2Hrs 30 min **75 Marks**

Please check whether you have got the right question paper.

Note :
1. All questions are compulsory. (Subject to Internal Choice)
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 papers will be supplied on request.

Q.1A) 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) Value of Game = 0	a) Training programme scheduling
2) Optimistic Time	b) If No. of Rows > No. of Columns
3) Application of O.R. in HRM	c) Minimization type Transportation Problem
4) Pessimistic Time	d) Does not affect the feasible region.
5) Add Dummy Row in Assignment	e) To maximize per capita income.
6) Redundant Constraint in Graphical	f) one player's gain is the other player's loss.
7) Application of O.R. in Finance	g) If No. of Rows < No. of Columns
8) Transportation elements as time	h) Fair Game
9) Add Dummy Column in Assignment	i) Shortest and ideal Time estimate in PERT
10) Zero Sum Game	j) Time estimate in PERT by considering worst delays

Q1 B) State whether following statements True or False: (Attempt any 8) (8)

1. One of the areas of application of Operations Research is in Agriculture.
2. A linear programming model consists of only decision variables and constraints.
3. In graphical method of LPP, the optimum value occurs anywhere in feasible region.
4. If the assignment elements are cost elements , then the objective of the optimal assignment is to maximize the cost.
5. In transportation problem, number of basic allocated (or Occupied) cells should be exactly $m + n + 1$, so that it becomes non-degenerate.
6. Dummy activity does not consume time or resources.
7. The three time estimates employed in PERT are: optimistic time, average expected time, and pessimistic time.
8. In Sequencing, the time taken by each job in changing over from one machine to another is negligible.
9. The row [−1, 10, 20] dominates the row [0, 0, 0]
10. The column [0, −1, −2] dominates the column [0, −1, −1]

Q2 A) Use Graphical method to solve the following Linear programming problem (8)

Objective Function

Max. $Z = 3X_1 + 4X_2$

Subject to Constraints

$3X_1 + 2X_2 \leq 18$

$X_1 \leq 5$

$X_2 \leq 6$

$x_1 \geq 0, x_2 \geq 0$

Q2.B) There are 7 different products in a machine shop. Their manufacturing time in Hrs on machines 1 and 2 are given below. Each of the product must go through two machines 1 and 2 in the order 1-2.

Products	Time in Hrs on Machine 1	Time in Hrs on Machine 2
A	20	10
B	30	25
C	10	25
D	20	30
E	55	35
F	60	40
G	50	45

(i) Find the sequence of Products that minimizes the total elapsed time. (2)
(ii) Find the Total Elapsed Time for the optimum Sequence. (3)
(iii) Calculate the idle time for machine 1. (1)
(iv) Calculate the idle time for machine 2. (1)

OR

Q.2 C) 'BMS Ltd' prepared a set of interdependent activities for their upcoming project; details of which is given in below table.

Activity	**Preceding Activity**	**Duration (weeks)**
(1, 2) A	–	2
(1, 3) B	–	3
(2, 4) C	A	3
(3, 5) D	B	4
(4, 6) E	C	3
(5, 6) F	C,D	2
(6, 7) G	E,F	9
(4, 5) Dummy	C	0

(i) Construct a network diagram, find critical path and project completion time. (3)
(ii) Tabulate/Calculate Earliest Start and Finish Time, Latest Start and Finish Time and Total Float. (5)

Q.2 D) A company is transporting its units from three manufacturing plants P_1, P_2 and P_3 to four distribution centres D_1, D_2, D_3 and D_4. The supply and demand of units with unit cost of transportation (in Rs.) and the schedule followed from plants to distribution centres are given below : (The numbers which are in circle indicates number of units transported from plant to distribution centre).

