33. Five operators have to be assigned to five machines. The assignment costs are given in the table below:

		Machine				
		I	II	III	IV	V
Operator	A	5	5	--	2	6
	B	7	4	2	3	4
	C	9	3	5	--	3
	D	7	2	6	7	2
	E	6	5	7	9	1

Operator A cannot operate machine III and operator C cannot operate machine IV. Find the optimal assignment schedule.

(**$6 \times 5 = 30$ Marks**)

Section D

Answer any ***two*** questions. Each question carries 10 marks.

34. Find all the basic feasible solutions for the system

$2x_1 + 6x_2 + 2x_3 + x_4 = 3$

$6x_1 + 4x_2 + 4x_3 + 6x_4 = 2$

$x_i \geq 0, i = 1,2,3,4$

35. A company has 4 warehouse and 6 stores .The surplus in the warehouse, the requirements of the stores and costs (in Rs.) of transporting one unit of the commodity from warehouse i to the store j are given below .How should the commodity be transported so that the total transportation cost is minimum. Obtain the initial program by applying the north-west corner rule:

	Store						
Warehouse	1	2	3	4	5	6	Surplus
1	7	5	9	5	10	7	**30**
2	7	8	14	7	9	13	**40**
3	4	10	5	6	10	4	**20**
4	11	8	12	7	12	11	**80**
Requirement	**30**	**30**	**60**	**20**	**10**	**20**	**170**

36. Use two phase simplex method to solve the following L.P.P

Maximize $z = 2x_1 - x_2 + x_3$

Subject to

$x_1 + x_2 - 3x_3 \leq 8$

$4x_1 - x_2 + x_3 \geq 2$

$2x_1 + 3x_2 - x_3 \geq 4$

$x_1, x_2, x_3 \geq 0$

(**$2 \times 10 = 20$ Marks**)

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17U605 (Pages: 4) Name: ……..…….

Reg. No……..……

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, APRIL 2020

(CUCBCSS-UG)

(Regular/Supplementary/Improvement)

CC15U MAT6 E02 - LINEAR PROGRAMMING

Mathematics - Elective

(2015 Admission onwards)

Time: Three Hours Maximum: 80 Marks

Section A

Answer ***all*** questions. Each question carries 1 mark.

1. Give an example of a convex set in $\mathbb{R}^n$.
2. Define a simplex in n dimension.
3. What is meant by a feasible solutions of a linear programming problem?
4. Define slack variable.
5. Is the number of extreme points of the convex set of feasible solutions is finite?
6. Define artificial variable.
7. State a necessary and sufficient condition for a given basic solution to be non-degenerate.
8. When do we call a variable as an unrestricted variable?
9. Is the number of dual constraints same as the number of primal variable?
10. All the basis for a transportation problem are triangular. True or false.
11. How does the problem of degeneracy arise in a transportation problem?
12. When can we say that an assignment problem is said to be unbalanced?

(**$12 \times 1 = 12$ Marks**)

Section B

Answer any ***nine*** questions. Each question carries 2 marks.

13. Prove that the intersection of the members of any family of convex set is again a convex set.
14. A firm can produce three types of cloths say A, B, C and three kinds of wool are required for it, say red green and blue wool. One unit length of type A cloth needs 2 yards of red wool and 3 yards of blue wool: one unit length of type B cloth need 3 yards of red wool, 2 yards of green wool and 2 yards of blue wool: and one unit of type C cloth needs 5 yards of green wool and 4 yards of blue wool. The firm has only a stock of 800 yards of red wool, 1000 yards of green wool and 1500 yards of blue wool. It is assumed that the income obtained from one unit length of type A cloth is ` 3, of type B cloth is ` 5 and of type C is ` 4. Determine how the firm should use the available materials, so as to maximize the income from the finished cloth. Formulate this as a linear programming problem.

15. What is the limitation of graphical method in solving linear programming problems?
16. Write down the following L.P.P in standard form

    Maximize $z = 3x_1 + 2x_2 + 5x_3$ Subject to the constraints

    $$2x_1 - 3x_2 \leq 3$$
    $$x_1 + 2x_2 + 3x_3 \geq 5$$
    $$3x_1 + 2x_3 \leq 2$$
    $$x_1, x_2, x_3 \geq 0$$
17. In the two-phase method explain when phase I terminates.
18. Write the dual of the following linear programming problem

    Maximize $z = 100x_1 + 15x_2$ Subject to the constraints

    $$x_1 + 4x_2 \leq 20$$
    $$4x_1 + x_2 \leq 35$$
    $$x_1, x_2 \geq 0$$
19. List the various method that can be used for obtaining an initial basic feasible solution for a transportation problem.
20. State minimax theorem.
21. Determine an initial basic feasible solution to the following transportation problem using column minima method.

Origin	Destination				Available
	D_1	D_2	D_3	D_4	
O_1	21	16	25	13	**11**
O_2	17	18	14	23	**13**
O_3	32	27	18	41	**19**
Requirement	**6**	**10**	**12**	**15**	**43**

22. Explain how to solve the degeneracy in transportation problem?
23. State Fundamental theorem of linear programming.
24. When in an assignment problem, the objective function is that of maximization instead of minimization, what modification are needed in the assignment algorithm to achieve this maximal assignment?

($9 \times 2 = 18$ Marks)

Section C

Answer any ***six*** questions. Each question carries 5 marks.

25. A factory uses three different resources for manufacture of two different products, 20 units of the resource A, 12 units of B and 16 units of C being available. 1 unit of the first product requires 2, 2 and 4 units of the respective resources and 1 unit of the second product requires 4, 2 and 0 units of the respective resources. It is known that the first product gives a profit of 2 monetary units per unit and the second 3. Formulate the linear programing problem. How many units of each product should be manufactured for maximizing the profit? Solve it graphically.

26. Let $A \subset \mathbb{R}^n$ be any set. Then prove that $\langle A \rangle$, the convex hull of A, is the set of all finite convex combinations of vectors in A
27. Prove that the set of feasible solutions to an L.P.P is a convex set.
28. Solve using simplex method

    Maximize $z = 6x_1 - 2x_2$ Subject to

    $$2x_1 - x_2 \leq 2$$
    $$x_1 \leq 4$$
    $$x_1, x_2 \geq 0$$
29. Solve the following linear programming problem by Big-M method

    Maximize $z = 4x_1 + 2x_2$ Subject to the constraints

    $$2x_1 + x_2 \leq 4$$
    $$5x_1 + 3x_2 \geq 15$$
    $$x_1, x_2 \geq 0$$
30. Consider the problem of assigning five jobs to five persons. The assignment costs are given as follows

	Job				
Persons	1	2	3	4	5
A	8	4	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

    Determine the optimum assignment schedule.
31. Verify that dual of the dual is a primal for the following L.P.P.

    Maximize $z = 5x_1 + 12x_2 + x_3$ Subject to the constraints

    $$x_1 + 2x_2 + x_3 \leq 5$$
    $$2x_1 - x_2 + 3x_3 = 3$$
    $$x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$$
32. Determine an initial basic feasible to the following transportation problem using Vogel's approximation method

Origin	Destination				Available
	D_1	D_2	D_3	D_4	
O_1	11	13	17	14	**250**
O_2	16	18	14	10	**300**
O_3	21	24	13	10	**400**
Demand	**200**	**225**	**275**	**250**	**950**

Turn Over