[Time: - $2\frac{1}{2}$ Hours] **[Marks: 75]**

Please check whether you have got the right question paper.

N.B:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Use of non-programmable calculator is allowed and mobile phones are not allowed.
4. Normal distribution table is printed on the last page for reference.
5. Support your answers with diagrams/illustration, wherever necessary.
6. Graph papers will be supplied on request.

1. Attempt any two from the following: 7.5

a) Solve the following maximization LPP by Simplex Method.

Max. $Z = 16X_1 + 40X_2$

Subject to : $4X_1 + 2X_2 \leq 160$

$6X_1 + 8X_2 \leq 192$

$X_1, X_2 \leq 0$

b) A firm manufactures two products P and Q which requires the processing through three machines Cutting, Polishing and Packing. The maximum machine hours available per week for each of the process Cutting, Polishing and Packing are 200 hours, 125 hours and 900 hours respectively. Product P requires 1 hour of Cutting and 3 hours of packing per unit. Product P is not required to be polished. While Product Q requires 1 hour in Cutting, 1 hour in Polishing and 6 hours in packing per unit. The profit per unit for product P and Q are Rs.80 and Rs.160 respectively. Convert the given information into a LPP and solve it graphically to ascertain the optimal production mix of the two products to ensure maximum profit. 7.5

c) Answer the following question

i. Application Areas for Operation Research Techniques 2.5

i. Explain 'Infeasibility' in LPP using graphical sketch 2.5

ii. Duality in Simplex Method of Linear Programming 2.5

2. Attempt any two from the following:

a) A sales manager has to assign salesman to four territories. He has four candidates of varying experience and capabilities. The manager assesses the possible sales in crores for each salesman in each territory as given below.

Salesman	Territory			
	Mumbai	Chennai	Kolkata	Delhi
S1	2	3	1	1
S2	5	8	3	3
S3	4	9	5	1
S4	8	7	8	4

Find the assignment of salesman to territories so that total sales is maximum. 7.5

b) Given below is a table taken from the solution process for a transportation problem.

Warehouse	Markets (Cost per unit in Rupees				Availability (units)
	M1	M2	M3	M4	
W1	10 **300**	10	16	20	300
W2	16	6 **175**	17 **25**	25	200
W3	8 **25**	21	10 **75**	15 **150**	250
Demand(units)	325	175	100	150	

(Figures m the right top comer are cost of transportation per unit)

Answer the following questions with justification

i. Is the solution feasible? 1

ii. Is the solution degenerate? 1

iii. Is the solution optimal? If not find the optimal solution? 3

iv. Does the problem have alternate optimal solutions? If yes give another optimal solution? 2.5

c) A manufacturer has manufacturing centers at P1, P2 and P3. These centers have maximum availability of 400, 300 and 300 units of the products respectively. The company has Warehouses at W1, W2, W3, and W4 with demand capacities of 50, 150, 350, and 450 units respectively. The transportation cost in rupees per unit between each manufacturing center and warehouse is given below.

Manufacturing Centers	Warehouse			
	W1	W2	W3	W4
P1	10	12	18	22
P2	22	18	28	26
P3	30	36	52	40

i. Determine the Initial Feasible Solution using Vogel's Approximation Method. 3.5

ii. Test its optimality using Modified Distribution Method? 4

3. Attempt any two from the following:

a) The following information is available about the eight activities of a project

Activity	Preceding Activity	Time in days
A	—	4
B	—	8
C	—	5
D	A	5
E	B	6
F	C	3
G	D, E	7
H	B	4
I	F	9

You are required to answer the following questions

i. Draw Network Diagram and find the critical path and project completion time. 2.5
ii. Find the earliest and latest starting and finishing time of all activities. 3.5
iii. Find Total float of all activities. 1.5

b) A project consists of eight activities with the following relevant information

