Time: 2 ½ Hours **Marks: 75**

Note : 1. All questions are compulsory. (Subject to internal Choice)
2. Figures to the right indicate full marks.
3. Use non--programmable calculator is allowed
4. The 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.

Q1 (A) Multiple choice questions (Attempt Any 8) **(8)**

1. A BFS of a LPP is said to be ---------- if at least one of the basic variables is zero
   a) Degenerated b) Non-degenerated c) Infeasible d) Feasible
2. For solving an assignment problem, which method is used?
   a) Hungarian b) American c) German d) Italian
3. A feasible solution is called a basic feasible solution if the number of non-negative allocations is equal to ----------
   a) m-n+1 b) m+n-1 c) m-n-1 d) m+n+1
4. Which method is an iterative procedure for solving LPP in a finite number of steps
   a) Simplex algorithm b) Simplex method c) slack method d) M-method
5. An objective function is maximized when it is a ---------- function.
   a) Profit b) passive c) cost d) time
6. In an assignment problem involving 5 workers & 5 jobs, the total number of assignments possible is ----------.
   a) 15 b) 10 c) 5 d) 20
7. _____ is known as the time by which activity completion time can be delayed without affecting the start of succeeding activities,
   a) Total float b) interfering float c) independent float d) Free float
8. The probability of a normal curve is _____
   a) 60% b) 70% c) 50% d) 55%
9. What is the probability of project completing in 55 days if the expected project completion time is 47 days & table value is :(+0.4890)
   a) 98.90% b) 99% c) 90% d)98%
10. What is the total idle time if jobs are processed on 2 machines and idle time on machine A is 11 and on machine B is 15.
    a) 25 b) 26 c) 23 d) 24

Q1 (B) True or false (Attempt Any 7) **(7)**

i. Is concerned with using scientific approach i.e. logical reasoning to solve problems for the management by ensuring optimum utilization of resources
ii. Any change in the constraint inequalities will have a proportional change in the objective function
iii. In graphical method, infeasibility happens we cannot find feasible region.
iv. Graphical method can be used when the number of decision variable at two
v. An artificial variable is a fictitious variable in LPP problems.
vi. Surplus variables represent an excess amount of resources utilize
vii. When the number of lines is not equal to size of matrix the solution is optimum.
viii. There are two types of techniques available to find the initial basic feasible solution.
ix. The network can have one or more start node and end node.
x. Pessimistic time is the shortest time period expected to complete the activity.

Q.2 A) A Company manufactures two products A and B. To manufacture one unit of A, 1.5 machine hours and 2.5 labour hours are required. To manufacture product B, 2.5 machine hours and 1.5 labour hours are required. In a month, 300 machine hours and 240 labour hours are available. Profit per unit, for A is Rs. 50 and for B is Rs. 40.
Formulate as LPP (8)

Q.2 B) Solve following LPP by Simplex method . (7)
Maximize $Z = 50 x_1 + 20 x_2$
Subject to Constraints
$20x_1+10x_2 \leq 500$
$50x_1 + 50x_2 \leq 300$
$x_1, x_2 \geq 0$

OR

Q.2 C) Solve following LPP by Graphical method. (7)
Maximize $Z = 2x_1 + 10 x_2$
Subject to Constraints
$2x_1+5x_2 \leq 16$
$6x_1 \leq 30$
$x_1, x_2 \geq 0$

Q.2 D) A Sales manager has to assign salesmen to four territories. He has four candidates of varying experience and capabilities. The manager assesses the possible profit for each salesman in each territory as given below

Salesman	Territory			
	T1	T2	T3	T4
S1	35	27	28	37
S2	28	34	29	40
S3	35	24	32	33
S4	24	32	25	28

Find the assignment of salesmen to the territories so that total profit is Maximum. (8)

Q.3 A) From the Following details of the project
i. Draw the network diagram and identify critical path (3)
ii. Find out Earliest Start and Finish Time, Latest Start and Finish Time of Each activity (5)

Activity	Node	Duration (Days)
A	1-2	4
B	1-3	6
C	1-5	13
D	2-3	5
E	2-4	20
F	4-6	10
G	3-6	6
H	5-6	16

