[Time: 2 ½ 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/ illustrations, wherever necessary.
6. Graph paper will be supplied on request.

Q.1 **Attempt any two from the following :** 7.5

a. Solve by simplex method

Max Z = $8x_1 + 20x_2$

subject to:

$2x_1 + x_2 \leq 80$... Resource I

$3x_1 + 4x_2 \leq 96$... Resource II

$(X_1, X_2) \geq 0$

Find optional profit (Max Z)

b. ABC Ltd. manufactures two products P and Q. Profit per unit for P and Q is Rs 40 and Rs 80 respectively. 7.5
One unit of P requires 2 machines hours and one unit of Q requires 3 machines hours. Availability of machine hours is 48.
Maximum market demand for P is 15 units and for Q is 10 units. Formulate as LPP and solve by graphical method to obtain maximum total Profit.

c. **Answer the following:**

i) Explain the use of slack, surplus and artificial variables in simplex method. 2.5

ii) Explain what is redundant constraint in graphical solution with the help of a neat sketch. 2.5

iii) Explain the different types of constraints in LPP. 2.5

Q.2 **Attempt any two from the following:**

a. A company has three factories F_1, F_2 and F_3 with supply of 800, 600 and 1000 units respectively. There are four warehouses W_1, W_2, W_3 and W_4 with demand of 400, 500, 700 and 800 units respectively. A feasible solution is given below. (With allocations and unit cost data).

i. Test the solution for optimality using modified distribution method. 03

ii. If the solution is not optimal, find optimal solution by modifying it. 3.5

iii. Find minimum transportation cost. 01

From \ To	W1	W2	W3	W4	Supply
F1	12 (300)	6 (500)	20	25	800
F2	6 (100)	11	15 (500)	12	600
F3	9	15	17 (200)	7 (800)	1000
Demand	400	500	700	800	2400 / 2400

b. There are four machines M_1, M_2, M_3 and M_4. There are five jobs P, Q, R, S and T. 7.5
Cost of doing each job on each machine is given below (in Rs. hundreds).
Machine M_2 cannot process Job R and Machine M_3 cannot process Job P.
Find optional assignment of machines and jobs to minimize total cost.

Jobs / Machines	P	Q	R	S	T
M_1	9	11	15	10	11
M_2	12	9	-	10	9
M_3	-	11	14	11	7
M_4	14	8	12	7	8

c. **Answer the following:**

i) Explain the steps involved in solution of an unbalanced maximization assignment problem. 2.5

ii) Explain what is meant by degeneracy in a transportation problem and how to resolve it. 2.5

iii) Explain why Vogel's approximation method (VAM) is a better method than North West corner rule (NWCR) to find initial feasible solution of a transportation problem. 2.5

Q.3 **Attempt any two from the following:**

a. A small project consists of following activities

Activity	Preceding activity	Time (days)
A	-	4
B	-	5
C	-	7
D	A	6
E	B	7
F	C	6
G	D	5
H	E	8
I	F	5

i. Draw network diagram and find critical path and project completion tine. 3.5

ii. Find earliest and latest starting and finishing times of all activities (EST, EFT, LST, LFT). 04

b. Three time estimates are given for each activity of following project.

Activity	Optimistic (a)	Most likely (m)	Pessimistic (b)
1-2	6	6	24
1-3	6	12	18
1-4	12	12	30
2-5	6	6	6
3-5	12	30	48
4-6	12	30	42
5-6	18	30	54

i) Tabulate expected time (te) and variance of all activities. 03

ii) Draw network diagram and find total project completion time (Critical path). 2.5

iii) What will be project completion for 90% confidence of completion? 02

c. **Answer the following:**

i) Explain difference between CPM and PERT. 2.5

ii) Explain what is time cost trade off in project crashing. 2.5

iii) What are the objectives of project crashing? 2.5

Q.4 **Attempt any two from the following:**

a. Four strategic alternatives S_1, S_2, S_3 and S_4 are available for countering four states of nature N_1, N_2, N_3 and N_4

	States of nature			
	N_1	N_2	N_3	N_4
Probability	0.2	0.1	0.3	0.4
Strategy S_1	1200	1200	1200	1200
Strategy S_2	1040	1280	1280	1280
Strategy S_3	880	1080	1360	1360
Strategy S_4	700	840	1080	1440

Based on the above information:

i) Calculate EMV (expected monetary value) for each strategy and find optimal decision. 03

ii) Find EPPI (expected payoff with perfect information) and EVPI (expected value of perfect information). 02

iii) Construct regret table and calculate EOL (expected opportunity loss). 2.5

b. Following payoff matrix refers to a two player game, player A and player B. Each player has four strategic options.

(Pay off in Rs.)

		Player B			
		I	II	III	IV
Player A	I	500	260	200	210
	II	-50	-100	-40	240
	III	200	400	160	-20
	IV	250	300	100	50

i. Find the Maximin Strategy. 2.5

ii. Find the Minimax Strategy. 2.5

iii. What is the value of the Game? 2.5

c. Five jobs I, II III IV and V are to be processed on two machines A and B in the order AB.

	Processing time (minutes)	
Job	Machine A	Machine B
I	90	70
II	40	80
III	40	50
IV	30	10
V	25	35

i. Find optimal sequence of jobs. 02

ii. Find total minimum elapsed time. 3.5

iii. Find idle time for each machine. 02

Q.5 A company produces two products A and B. Profit per unit for A and B is Rs 30 and Rs 50 respectively. Three resources M_1, M_2 and M_3 are utilized. Capacities of M_1, M_2 and M_3 are 4, 6 and 12 hours respectively. Following feasible solution has been obtained by simplex method.
Based on the solution answer the following questions.

$C_j \rightarrow_3$		30	50	0	0	0	
C	X	X_1	X_2	S_1	S_2	S_3	B_i
0	S_1	1	0	1	0	0	4
0	S_2	$-3/2$	0	0	1	$-1/2$	0
50	X_2	$3/2$	1	0	0	$1/2$	6
Z_j		75	50	0	0	25	

i. Is this optimal solutions? Justify. 02
ii. What is optimal product mix and optimal profit? 02
iii. Is there degeneracy in the solution? Justify. 02
iv. Is it unique solution or are there multiple optimal solution? Justify. 02
v. What are the shadow prices of M_1, M_2 and M_3? 03
vi. Which resources are scarce and which are abundant? 02
vii. Find percentage utilization of M_1 and M_2. 02

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