(2½ Hours) **[Total Marks :75]**

Note : l. All questions are compulsory. (Subject to internal Choice)
2. Figures to the right indicate full marks.
3. Use non--programmable calculator is allowed
4. Normal distribution table is printed on the last page for reference.
5. Support your answers with diagrams / illustrations, wherever necessary.
6. Graph papers will be supplied on request.

Q.1A) State whether following statements True or False: (Attempt any 8) **(8)**

1. Operation Research is also termed as Management Science.
2. The objective function is a linear relationship reflecting the objective of an operation.
3. The feasible region is a convex set.
4. The value of $\Delta j = Cj - Zj$ row in the simplex table tells us whether the current solution is optimal, and, if it is not, what variable will be in the optimal solution.
5. If the assignment elements are cost elements, then the objective of the optimal assignment is to maximize the cost.
6. MODI method is the best method to get Initial Feasible Transportation solution.
7. The dummy activity has an expected time of zero by definition.
8. The PERT pessimistic time estimate is an estimate of the minimum time an activity will require.
9. In solving a job sequencing problem, it is assumed that all jobs require the same sequence of operations.
10. If saddle point is available in a game, it is called as pure strategy game.

Q.1 B) Match the right and closely related answer from Column Y with the text / term given in Column X. (Attempt Any 7 questions) **(7)**

Column X	Column Y
1. Leaner relationship of variables	a) Completely utilized resources
2. Infeasible region	b) Minimum cost in the table
3. Scarce resource	c) No feasible Solution possible
4. LCM	d) LPP
5. NWCR	e) In the game, gains of the winner are equal to total losses of all other players
6. Critical activity	f) Optimistic time
7. Zero sum game	g) Fair game
8. Shortest activity time in PERT	h) Zero float value
9. Value of game =0	i) The time during which a machine is waiting or not working
10. Ideal time	j) Top left side corner of the table

Q.2 A) M/S. Rajaram Pvt.ltd. and engineering firm has to decide profitable mix for its products i.e. Condenser, Transmitter and Connector with a profit (per 100 units) of ₹10, ₹6 and ₹4 respectively. To produce a shipment of condenser containing 100units required 1 hour of engineering 10 hours of direct labour and 2 hours of administration service. To produce one shipment of transmitter 1000 units require 1 hour of engineering 5 hours of direct labour and 6 hours of administration, similarly these figures for connectors are 1,4 and 2. There are 100 hours of engineering services available 600 hours of direct labour and 300 hours of administration. What is the most profitable mix find with the help of LPP formulation and simplex method.

From the above information Formulate as LPP **(7)**

B) Find the optimum solution with the help of simplex method **(8)**

OR

Q.2 C) Five salesmen are to be assigned to five territories. Based on past performance, the followingtable shows the annual sales (is Rs. lakh) that can be generated by each salesman in each territory. Find optimum assignment to maximize sales. **(8)**

Salesman	Territory				
	T_1	T_2	T_3	T_4	T_5
S_1	26	14	10	12	9
S_2	31	27	30	14	16
S_3	15	18	16	25	30
S_4	17	12	21	30	25
S_5	20	19	25	16	10

Q.2 D) Solve by using graphical method **(7)**

Max $Z = 4x_1 + 3x_2$

Subject to constraints,

$4x_1 + 3x_2 \leq 24$

$X_1 \leq 4.5$

$X_2 \leq 6$

$X_1 \geq 0\ X_2 \geq 0$

Q.3 A) From the data given below

1. Draw a diagram (2)
2. Find Critical path (2)
3. Crash systematically the activities and determine optimal project duration (4)

Activity	1-2	1-3	2-4	2-5	3-4	4-5
Normal time (days)	8	4	2	10	5	3
Normal cost (Rs.)	100	150	50	100	100	80
Crash Time (days)	6	2	1	5	1	1
Crashed Cost (Rs)	200	350	90	400	200	100

Indirect Cost is Rs. 70 per day

Q.3 B) You are given a solution for a transportation cost problem. Figures in each cell represent per unit transportation cost. Figures in circle within each cell represent number of units allocated for transportation. P1, P2 and P3 are the 3 Plants and W1, W2 and W3 are the 3 Warehouses**.** You are required to check the above solution for optimality, if it is not optimal, use MODI method to obtain optimal solution and Find optimal transportation cost. **(7)**

Plant\WH	W1	W2	W3	Supply
P1	500 **18**	**20**	1500 **16**	**2000**
P2	1000 **26**	1000 **22**	**30**	**2000**
P3	**6**	2000 **2**	**0**	**2000**
Demand	**1500**	**3000**	**1500**	**Total=6000**

OR

Q.3 C) A Project which is planned using PERT technique has following details of Average Expected Times calculated using the formula, te = (a + 4m + b) / 6 and the details of standard deviation.

Activity	Average Expected Time in weeks (te)	Standard Deviation
1 – 2	3	4/6
1 – 3	4	4/6
2 – 5	5	4/6
2 – 4	6	2/6
5 – 6	7	4/6
4 – 6	8	4/6
3 – 6	9	4/6
6 – 7	3	2/6

i) Construct the network diagram of PERT network and find expected completion time of the project. (3)

ii) Calculate the Variance of each activity. (4)

iii) Determine the probability of completing the project in 21 Weeks. (4)

iv) If the project manager wants to be 99% certain that the project should be completed on schedule what will be the project duration? (4)

Q.4 A) You are given the pay-off (profit in ₹) matrix in respect of a two person zero-sum game as follows: **(7)**

		Player: B		
		I	II	III
Player: A	I	2	4	2
	II	1	-5	-4
	III	2	6	-2

i. Find the Maximim strategy.

ii. Find the Minimax strategy.

iii. What is the Value of the game.

Q.4 B) Six jobs I, II, III, IV, V and VI are to be processed on two machine A and B in order AB

Jobs	Processing Time (Min)	
	Machine A	Machine B
I	5	8
II	2	6
III	10	3
IV	9	4
V	6	3
VI	8	9

(i) Find the sequence that minimizes the total elapsed time required to complete the jobs. (2)

(ii) Calculate the total elapsed time (3)

(iii) Idle time on for each Machine (3)

OR

Q.4 C) Find the optimal sequence: (8)

JOB	I	II	III	IV	V
Machine-A	3	8	7	5	2
Machine-B	3	4	2	1	5
Machine-C	5	8	10	7	6

a) Determine the optimum sequence for performing jobs

b) Total minimum elapsed time

c) Idle time for each machine.

Q4 (D) you are given the following pay-off matrix of a zero-sum game, determine the optimal strategies for the players and the value of the game. **(7)**

A' Strategy	B' Strategy			
	B1	B2	B3	B4
A1	5	-4	5	9
A2	6	2	0	-3
A3	9	15	10	11
A4	2	8	-6	5

Q.5 A) Define Operations Research. Explain limitation of Operation Research. (8)

B) Explain various cost involved in project crashing. (7)

OR

Q.5 C) Write a Short note (Attempt three) **(15)**

i) Project crashing

ii) Basis and non-basis variable in simplex table

iii) Interfering float

iv) Objectives of critical path

v) NWCM

NORMAL DISTRIBUTION TABLE

Area Under the Standard Normal Distribution

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2518	0.2549
0.7	0.2580	0.2612	0.2642	0.2673	0.2705	0.2734	0.2764	0.2797	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4464	0.5473	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4938	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4846	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.7893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4820	0.4922	0.4925	0.4927	0.4931	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4958	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4988	0.4986
3.0	0.49865	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4996
4.0	0.49968									