This question paper contains 5 printed pages.

7238 *Your Roll No.....* .....

M.Sc. / I

J

OPERATIONAL RESEARCH - Paper X

(Network Analysis and Theory of Sequencing)

(Admissions of 2001 and onwards)

Time 3 hours *Maximum Marks 75*

(Write your Roll No on the top immediately on receipt of this question paper)

Answer any five questions.

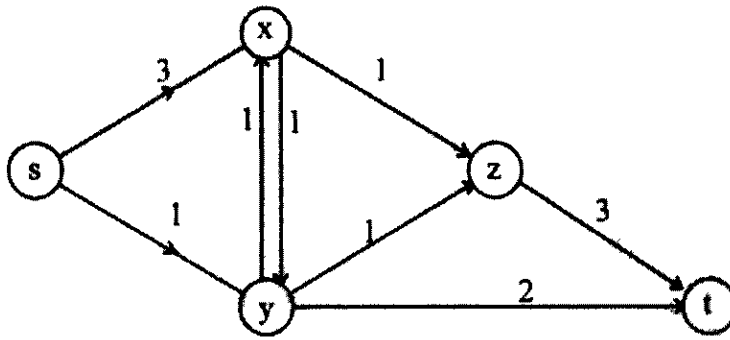
1. a) Define node-arc concept of flow in a network *05*

   b) Prove that for any network the maximal flow value from source to sink is equal to the minimal cut capacity of all cuts separating the source and the sink *06*

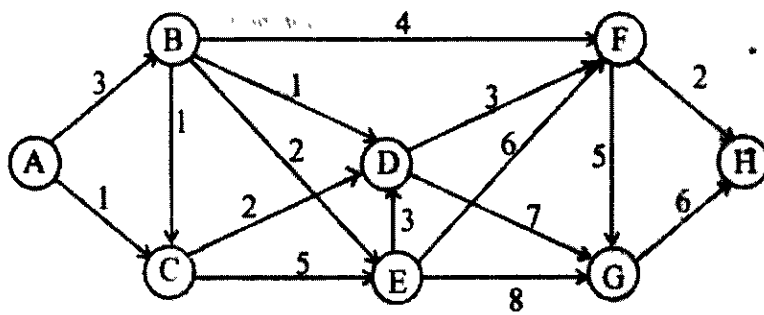
   c) Formulate the flow maximization problem of a network as a linear programming problem and write its dual *04*

2 (a) Find the maximal flow in the following network Figures along the arcs represent their capacities. *08*

P.T.O

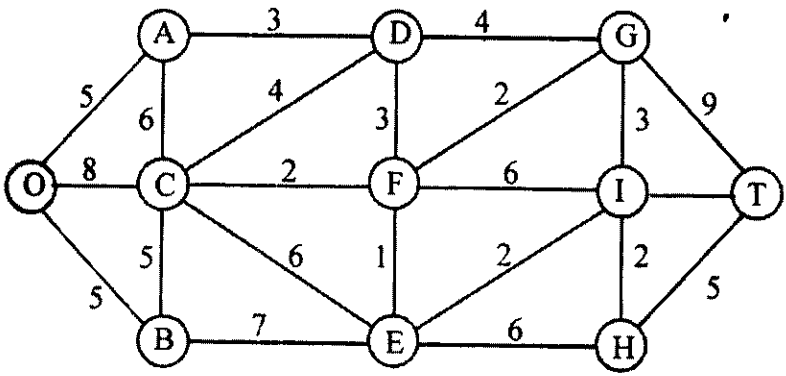


b) Consider the following network :



The distance (in miles) between different stations is shown on each link. Determine the shortest route from station A to station 4. *07*

3 (a) Define minimal spanning tree. Given the sets of nodes X and N - X Let F be the set of edges between X and N - X and let *a* be the smallest weight of an edge from F. Then prove that every MST must contain at least one edge of weight 'a' from set F For the following network, find the minimal spanning tree. Numbers on the links represent actual distance. *08*



b) Given below is the distance matrix between five cities. Using Eastman's branch and bound algorithm, find the shortest distance tour for a travelling salesman with his head-office at city 1. *07*

From \ To	1	2	3	4	5
1	-	5	10	8	4
2	9	-	7	10	5
3	12	8	-	6	10
4	15	6	9	-	12
5	4	8	5	10	-

4 a) Show that in PERT, expected completion time of an activity is

$$\frac{a + 4m + b}{6}$$

Where a, b and m are the optimistic, pessimistic and most likely completion time estimates respectively Specify clearly the assumptions to be made in the above derivation. *08*

b) The following table gives the duration and the manpower requirement for the various activities in a project. Determine the optimal allocation of resources to perform the activities when the total number of men available is 3 :

Activity	Duration	Men required
1-2	8	1
1-3	6	2
1-5	5	3
2-3	Dummy activity	
2-6	10	1
3-4	12	2
4-7	10	3
5-6	7	1
6-7	5	2

07

5 (a) The following table gives data on normal time and cost, crashed time and cost for a project :

Activity	Normal time (days)	Crash time (days)	Normal cost (Rs)	Crash cost (Rs.)
1→ 2	9	4	1300	2400
1→ 3	15	13	1000	1380
2→ 3	7	4	1200	1440
2→ 4	7	3	1200	1920
2→ 5	12	6	1700	2240
3→ 6	12	11	600	700
4→ 5	6	2	1000	1600
5→ 6	9	6	900	1200

The indirect cost per day is Rs 400 Find the optimum project time and the corresponding minimal total project cost. *07*

b) Describe briefly the following:
   a. Dummy activity
   b Gantt. Chart
   c Total Float and free Float
   d. Work Break Down Structure *08*

6 a) Formulate a general n/m job-shop problem as a mixed integer programming problem.

b) Processing times of four jobs on six machines in a flow-shop are given below

Machines

Job	M1	M,	M_3	M_4	Ms	M_6
A	18	8	7	2	10	25
B	17	6	9	6	8	19
C	11	5	8	5	7	15
D	20	4	3	4	8	12

Determine the optimal sequence of jobs that minimizes the total elapsed time. *07*