(2½ Hours) **(Total 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 **necesssary**.
6. **Graph paper** will be **supplied on request**.

1. Atempt any two questions :

a) Use simplex method to solve the following linear programming problem. **(7.5)**

Maximize $Z = 2x_1 + 5x_2$

Subject to constraints

$2x_1 + x_2 \leq 20$

$3x_1 + 4x_2 \leq 24$

$x_1, x_2 \geq 0$

b) ABC Ltd. manufactures tables and chairs. They have just acquired a new workshop that can operate 48 hours a week. Production of a table will require 2 hours and a chair will require 3 hours production time. Each table will contribute Rs. 40 to profit while a chair contributes Rs. 80. The marketing department has determined that maximum of 15 tables and 10 chairs can be sold every week. Formulate the linear programming model and determine the optimum product mix of tables and chairs that will maximize profits for the company, by using graphical method of linear programming. **(7.5)**

c) Answer each question in brief :

i) Discuss the advantages of O.R. **(2.5)**

ii) Explain "feasibility region" in graphical method of Linear Programming. **(2.5)**

iii) Explain the meaning of infeasibility in a Simplex linear programming problem? **(2.5)**

2. Attempt any two questions :

a) A departmental head has four subordinates who differ in efficiency and the tasks differ in their intrinsic difficulty. His estimate of the time each man would take to perform each task is given in the matrix below.

Time (in hours)

Tasks	**Men**			
	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

How should the tasks be allocated on one to one basis to minimize the total man-hours? Find optimal assignment of men and tasks. **(7.5)**

b) A company produces three models A, B and C of their products in three factories X, Y and Z.

Data regarding unit transportation cost in Rs., capacity and demand are given below :

Factories	A	B	C	Factory capacity (units)
X	7	8	5	200
Y	11	3	6	150
Z	8	5	7	350
Production demand (units)	150	175	425	

Find the optimal allocation of models to the factories and assess the minimum cost by MODI method. **(7.5)**

c) Answer each question in brief :

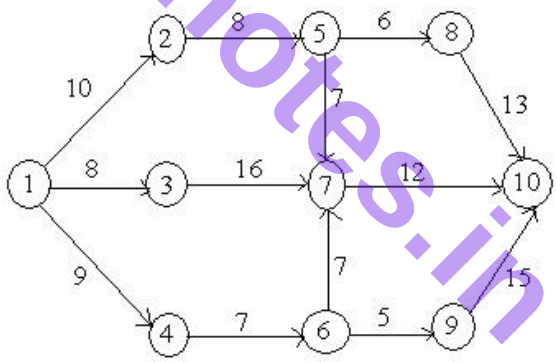
i) When do we say that an Assignment problem is unbalanced? How do you balance it? **(2.5)**

ii) Discuss difference between Assignment and Transportation Problem. **(2.5)**

iii) Degeneracy in a transportation problem. **(2.5)**

3. Attempt any two questions :

a) Determine EST, EFT, LST, LFT, Trail Event Slack, Head Event Slack in respect of all node points and identify critical path for the following network. The Activity time in days is mentioned on the activities. **(7.5)**



b) Three time estimates are given for each activity in days 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. **(2.5)**

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

iii) What will be Project completion 90% confidence of completion? **(2.5)**

c) Answer each question in brief :

i) What is PERT? Explain with examples. **(2.5)**

ii) What are predecessors or preceeding activities? Explain with examples. **(2.5)**

iii) Distinguish between Activity and Event. **(2.5)**

4. Attempt any two questions :

a) A consumer goods company has set up following pay–off table (in Rs. 1000) for the sales returns of their product. Three strategies (S_1, S_2, S_3) are identified to deal with three uncertain States of Nature (N_1, N_2, N_3).

	S_1	**S_2**	**S_3**
N_1	1000	700	500
N_2	450	500	300
N_3	500	800	200

You are required to identify right strategy under following criteria :

i) Maximin. **(1)**

ii) Maximax. **(1)**

iii) Laplace. **(1.5)**

iv) Hurwicz. (Hurwicz Constant Alpha = 0.7) **(1.5)**

v) Minimax Regret. **(2.5)**

b) There are nine jobs, each of which must go through two machines P and Q in the order PQ, the processing times (in hours) are given below:

Machine	Job(s)								
	A	B	C	D	E	F	G	H	I
P	2	5	4	9	6	9	7	5	4
Q	6	9	7	4	3	10	3	9	11

Find the sequence that minimizes the total elapsed time. Also calculate the idle time for the machines P and Q in this period. **(7.5)**

c) Given the following pay-off matrix of a zero-sum game, determine

i) The optimal strategy for the player A **(2.5)**

ii) The optimal strategy for the player A **(2.5)**

ii) The value of the game **(2.5)**

A's Strategy	**B's Strategy**			
	B_1	**B_2**	**B_3**	**B_4**
A_1	5	-4	5	9
A_2	6	2	0	-3
A_3	9	15	10	11
A_4	2	8	-6	5

5. A business problem is formulated and expressed below as an LPP, X_1 & X_2 are the product on volumes of products A & B respectively. The resources required for producing these products are R_1 & R_2. Total profit is Z.

Objective function Maximize $Z = 10X_1 + 4X_2$

Subject to the resource constaints,

$20X_1 + 10X_2 \leq 1200$ ….. R_1

$40X_1 + 10X_2 \leq 1600$ ….. R_2

$X_1 , X_2 \geq 0$

Simplex algorithm of LPP, applied to the above problem yielded the following feasible solution.

	Cj	10	4	0	0	
C	V	X_1	X_2	S_1	S_2	b_i
0	S_1	0	5	1	-1/2	400
10	X_1	1	1/4	0	1/40	40

a) Please improve the above solution to optimality. **(5)**

b) Study the solution found by you and answer the following questions with justification.

i) Is the solution found by you infeasible? **(2)**

ii) Is this a case of multiple optimal solutions (alternate optima)? **(2)**

iii) What is the product mix and the maximum profit? **(2)**

iv) Calculate the percent utilization of resources R_1 & R_2. **(2)**

v) If one unit of R_2 becomes unavailable what is the reduction in maximum profit? **(2)**

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	0.2705	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