Q.3 B) A company is transporting its units from three factories F_1, F_2 , F_3 with the production capacities od 11,13 and 19 units (in thousands). It has four warehouses W_1, W_2, W_3 and W_4. With demands of 6, 10, 12 and 15 units (in thousands)

units cost of transportation is given from each factory to each warehouse:

	W1	W2	W3	W4
F1	42	32	50	26
F2	34	36	28	46
F3	64	54	36	82

Construct a Transportation table and Find Initial feasible solution by Least Cost Method (LCM) **(7)**

OR

Q.3 C) From the data given below

i. **Draw a diagram** **(2)**
ii. **Find Critical path** **(2)**
iii. **Crash systematically the activities and determine optimal project duration** **(4)**

Activity	Normal Duration (Days)	Crash Cost per day(Rs)	Maximum possible Crash Time
1-2	6	80	2
1-3	8	90	4
1-4	5	30	2
2-4	3	-	0
2-5	5	40	2
3-6	12	200	4
4-6	8	50	3
5-6	6	-	0

Cost of completing eight activities in normal time is Rs. 6500 indirect cost Rs. 160 per day.

Q. 3 D) Five jobs I,II,III,IV and V are to be processed on two machine A and B in order AB

Jobs	Processing Time (Min)	
	Machine A	Machine B
I	90	70
II	40	80
III	40	50
IV	30	10
V	25	35

1) **Find the sequence that minimizes the total elapsed time** **(2)**
2) **Calculate the total elapsed time** **(3)**
3) **Idle time on for each Machine** **(3)**

Q.4 A) There are Six jobs (namely 1,2,3,4 ,5 and 6), each of which must go through machinesA, B and C in the order ABC. Processing Time (in hours) are given below:

Jobs	1	2	3	4	5	6
Machine A	12	8	7	11	10	5
Machine B	3	4	2	5	2	4
Machine C	7	10	9	6	11	4

(i) Find the sequence that minimizes the total elapsed time required to complete the job (2)
(ii) Calculate the total elapsed time (3)
(iii) Idle time on Machine A, Machine B and Machine C. (3)

Q.4 B) you are given the Pay-off (Profit in Rs.) matrix in respect of Two-Person-Zero – Sum Game as follows

		Player B			
		B1	B2	B3	B4
Player A	A1	500	260	200	210
	A2	-50	-100	-40	240
	A3	200	400	160	-20
	A4	250	300	100	50

(i) Find the Maximin Strategy. (3)
(ii) Find the Minimax Strategy. (3)
(iii) What is the value of the Game? (1)

OR

Q.4 C) A company is transporting its units from three factories F_1, F_2, F_3 to four warehouses W_1, W_2, W_3 and W_4. The supply and demand of units with transportation cost-per unit (in Rs.) are given below with feasible solution (The numbers which are in circle indicates number of units transported from Factory to warehouse).

Plants	Warehouses				Supply in Units
	W_1	W_2	W_3	W_4	
F_1	10	11 (16)	7	4 (24)	40
F_2	7	13 (15)	6 (16)	11	31
F_3	4 (25)	9 (4)	8	10	13
Demand in Units	25	35	16	24	100

(i) Test the solution for optimality (3)
(ii) If solution is not optimal find optimal solution. (5)

Q,4 D) A small project consist of seven activities. Optimistic, most likely and pessimistic time estimated in days are given below

Activity	Preceding Activity	Optimistic Time	Most likely Time	Pessimistic
A	-	2	5	8
B	-	2	5	14
C	A	4	6	14
D	A	5	7	15
E	B,C	2	3	10
F	D	3	3	3
G	E	1	2	3

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

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

Q.5 A) Define operation Research and What are the Characteristics of Operation research techniques? **(8)**

B) Explain Objective of Project Crashing of Network analysis **(7)**

OR

Q.5 C) Write a Short notes on Any Three **(15)**

i)Degeneracy in transportation
ii) Dummy activity in network analysis
iii) Three time estimates in PERT
iv) Project crashing
v) Assumption in LPP

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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	0.4573	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	0.4938	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									

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