



**SECTION "C"**  
[5Q. × 5 = 25 marks]

4. Write the dual problem of the following Linear Programming Problem.

$$\begin{aligned} \text{Min. } Z &= x_1 + x_2 + x_3 \\ \text{Subject to the constraints} \\ x_1 - 3x_2 + 4x_3 &= 5 \\ x_1 - 2x_2 &\leq 3 \\ 2x_2 - x_3 &\geq 4 \\ x_1, x_2 &\geq 0, \quad x_3 \text{ is unrestricted} \end{aligned}$$

5. The optimal solution table for the Linear programming problem

$$\text{Maximize } Z = x_1 + x_2$$

Subject to the constraints

$$(i) 3x_1 + 2x_2 \leq 5 \qquad (ii) x_2 \leq 2, \qquad x_1, x_2 \geq 0 \text{ is}$$

	$c_j$		1	1	0	0
Basic Variables	$C_B$	$b = x_B$	$x_1$	$x_2$	$s_1$	$s_2$
$x_1$	1	1/3	1	0	1/3	-2/3
$x_2$	1	2	0	1	0	1
	$c_j - z_j$		0	0	-1/3	-1/3

If  $x_1$  and  $x_2$  are both integers. Find the optimum solution for the integer programming problem using Gomory's cutting plane method.

6. An automobile production generally produces 100 cars a day but deviation in the production occurs due to various reasons. The production is more accurately describe by the probability distribution given below:

Production per day	Probability
95	0.03
96	0.05
97	0.07
98	0.10
99	0.15
100	0.20
101	0.15
102	0.10
103	0.07
104	0.05
105	0.03

Finished cars are transported across the bay at the end of each day by a ferry. If ferry has space for only 101 cars, what will be the average number of cars waiting to be shipped and what will be the average number of empty space in the ship. Use the random numbers: 97, 02, 80, 66, 96, 55, 50, 29, 58, 51, 04, 86, 24, 39, 47.

7. A company has four machines that are to be used for three jobs. Each job can be assigned to one and only one machine. The cost of each job on each machine is given in the following table. What are the optimal job assignment that minimizes the cost?

	I	II	III	IV
A	18	24	28	32
B	8	13	17	18
C	10	15	19	22

OR

A salesman has to visit four cities P, Q, R, S. The distances (in hundred km) between the four cities are as follows:

	P	Q	R	S
P	--	15	25	20
Q	22	---	45	55
R	40	30	--	25
S	20	26	38	--

If the salesman starts from city P and comes back to city P visiting all the cities, which route should he select so that total distance travelled by him is minimized?

8. A project consists of the following jobs whose precedence relationship is given below:

Job	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (Days)	15	15	3	5	8	12	1	14	3	14

- a. Draw the network diagram to represent the above information. [2]  
 b. Calculate the earliest occurrence time ( $E_i$ ) at each node using forward pass method. [3]

SECTION "D"

[2Q.  $\times$  2 = 4 marks]

9. Write the differences between assignment problem and travelling salesman problem.  
 10. In the table below the maximum profit is 600. If 8 units of resource 1 are added in the model what will be the new profit?

	$c_j$		40	60	0	0	0
Basic Variables	$C_B$	$x_B$	$x_1$	$x_2$	$s_1$	$s_2$	$s_3$
$x_2$	60	10	0.667	1	0.333	0	0
$s_2$	0	20	2.667	0	-0.667	1	0
$s_2$	0	30	-0.333	0	-0.667	0	1
	$c_j - z_j$		0	0	-20	0	0



KATHMANDU UNIVERSITY  
End Semester Examination  
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Marks Scored:

Level : B.Sc.

Year : III

26 JAN 2024

Course : MATH 304

Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date :

SECTION "A"

[20Q.  $\times$  0.5 = 10 marks]

Fill in the blank space(s) by writing the most appropriate word(s) or symbol(s).

1. The variable subtracted to the constraint of type greater or equal to ( $\geq$ ) in the linear programming problem is called \_\_\_\_\_.
2. The maximum amount we could pay if we want to add one unit of resource is called \_\_\_\_\_.
3. In integer programming, a new cut constraint is added to the existing set of constraints, and the resulting new feasible region is \_\_\_\_\_ than the old one.
4. In the transportation problem the opportunity cost ( $d_{ij}$ ) is calculated for all \_\_\_\_\_ cells.
5. Basic feasible solution of a transportation problem exists if the number of allocations in the transportation table with  $m$  rows and  $n$  columns is equal to \_\_\_\_\_.
6. Maximization in assignment problem can be converted into the minimization problem by \_\_\_\_\_ all the elements from the largest element including itself.
7. Monte – Carlo simulation method is developed through the use of the probability distribution and \_\_\_\_\_.
8. If  $W$  denotes the mean time spent in the queueing system,  $L$  refers to the average number of customers in the system and  $\lambda$  stands for mean arrival rate, then the formula for the Little's law is \_\_\_\_\_.
9. In a  $M/M/1$  queueing system, if  $\mu = 22$  and  $\lambda = 20$ , then the average number of customers in the system is equal to \_\_\_\_\_.
10. While constructing a network diagram using forward pass computations the earliest occurrence time for the initial project event is equal to \_\_\_\_\_.

Fill in the blank space(s), **DO NOT TICK**, by selecting the most appropriate answers from among the given ones.

11. If there are multiple optimal solutions in a linear programming problem then  $c_j - z_j$  value of \_\_\_\_\_ decision variables is zero in the optimal solution mix.  
[basic; non-basic; all; none of the mentioned]
12. The optimum solution of a Linear Programming Problem with all the constraints of  $\leq$  type exist at  $x_1 = 10$ ,  $s_2 = 20$  and  $x_3 = 25$ . What does  $s_2 = 20$  indicate?  
\_\_\_\_\_.  
[there is lack of resource 2; 20 units of resource 2 are misused;  
resource 2 is fully utilized; resource 2 is not fully utilized]
13. A non – integer variable is chosen in the optimal table of the Integer Linear Programming Problem to \_\_\_\_\_.  
[leave the basis; enter the basis;  
construct a Gomory cut, increase the solution values]
14. Optimality of a transportation problem is verified by using \_\_\_\_\_.  
[north west corner rule; least cost method;  
Vogel's approximation method; MODI method]
15. If salesman has to visit  $n$  number of cities, in how many ways he/she can make tour plan?  
\_\_\_\_\_.  
[ $(n - 1)!$ ;  $n!$ ;  $(n + 1)!$ ;  $n$ ]
16. In assignment problem, number of allocations in each row and column are \_\_\_\_\_.  
[equal; unequal; greater; smaller]
17. In Monte – Carlo simulation random number interval is to be considered based on \_\_\_\_\_.  
[the random numbers; probability;  
cumulative probability; frequency]
18. In the Kendall's notation  $a/b/c : d/e/f$ , what does  $b$  denote? \_\_\_\_\_.  
[service time distribution; inter – arrival time;  
traffic intensity; number of servers]
19. For the stability of queueing system the value of  $\rho = \frac{\lambda}{\mu}$  should be \_\_\_\_\_.  
[0;  $< 1$ ;  $> 1$ ;  $\neq 1$ ]
20. Network models have advantage in terms of project \_\_\_\_\_.  
[Planning; Scheduling; Controlling; All of the above]