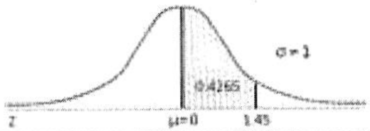
Areas Under the One-Tailed Standard Normal Curve

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	0.187
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	0.499
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

[This question paper contains 12 printed pages.]

Your Roll No..............

Sr. No. of Question Paper : 5104 **H**

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. Attempt any **two** of the following :

(a) A company manufactures two types of boxes, corrugated and ordinary cartons. The boxes undergo two major processes: cutting and pinning operations. The profits per unit are Rs. 6 and Rs. 4 respectively. Each corrugated box requires 2 minutes for cutting and 3 minutes for pinning operation, whereas each carton box requires 2 minutes for cutting and 1 minute for pinning. The available operating time is 120 minutes and 60 minutes for cutting and pinning machines. Formulate the above as Linear Programming Problem and solve by graphical Method. What are the optimum quantities of the two boxes to maximize the profits.

(b) State the two conditions for writing a dual to a primal for a Linear Programming Problem (LPP). Write the dual to the following LPP.

Activity	Precedence	Normal Time (in weeks)	Crash time (in weeks)	Normal Cost (in ₹)	Crash Cost (in ₹)
A	-	5	4	8,000	9,000
B	A	6	4	16,000	20,000
C	A	4	3	12,000	13,000
D	B	7	6	34,000	35,000
E	C	6	4	42,000	44,000
F	D	6	5	16,000	16,500
G	E	7	4	66,000	72,000
H	G	4	3	2,000	5,000

Determine a crashing scheme for the above project so that the total project time is reduced by 4 weeks and the associated cost. (12)

6. (a) Use the given details about a construction project to determine (a) critical path (b) non-critical activities (c) Free float and (d) duration of each activity

Time (in days)

Activity	ES	EF	LS	LF
1-2	0	2	7	9
1-3	0	4	0	4
1-4	0	3	9	12
2-5	2	3	9	10
3-5	4	10	4	10
4-6	3	8	12	17
5-6	10	17	10	17

(6)

(b) A project has eight activities with the following normal and crash estimates :

Minimize $Z = x_1 + x_2 + x_3$

Subject to constraints

$$x_1 - 3x_2 + 4x_3 = 5$$

$$x_1 - 2x_2 \leq 3$$

$$2x_2 - x_3 \geq 4$$

$$x_1, x_2 \geq 0, x_3 \text{ is unrestricted in sign}$$

(c) Differentiate between primal and dual of a Linear Programming Problem. How would you identify degeneracy while solving an LPP using simplex method? What are the implications of degenerate solution? (9×2=18)

2. Solve the following LP Problem using Big M Method.

Minimize $Z = 3x_1 + 10x_2 + 5x_3$

Subject to constraints

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

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

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

What is the optimum solution and the objective function value? How would you identify whether the problem has an alternate solution? (18)

3. (a) Consider the following linear programming problem:

Maximize $Z = 50x_1 + 30x_2$ (Profit function)

Subject to the constraints

$3x_1 + 2x_2 \leq 250$ (Labor constraint)

$2x_1 + x_2 \leq 150$ (Raw material constraint)

$x_1, x_2 \geq 0$

The optimal simplex table is given below :

Determine the optimal assignment of customer zones to the distribution centres so that the total cost of supplies is minimised and find the total cost. Will a customer zone remain unserved? If yes, which one? (9)

(b) There are 9 activities in a project with the following time estimates (in months) :

Activity	Optimistic time	Most likely time	Pessimistic time	Preceding Activity
A	4	6	8	-
B	1	2	3	-
C	4	4	4	A
D	4	5	6	A
E	7	9	17	B
F	8	9	10	B
G	2	2	2	C
H	2	4	12	D, E
I	1	3	11	F

Draw the network diagram and find the expected project duration. Estimate the probability of completing the project within 18 months. (9)

First, reduce the given game to a 2×3 matrix using the dominance property. Then, solve the simplified game graphically. What is the optimal strategy mix for Player B? (9)

5. (a) Nutrio Ltd deals in pharmaceuticals uses a distribution system in north India that has five distribution centres and six customer zones. In terms of the company policy, every customer zone is assigned an exclusive supplier and, therefore, receives all its requirements from the same distribution centre. Given below is the estimated monthly cost (in '000 Rs) of supplying each customer zone from different distribution centres:

Customer Zone

Distribution Centre	**A**	**B**	**C**	**D**	**E**	**F**
New Delhi	80	140	80	100	56	98
Ambala	48	64	94	126	170	100
Gurugram	56	80	120	100	70	64
Chandigarh	99	100	100	104	80	90
Bhatinda	64	80	90	60	60	70

Basic Variables	C_B	x_1	x_2	x_3 (Slack)	x_4 (Slack)	Solution (X_B)
x_2	30	0	1	2	-3	50
x_1	50	1	0	-1	2	50
Z_j		50	30	10	10	4,000
C_j-Z_j		0	0	-10	-10	

Using the information provided above, answer the following :

(i) Write down the solution for both the primal and associated dual variables from the optimal simplex table.

(ii) Determine the range of labor and raw material resource within which the present solution will remain feasible.

(iii) Specify the range of objective function coefficient for both variables for which the solution will remain optimal.

(4×3=12)

(b) Define a two person zero sum game. What is the difference between game with pure strategy and game with mixed strategy. Explain with example. (6)

4. (a) TechGear Inc., produces electronic components that are in high demand by three different retailers across the country. TechGear has three production facilities. However, due to various logistical constraints, TechGear Inc. cannot meet the entire demand of these retailers. Now, suppose TechGear Inc. incurs penalty costs for not meeting the demand requirements of these retailers. The penalty costs per unit of unsatisfied demand are ?30, ?60, and ?40 for retailers A, B, and C, respectively. The transportation costs between TechGear Inc.'s production facilities and the retailers are given in the following transportation table in terms of hundreds of rupees:

		Retailers			
		A	B	C	Supply
Facilities	F1	5	7	6	80
	F2	8	4	9	130
	F3	6	5	7	110
	Demand	100	150	120	

Utilize the Northwest Corner method to find an initial solution, then determine the optimum solution. What is the minimum transportation cost, inclusive of any penalty costs? (9)

(b) Consider the following game. The payoff is for Player A:

		Player B			
		B1	B2	B3	B4
Player A	A1	2	-3	8	4
	A2	3	3	-6	3
	A3	1	-4	7	3