Activity	Estimated Duration (days)		
	Optimistic	Most Likely	Pessimistic
1 – 2	1	3	5
1 – 3	2	4	6
2 – 5	3	5	7
2 – 4	5	6	7
5 – 6	5	7	9
4 – 6	6	8	10
3 – 6	7	9	11
6 – 7	2	3	4

i. Tabulate expected time and variances of all activities. 3
ii. Draw the PERT network and find out the expected project completion time. 3
iii. Calculate the probability of completing the project in 21 days. 1.5

c) Answer the following questions.

i. What is a Float? What are the different types of Floats? 2.5
ii. Distinguish Between CPM and PERT. 2.5
iii. Explain the objectives of Project Cashing? 2.5

4. Attempt any two from the following:

a) Safe Foods Ltd manufactures a particular product incurring a production cost ofRs.30 per unit and is sold to its customers for Rs.50 per unit. Being a perishable commodity any unit unsold gets perished and becomes worthless. The daily sales records in the past are as given below.

Daily Demand in Units	20	30	40	50
Probability	0.2	0.3	0.3	0.2

You are required to answer the following questions.

i. Construct Pay off table 3
ii. Calculate EMV and decide the optimal production strategy for the company 2
iii. Calculate EPPI and EVPI 2.5

b) The ABC company is faced with four decision alternatives relating to investment in a capital expansion programme. Since these investments are made in future the company foresees different market conditions as expressed in the form of states of nature. The following table summarizes the decision alternatives, the states of nature and the rate of return in percentage associated with each state of nature.

Decision Alternatives	States of Nature		
	High	Moderate	Low
A1	17	15	8
A2	18	16	9
A3	21	14	9
A4	19	12	10

Decide the best Alternative using

i. Maximin Criterion 1.5

ii. Maximax Criterion 1.5

iii. Minimax Regret Criterion 2.5

iv. Hurwicz Criterion with $\dot{\alpha}$= 0.7 2

c) Fast Track Ltd. is evaluating four alternative single period investment opportunities whose returns are based on the state of the economy. The possible states of the company and the associated probability distribution is as follows.

States of Nature :	Low Demand	Moderate Demand	High Demand
Probability :	0.2	0.4	0.4

The returns for each investment opportunity and each state of the economy are as follows.

Investment Alternatives	States of Nature (Demand)		
	Low	Moderate	High
W	-25,000	50,000	80,000
X	-10,000	45,000	70,000
Y	0	40,000	50,000

i. Construct Decision Tree for the above data. 4

ii. Using EMV method, find optimal strategy and optimal profit. 3.5

5. A Company produces 3 products P, Q and R. It uses 3 resources R1, R2 and R3. The profit per unit for P, Q, R is Rs.30, Rs.40 and Rs.20 respectively. Capacity of resources R1, R2 and R3 is 10000, 8000 and 1000 units respectively. Following Simplex Solution is obtained. Based on this solution answer the questions given below with justification.

Basis		Cj	30	40	20	0	0	0
Ci	Xi	Bi	X1	X2	X3	S1	S2	S3
30	X1	250	1	0	-13/8	5/8	-3/4	0
40	X2	625	0	1	31/16	-7/16	5/8	0
0	S3	125	0	0	11/16	-3/16	1/8	1
Zj			30	0	115/4	5/4	5/2	0
Δj = Cj – Zj			0	0	-35/4	-5/4	-5/2	0

X1, X2, X3 represents products P,Q, R. SI, S2,S3 represents slack variable of resources R1, R2, R3.

Answer the following questions with justification

i.	Is the solution optimal?	1
ii.	Is there alternate optimal solution?	1
iii.	Is the solution feasible?	1.5
iv.	Is the solution degenerate?	1.5
v.	What is the optimal product mix and optimal profit.	3
vi.	Which resources are abundant and which resources are scarce as per optimal solution.	3
vii.	If a new product 'T' is to be introduced which can give profit of Rs.25 per unit. It requires 8 units of R1, 4 units ofR2 and 6 units of R3 should it be produced?	4

NORMAL DISTRIBUTION TABLE

Area Under Standard Normal Distribution

	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	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	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	0.4564	0.4573	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	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	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	0.4957	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	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
