[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1143 **L**

Unique Paper Code : 2922062401

Name of the Paper : Quantitative Techniques for Management

Name of the Course : **BMS**

Semester : IV

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. **All** questions carry equal marks.
4. Use of Simple calculators are allowed.
5. Use of standard normal table is allowed.

1. Consider the following Linear Programming Problem :

   Minimize $Z = 2x_1 + 3x_2 + 4x_3$

   Subject to :

   $$x_1 + x_2 + x_3 \geq 5$$

   $$x_1 + x_2 + 2x_3 \geq 5$$

   $$x_1, x_2, x_3 \geq 0$$

   (i) Solve the above problem using Big M Simplex Method.

   (ii) Determine whether the problem has a unique optimal solution or multiple optimal solutions. Justify your answer.

   (iii) What is degeneracy? Determine whether the solution obtained above is degenerate. (18)

P.T.O.

2. (a) What are the steps involved in the formulation of a Linear Programming model? Illustrate these steps with the help of the following situation and solve the resulting problem graphically.

Mr. Gopal has received an inheritance of ₹95,000, which he plans to invest for one year in two alternatives - land and a small retail business. Each rupee invested in land yields a return of 20%, while each rupee invested in the retail business yields a return of 30%. Since both investments involve risk, Mr. Gopal wants to limit his overall exposure. He estimates that the risk associated with land is 18% of the amount invested, while for the retail business it is 30%. He does not want the total risk to exceed ₹20,000.

(b) A firm is considering four pricing strategies – A1, A2, A3, and A4 to compete in the market. Its competitor may respond with either an aggressive strategy B1 or a passive strategy B2. Based on market analysis, the firm estimates that if the competitor adopts an aggressive strategy, the payoffs (in ₹ lakhs) corresponding to A1, A2, A3, and A4 are 2, 4, 10, and 6 respectively. If the competitor adopts a passive strategy, the corresponding payoffs are 10, 5, 2, and 4, respectively. Assuming that the situation can be modeled as a two-person zero-sum game, formulate the payoff matrix and solve the game using the graphical method. Determine the optimal strategies and the value of the game. (9+9)

3. Consider the following LPP:

$$\text{Min } Z = 14x_1 - 10x_2 + 18x_3$$

$$\text{s.t} \quad 2x_1 - x_2 + 3x_3 \geq 9$$

$$x_1 - 2x_2 + x_3 \geq 4$$

$$\text{where} \quad x_1, x_2, x_3 \geq 0$$

The final optimal solution table for the LPP is given below :

Basic Variables	C_B	x_1	x_2	x_3	S_1	A_1	S_2	A_2	b_i
x_3	18	0	3	1	-1	1	2	-2	1
x_1	14	1	-5	0	1	-1	-3	3	3
Z_j		14	-16	18	-4	4	-6	6	
$C_j - Z_j$		0	6	0	4	M-4	6	M-6	

(i) Write the dual to the above primal and explain the relationship between the primal and the dual. State the solution to the dual and show that it gives the same objective function value as that of the primal.

(ii) Comment whether the constraints are binding or non-binding giving suitable justification.

(iii) State the range within which change in objective function coefficients for variables X2 and X3 will not affect the optimal solution obtained above. (18)

4. A company has factories at three different places S1, S2 and S3 and supply markets at four destinations D1, D2, D3 and D4. Monthly factory capacities are 250, 350 and 300 units respectively. Monthly requirements at demand centres are 200, 240, 210 and 250 units respectively. The per unit profit for different supply centre and market combinations are provided in the table below. For certain reasons the supply route from source S2 to market D3 is unavailable.

Profit (in Rs. per unit)

	D1	D2	D3	D4
S1	12	8	15	9
S2	10	14	X	11
S3	16	9	13	7

(i) Formulate the above as a transportation problem. Find the initial basic feasible solution to the transportation problem using Vogel's Approximation Method.

(ii) Explain the procedure for testing a transportation solution for optimality using Modified Distribution Method. Also state the rules for constructing a closed loop to transfer quantities for finding an improved/alternate solution.

(iii) Find the optimal transportation schedule that will maximise total profit. Comment if the optimal solution is unique or multiple. Find the alternate optimal solution if any. (18)

5. (a) A municipal council has received a special grant of Rs. 10 lakhs for carrying out maintenance work on five public parks in the city. The work must be completed at the minimum possible cost and in the least possible time. If needed, a supplementary token grant may also be considered. Six service agencies have submitted bids and each park can be assigned to only one agency.