Manufacturing Plants	Distribution Centres				Supply (Units)
	D_1	D_2	D_3	D_4	
P_1	10	11 (16)	7	4 (24)	40
P_2	7	13 (15)	6 (16)	11	31
P_3	4 (25)	9 (4)	8	10	29
Demand (Units)	25	35	16	24	100

(i) Test the solution for optimality (3)
(ii) If solution is not optimal find optimal solution. (4)

Q.3 A) 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	450	230	200	300
	II	-50	-80	-40	240
	III	280	320	150	60
	IV	450	380	100	150

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

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

Jobs	1	2	3	4	5
Machine A	5	6	6	9	6
Machine B	3	2	5	5	3
Machine C	3	7	5	6	7

(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 Machine A, Machine B and Machine C. (3)

OR

Q.3 C) Five salesmen are to be assigned to five territories. Base on past performance, the following table shows the annual sales (is Rs. lakh) that can be generated by each salesman in each territory. Find optimum assignment to maximise sales. (7)

Salesman	Territory				
	T_1	T_2	T_3	T_4	T_5
S_1	24	12	8	10	7
S_2	29	25	28	12	14
S_3	13	16	14	23	28
S_4	15	10	19	28	23
S_5	18	17	23	14	8

Q.3 D) Use Simplex method to solve the following Linear programming problem (8)

Maximize $Z = 4x_1 + 7x_2$

Subject to the constraints,

$$x_1 + 3x_2 \leq 18$$
$$4x_1 + 2x_2 \leq 8$$
$$x_1 \geq 0 \ , \ x_2 \geq 0$$

Q.4 A) The table given below has been taken from the solution procedure of a transportation problem, involving minimization of cost (in Rs.)

Factories	Stockists			Monthly Capacity (units)
	P	Q	R	
A	4 (30)	8 (25)	8	55
B	18 (44)	24	18 (44)	88
C	12	16 (77)	24	77
Monthly Demand (Units)	74	102	44	220

i) Show that the above solution is optimal. Find an optimal solution. (3)

ii) Does the problem have multiple optimal solutions? Give reasons. (2)

iii) If multiple solutions exist, then find one more optimal solution. (3)

iv) Comment upon the managerial significance of multiple optimal solutions (2)

Q.4 B) A company is making a chart to decide the minimum amount of constituents like proteins, vitamins, carbohydrates, fats etc. Which a man needs on daily basis to fulfil his requirement for medical awareness. The choice is to be made from different type of foods (4 types). The yields per unit for different types of foods are explained below in the chart. Formulate the given linear programming problem. (5)

Type of food	Yield per unit			Cost per unit
	Proteins	Fats	Vitamins	(Rs.)
A	5	6	12	130
B	7	6	9	125
C	16	20	14	160
D	12	18	10	120
Minimum reqd.	1600	800	1000	

OR

4) (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	2	1
1 – 3	5	0.5
2 – 3	4	0.5
2 – 4	8	1
3 – 5	3	1
4 – 6	5	0.5
5 – 6	2	1
6 – 7	3	1

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

ii) Calculate and tabulate the Variance of each activity. (2)

b) iii) Determine the probability of completing the project in 17 Weeks. **(**2)

iv) If there is a huge penalty for exceeding the project completion deadline of two weeks after estimated projected completion time (T_E or Critical Path Duration). What is the probability of being penalized? (2)

v) Find project completion time for 95% confidence level. (2)

vi) If the fixed cost of the project is Rs. 4000000 /- and the variable cost is Rs. 20000/- per week. Find the amount the firm should bid under the policy of 95% confidence of completion of the project. (For the purpose of bidding, consider only cost that is break even – no loss and no profit) (2)

vii) If the project manager wants to complete the project with 95% confidence in 19 weeks, by how much time he crash the critical activities? (1)

viii) If the head of activity 3 - 5 wants to work overtime so that he can complete this activity in 2 weeks (instead of 3 weeks), should he be permitted? (1)

Q5 A) Define Operations Research. Discuss the advantages and limitations of O.R. (7)

B) What do you mean by alternative optimal solution in an Assignment? How do you identify alternative solution in an Assignment problem? Further what is the procedure to find that alternative solution**?** (8)

OR

C) Answer <u>Any 3</u> of the following: (15)

i) Assumptions in LPP
ii) Degeneracy in Transportation
iii) Principles of Dominance
iv) Assumptions in Job Sequencing
v) Dummy activity and its use in network analysis

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									

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