of maximization
    (c) The matrix D is non-null
    (d) All of the above

20. The use of Goal Programming model is preferred when :
    (a) goals are satisfied in an ordinal sequence
    (b) goals are multiple incommensurable
    (c) more than one objective is set to achieve
    (d) All of the above

Section—B 2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. What is individual replacement problem ?
2. What is 'Project Evaluation Review Technique' (PERT) ?
3. What is 'Critical Path Method' (CPM) in network analysis ?
4. Write the standard form of integer linear programming problem.
5. Define and write the standard form of dynamic programming problem.
6. Define 'sates', 'stages' and 'return function' in DPP.
7. Write the standard form of quadratic programming problem.
8. Write the standard form of goal programming problem.

Section—C 3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. Explain group replacement policy and mathematical model of it.
2. What are 'Present Worth Factor Criteria' to calculate the optimal value of replacement age of an equipment ?
3. Write the algorithm to obtain 'Earliest Event Time' by Forward Pass method in network analysis.
4. Explain what is 'critical path' and how to calculate length of the critical path.
5. Write the Gomory's all integer cutting plane method.
6. Write the concept of 'goal programming' and write the standard form of GPP.
7. When a NLPP is called quadratic programming problem ? Write the application of QPP.
8. Write the algorithm of Beale's method to solve NLPP.

Section—D 5 each

(Long Answer Type Questions)

Note : Attempt all questions.

1. Write the replacement policy of items that fails completely. Also obtain the 'probability of failure', 'probability of survival' and 'conditional probability' by using 'mortality tables'.

Or

Write the 'replacement policy' when maintenance cost increases with time and the money value decreases with constant rate *i. e.* depreciation value is given.

2. A small maintenance project consists of the following ten jobs whose 'precedence' relations are identified by their node number :

Job	Time Duration (in days)
(1, 2)	2
(2, 3)	3
(2, 4)	5
(3, 5)	4
(3, 6)	1
(4, 6)	6
(4, 7)	2
(5, 8)	8
(6, 8)	7
(7, 8)	4

(a) Draw an arrow diagram for the project.

(b) Calculate the early start time, early finish time and late finish time for all the activities.

Or

The following table gives the activities in a project and time duration required for each activity :

Activity	Preceding Activity	Norma Time (days)
1—2	—	10
1—3	—	25
2—3	1—2	10
2—4	1—2	12
3—4	1—3, 2—3	5
4—5	2—4, 3—4	10

(a) Draw the activity network diagram.

(b) Calculate 'total float' and 'free-float' for each activity.

3. Write the Bellman's principle of optimality in a dynamic programming problem. Also explain the algorithm for solving dynamic programming problems.

Or

Write the algorithm of Wolfe's method for solving NLPP, defined as :

Maximize :

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

Subject to the constraints :

$$AX \leq b \text{ and } X \geq 0 .$$

4. What is Branch-and-Bound method for solving integer linear programming problem ?

Or

Write the concept of 'goal programming' and 'priority goal programming'. Write and explain the standard general goal programming formula.