(i) Find the best way of assigning the maintenance work to the agencies and the total cost.

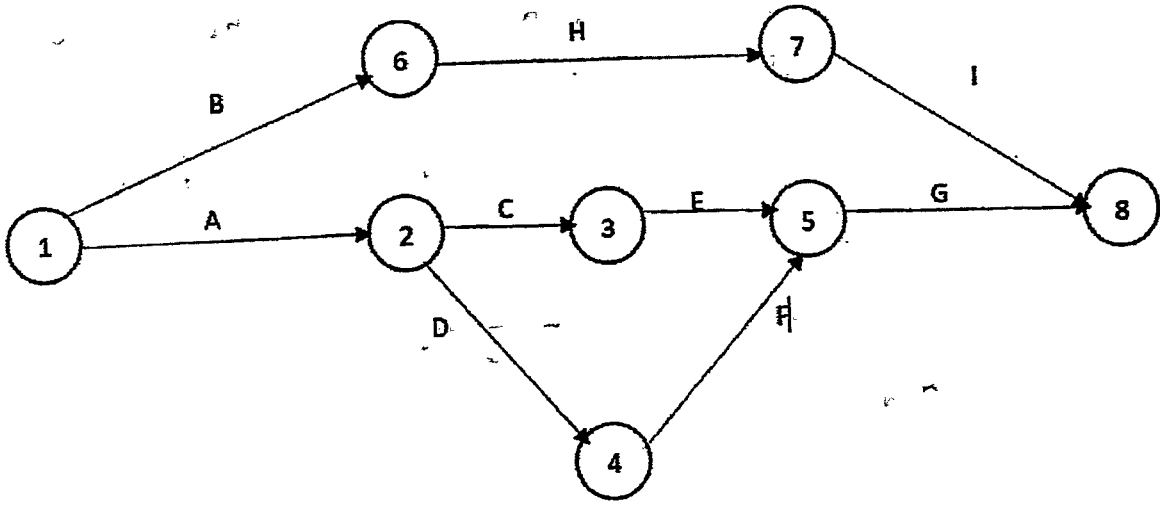
(ii) If it is necessary to seek supplementary grants, what should be the amount sought?

(iii) Which of the five agencies will remain unsuccessful in getting the contract?

	Cost of Maintenance (Rs. Lakhs)				
Service Agencies/ Park	P1	P2	P3	P4	P5
S1	6	2	5	3	6
S2	2	5	8	7	7
S3	7	8	6	9	8
S4	6	2	3	4	5
S5	9	3	8	9	7
S6	4	7	4	6	8

(b) A project has nine activities with the following time estimates (in weeks) and the project network :

Activity	Most Optimistic Time	Most Likely Time	Most Pessimistic Time
A	3	6	15
B	2	5	14
C	6	12	30
D	2	5	8
E	5	11	17
F	3	6	15
G	1	4	7
H	3	9	27
I	4	19	28



(i) Determine the critical path, expected duration and variance of the project.

(ii) If a 31-week deadline is imposed, then what is the probability that the project will be finished within the time limit?

(iii) If the project manager wants to be 99% sure that the project is completed on the scheduled date, how many weeks before that date should he start the project work? (9+9)

6. The following table shows details of a project.

Activities	Immediate Predecessor	Normal Time (days)	Crash Time (days)	Crash Slope (Rs./day)
A	-	3	1	2000
B	A	4	3	6000
C	A	3	2	2000
D	A	8	7	1000
E	B	4	4	-
F	C	6	6	-
G	E,F	5	4	4000
H	D	3	1	1800

Compute the following :

(i) Draw a network diagram representing the project.

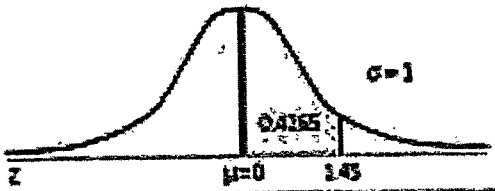
(ii) Calculate the Earliest and Latest event times and Total Float of the project.

(iii) Determine the Critical Path and Total Duration of the project.

(iv) Determine a crashing scheme for the above project so that the total project time is reduced by 4 days and the associated cost. (18)

Areas Under the One-Tailed Standard Normal Curve

This table provides the area between the mean and some Z score.
For example, when Z score = 1.45 the area = 0.4265.



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	0.2224
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
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000