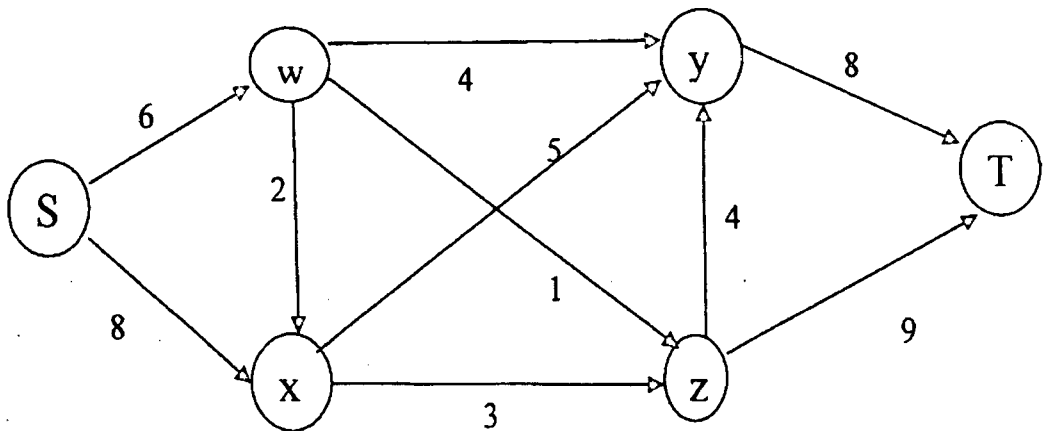This question paper contains **7 printed pages]**

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

Do any *Five* questions.

All questions carry equal marks.

Simple calculators are allowed.

1. Consider the following directed network where S is the source node, T is sink node, and the numbers on each arc represents its capacity of flow :

   (*a*) Define the following notions with an example for the above network :

   (*i*) A path connecting the source and the sink.

    (*ii*)   A cut set separating the source and the sink.

    (*iii*) The capacity of a cut set.

                                         2+2+2

  (*b*) Formulate the Maximal Flow problem of the above network as a Linear Programming Problem.

                                              3

  (*c*) Find the Maximal Flow from the Source to sink in the above network.   6

2. (*a*) What is Updating in project management ? Consider the network shown in figure as originally planned. The critical path is 1-2-3-4-5-6 and the project completion time is 24 days. At the end of 15th day, a review of the existing conditions is made and the observations are listed below :
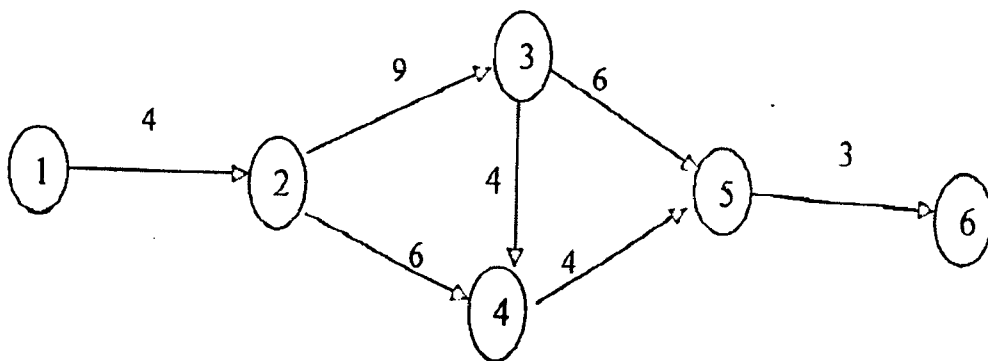
    (*i*)   Activities 1-2, 2-3 and 2-4 are completed.

    (*ii*) Activities 3-5 in progress since last 2 days and needs 6 more days for completion.

