(Pages : 6) **M – 1460**

Reg. No. : .....

Name : .....

ALL SAINTS COLLEGE LIBRARY
No.....
TRIVANDRUM

Fifth Semester B.A./B.Sc./B.Com. Degree Examination, December 2021.

First Degree Programme under CBCSS

Mathematics

Open Course

MM 1551.1 – OPERATIONS RESEARCH

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 80

I. Answer **all ten** questions. These questions carry **1** mark each.

1. What are non-negative constraints in LPP?

2. Define feasible solution.

3. The optimal LP solution is always associated with a ———— point of the solution space.

4. What are slack variables?

5. In transportation model, what are arcs?

6. What do you mean by balancing a transportation problem?

7. What happens to a basic feasible solution of a transportation problem if one or more basic variables assume a zero value?

8. Write a necessary and sufficient condition for the existence of a feasible solution to the general transportation problem.

P.T.O.

9. Who developed the Hungarian method for solving an Assignment problem?

10. What is PERT?

(10 × 1 = 10 Marks)

II. Answer **any eight** questions from among questions **11 to 26**. These questions carry **2** marks each

11. Explain any two properties of LPP.

12. Determine the feasible space for $3x_1 + x_2 \leq 6,\ x_1, x_2 \geq 0$.

13. An individual wishes to invest \$5000 over the next year in two types of investments. Investment A yields 5% and Investment B yields 8%. Market research recommends an allocation of at least 25% in A and at most 50% in B. Moreover, investment in A should be at least half the investment in B. Formulate an LPP to find how should the fund be allocated to the two investments?

14. Write any two requirements on the constraints to apply Simplex method.

15. Write a brief note on how to deal with the unrestricted variable in linear programming.

16. Compare graphical and algebraic methods for solving a linear programming problem.

17. Give any two applications of transportation model.

18. A transport company ships truckloads *of* grain from three silos to four mills. The supply and the demand together with the unit transportation costs per truckload on the different routes are summarized in the following transportation model. The model seeks minimum-cost shipping schedule x_{ij} between silo i and mill j. Find an initial basic feasible solution using North-West corner rule.

		Mill 1	Mill 2	Mill 3	Mill 4	Supply
Silo	1	10 x_{11}	2 x_{12}	20 x_{13}	11 x_{14}	15
	2	12 x_{21}	7 x_{22}	9 x_{23}	20 x_{24}	35
	3	4 x_{31}	14 x_{32}	16 x_{33}	18 x_{34}	10
Demand		5	15	15	15	

19. What is an assignment problem? How does it differ from a transportation problem?

20. Give the mathematical formulation of an assignment problem.

21. Write two properties of assignment problem.

22. What is minimum cost flow problem?

23. Give any example for a maximum network flow diagram.

24. What is work force scheduling problem?

25. A bank wishes to purchase Bonds 1,2, and 3 in amounts whose total cash flow will offset the liabilities. Assume that fractional amounts of each bond are permitted. Formulate a linear programming model to find the lowest-cost set of bonds (i.e., portfolio) consisting of Bonds 1, 2, and 3 above that will meet the liabilities.

Bond	1	2	3
Price	$102	$99	$98
Coupon	$5	$3.5	$3.5
Maturity year	1	2	3

26. Write the advantages of PERT.

(8 × 2 = 16 Marks)

III. Answer **any six** questions from among questions **27 to 38**. These questions carry **4** marks each

27. A farm uses at least 800 lb of special feed daily. The special feed is a mixture of corn and soybean meal with the following composition.

	lb per lb feedstuff		
Feedstuff	Protein	Fiber	Cost($/lb)
Corn	.09	.02	.30
Soybean meal	.60	.06	.90

The dietary requirements of special feed are at least 30% protein and at most 5% fibre. Formulate an LPP to determine the daily minimum cost feed mix.

28. Explain briefly any four applications of Linear Programming.

29. A manufacturer produces three products I, II and III using the raw materials A and B. The following table gives the data for the problem.

Raw materials	Requirements per unit			Availability
	I	II	III	
A	2	3	5	4000
B	4	2	7	6000
Minimum demand	200	200	150	
profit per unit ($)	30	20	50	

The labor time per unit of model I is twice that of II and three times that of III. The entire labor force of the factory can produce the equivalent of 1500 units of model I. Market requirements specify the ratios 3:2:5 for the production of the three respective models. Formulate the problem as a linear program.

