Sr. No. of Question Paper : 5233 F-

Unique Paper Code : 236551

Paper : Network Analysis & Theory of Sequencing

Name of the Course : B.A. Programme Operational Research

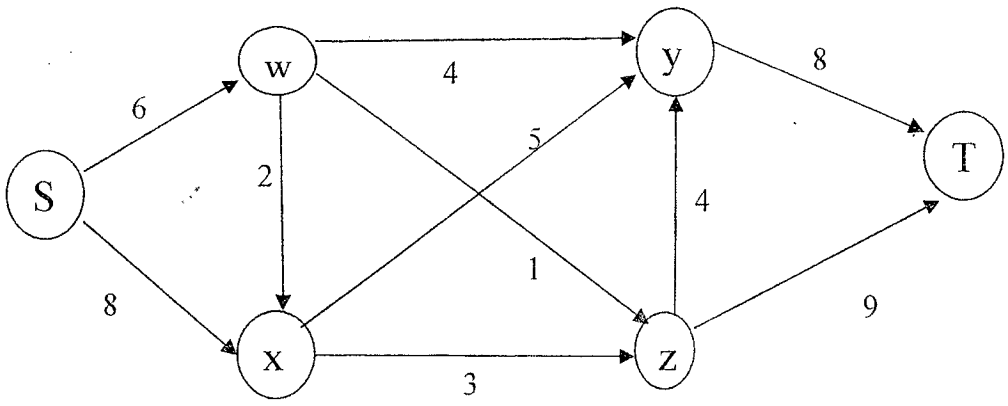
Semester : V

Duration : 3 Hours. **Maximum Marks: 75**

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of the question paper.
2. Attempt any **Five** Questions.
3. All questions carry equal marks.

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. **(3,2,2)**

(b) Find the maximal flow from the source to sink in the above network. **8**

2. (a) Define minimal spanning tree and give its applications. **5**

(b) Define a Traveling Salesperson Problem. Consider the following cost matrix of a traveling salesperson visiting 5 cities:

$$\begin{bmatrix} \infty & 43 & 21 & 20 & 10 \\ 12 & \infty & 9 & 22 & 30 \\ 20 & 10 & \infty & 5 & 13 \\ 14 & 30 & 42 & \infty & 20 \\ 44 & 7 & 9 & 10 & \infty \end{bmatrix}$$

Use branch and bound technique to solve the problem in the sense of obtaining an optimal tour of the salesperson. **10**

3. (a) Define the problem of sequencing. What is 'No Passing Rule' in a sequencing algorithm? **7**

(b) There are five jobs, each of which is to be processed through three machines A, B and C in the order ABC. Processing times of different jobs on different machines (in hours) are: **8**

Job:	**1**	**2**	**3**	**4**	**5**
Machine A:	3	8	7	5	4
Machine B:	4	5	1	2	3
Machine C:	7	9	5	6	10

Determine the optimum sequence of jobs and the minimum elapsed time.

4. The following table shows the details of a small project.

Activities	Preceding activity	Time estimates (Days)		
		Optimistic time	Most likely time	Pessimistic time
A	-	5	10	15
B	-	8	15	16
C	A	5	7	15
D	A	4	7	10
E	B	2	5	8
F	B	8	7	24
G	C	6	7	20
H	D, E	7	9	23
I	G, H	3	4	11

(i) Draw the project network. **3**

(ii) Find the expected duration and variance of each activity. **3**

(iii) What is expected project length and critical path of the network? **3**

(iv) What should be the due date to have 0.95(95%) probability of completion? **3**

(v) What is the probability that the project will be completed at least 2 days earlier than expected time of completion? **3**

5. A small project consists of nine activities, the details of which are given below:

Activity	*Duration*	*Immediate Predecessor*
A	3	-
B	6	-
C	7	A
D	2	A
E	5	A
F	20	E
G	60	D,F
H	3	B,C
I	10	G,H

i Draw the network diagram of the activities in the project. **3**

ii Calculate the earliest occurrence and the latest occurrence of all the events **4**

iii Highlight the critical path. **3**

iv Determine the total float and the free float of the non-critical activities. **5**

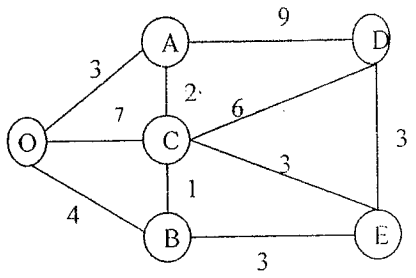
6. The following table gives the activities in a construction project and other relevant information:

Activity	Normal		Crash	
	Time(days)	Cost(Rs.000)	Time(days)	Cost(Rs.000)
1-2	8	15	6	20
1-4	10	20	7	30
2-3	6	11	4	15
2-4	5	8	4	14
2-5	8	9	5	15
3-4	2	5	2	5
4-6	12	3	8	4
5-6	5	5	4	8

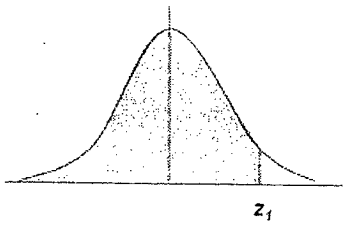
Indirect cost is Rs. 250/- per day. Find the optimum duration and the associated minimum project cost. **15**

7. (a) Discuss the Johnson's rule of optimality for solving the 2 machine n jobs flow shop problem. **7**

(b) Using Dijkstra's algorithm, determine the shortest path from node O to node E. **8**



Standard Normal Distribution



$$p(z \le z_1) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z_1} e^{-\frac{1}{2}z^2}\, dz$$

z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000