    (*iii*) Activity 3-4 is in progress since the last 2 days and needs 2 more days for completion.
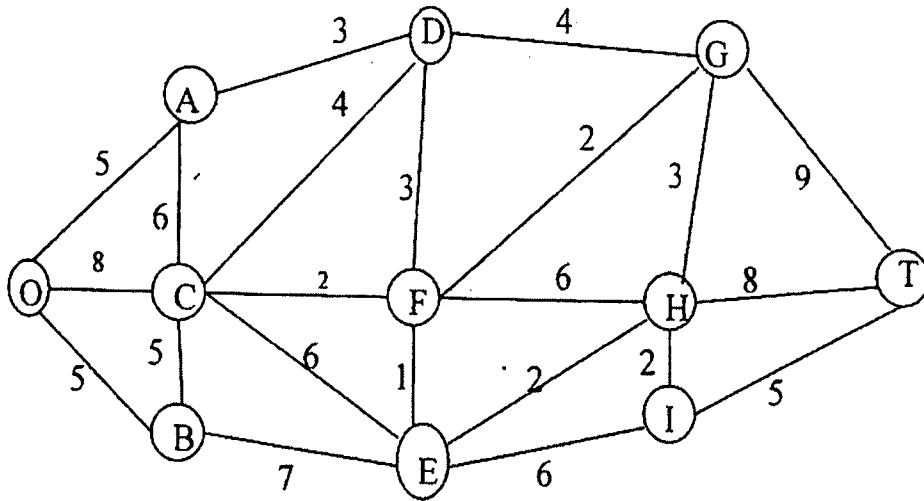
    (*iv*) Activity 4-5 can be completed in 3 days as against originally planned in 4 days.

    (*v*) Activity 5-6 needs 4 days for completion.

Formulate a new project based on the review at the end of 15 days.   7

(b) Define Minimal Spanning Tree and find the Minimal Spanning Tree of the following network : Numbers along the arcs represent distance between nodes.   8

3. (a) Define a Travelling Salesman Problem. Consider the following cost matrix of a travelling salesman visiting 5 cities :   10

To City

		A	B	C	D	E
	A	∞	43	21	20	10
	B	12	∞	9	22	30
From City	C	20	10	∞	5	13
	D	14	30	42	∞	20
	E	44	7	9	10	∞

Use branch and bound technique to solve the above problem so as to get an optimal tour of the salesperson.

(b) Formulate a shortest path as a flow problem in a network.   5

4. (a) Explain the procedure for solving a job shop problem.   5

    (b) (i) A book binder has one printing press, one binding machine and the manuscripts of a number of different books. The times required to perform the printing and binding operation for each book are known. Determine the order in which the books should be processed in order to minimize the total time required to process all the books. Also find the total time required.

Book	Printing time	Binding time
1	40	50
2	90	60
3	80	20
4	60	30
5	50	40

    (ii) Suppose that an additional operation is added to the process described in (i), viz. finishing. The times required for operation are given below :

Book	Finishing time
1	80
2	100
3	60
4	70
5	100

    What is the order in which the books should be processed ? Find also the minimum total elapsed time.   10

5. (a) Show that in PERT chart for a project, expected completion time of an activity is :

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

where a, b and m are Optimistic, Pessimistic, and Most likely completion time estimates respectively. Specify clearly the assumptions to be made in the above derivation. 7

(b) Discuss the Johnson's 'rule of optimality' for solving the 2 machine n jobs flow shop problem. 8

6. (a) What is Network Scheduling ? What are the differences between PERT and CPM ? 2+3

(b) The following table lists the normal and crash duration (in days) along with the cost of crashing (Rs.) for the various activities in a project :

Activities	Immediate Predecessor	Time (days)		Cost (Rs.)	
		Normal	Crash	Normal	Crash
A	—	4	3	60	90
B	—	6	4	150	250
C	—	2	1	38	60
D	A	5	3	150	250
E	C	2	2	100	100
F	A	7	5	115	175
G	D,B,E	4	2	100	240

Indirect costs vary as follows :

Days	Cost (Rs.)
15	600
14	500
13	400
12	250
11	175
10	100
9	75
8	50
7	35
6	25

(*i*) Draw the project network.

(*ii*) Determine the project duration which will result in minimum total project cost. 10

7. (*a*) Consider the following characteristics :

Activities	Immediate Predecessor	Estimated duration (days)		
		Optimistic	Most likely	Pessimistic
A	—	1	1	7
B	—	1	4	7
C	—	2	2	8
D	A	1	1	1
E	B	2	5	14
F	C	2	5	8
G	D, E	3	6	15
H	F, G	1	2	3

(i)   Draw the project network.

(ii) Find the expected duration and variance of each activity.

(iii) What is expected project length and critical path of the network ?

(iv) What should be the due date to have 95% probability of completion ?

(v)   What is the probability that the project will be completed at least 2 days earlier than expected time of completion ?

13

(b) What are the different types of floats ? How does a float differ from a slack ?   2