30. Two different products P1 and P2 can be manufactured by one or both of two different machines M1 and M2. The unit processing time of either product on either machine is the same. The daily capacity of machine M1 is 200 units and daily capacity of machine M2 *is* 250 units. The shop supervisor wants to balance the production schedule of the two machines such that the total number of units produced on one machine is within 5 units of the number produced *on* the other. The profit per unit of P1 is $10 and that of P2 is $15. Set up the problem as an LP in equation form.

31. Write the linear program formulation of a transportation problem.

32. Write a short note on vogal's approximation method.

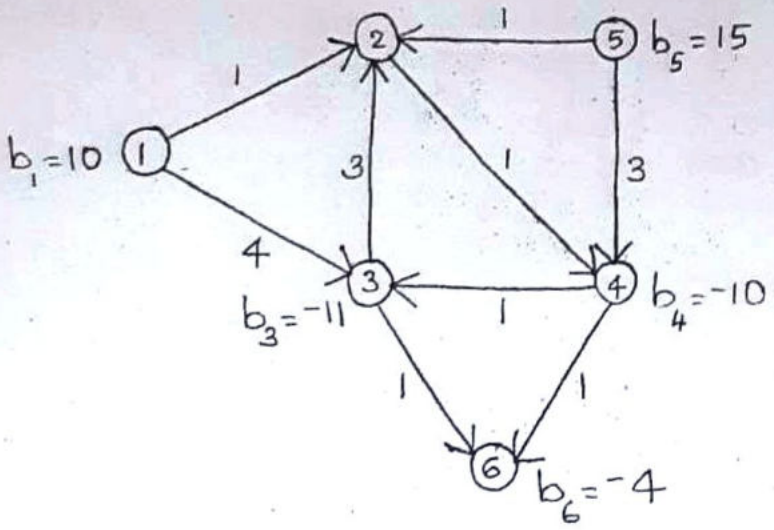
33. Explain the algorithm for the North-West corner rule.

34. Solve the following assignment problem using Hungarian method

	Mow	Paint	Wash
John	$15	$10	$9
Karen	$9	$15	$10
Terri	$10	$12	$8

35. *Give the simplex explanation of the Hungarian method.*

36. Solve the minimum cost flow problem given in the following network diagram.



37. Draw the network of the project consisting of 5 jobs A, B, C, D and E with the following job sequence: Job A precedes C and D Job B precedes D Job C and D precede E

38. For an activity with optimistic time of completion 3 days, pessimistic time of completion 5 days and most probable time of completion 4 days, find its expected time of completion and variance of the job time.

(6 × 4 = 24 Marks)

IV. Answer **any two** questions from among questions **39 to 44**. These questions carry **15** marks each

39. An industrial recycling center uses two scrap aluminium metals A and B to produce a special alloy. Scrap A contains 6% aluminium, 3% silicon and 4% carbon. Scrap B has 3% aluminium, 6% silicon and 3% carbon. The costs per ton for scraps A and B are $100 and $80 respectively. The specifications of the special alloy required that (a) the aluminium content must be at least 3% and at most 6% (b) the silicon content must lie between 3% and 5% and (c) the carbon content must be between 3% and 7%. Determine the optimum mix of the scraps that should be used in producing 1000 tons of the alloy using graphical method

40. A business executive has the option to invest money in two plans; Plan A guarantees that each dollar invested will earn $0.7 a year later, and plan B guarantees that each dollar invested will earn $2 after 2 years. In plan A, investments can be made annualy, and in plan B, investments are allowed for periods that are multiples of two years only. How should the executive invest $100,000 to maximize the earnings at the end of 3 years?

41. Three electric power plants with capacities 0 25 40 and 30 million kWh supply electricity to three cities. The maximum demands at the three cities are estimated at 30, 35 and 25 million kwh. The price per million kWh at the three cities is given below.

During the month of August, there is 20% increase in demand at each of the three cities, which can be met by purchasing electricity from another network at a premium rate of $1000 per million kwh. The network is not linked to city 3, however. The utility company wishes to determine the most economical plan for the distribution and purchase of additional energy.

(a) Formulate the problem as a transportation model.

(b) Determine an optimal distribution plan for the utility company.

(c) Determine the cost of the additional power purchased by each of the three cities

42. Compare the solutions obtained using North-West corner rule and Vogal's approximation method for the following transportation problem.

0	2	1	6
2	1	5	7
2	4	3	7
5	5	10	

43. Solve using Simplex method:

minimize: $-x_1 - x_2$

Subject to: $x_1 \leq 1$

$x_2 \leq 1$

$x_1 \geq 0, x_2 \geq 0.$

44. What are CPM and PERT? What are the differences and similarities between CPM and PERT?

(2 × 15 = 30 Marks)
