Semester-V

Skill Enhancement Paper

SEC-3: Transportation and Network Flow Problems

Total Marks: 100 (Theory: 55, Internal Assessment: 20 and Practical: 25)
Workload: 3 Lectures, 2 Practicals (per week) **Credits:** 4 (3+1)
Duration: 14 Weeks (42 Hrs. Theory + 28 Hrs. Practical) **Examination**: **3** Hrs.

Course Objectives: This course aims at providing applications of linear programming to solve real-life problems such as transportation problem, assignment problem, shortest-path problem, minimum spanning tree problem, maximum flow problem and minimum cost flow problem.

Course Learning Outcomes: This course will enable the students to:

i) Formulate and solve transportation problems.
ii) Learn to solve assignment problems using Hungarian method.
iii) Solve travelling salesman problem.
iv) Learn about network models and various network flow problems.
v) Learn about project planning techniques namely, CPM and PERT.

Unit 1: Transportation Problems
Transportation problem and its mathematical formulation, North West corner method, Least cost method and Vogel's approximation method for determination of starting basic feasible solution, Algorithm for solving transportation problem.

Unit 2: Assignment and Traveling Salesperson Problems
Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, Traveling salesperson problem.

Unit 3: Network Models
Network models, Minimum spanning tree algorithm, Shortest-route problem, Maximum flow model.

Unit 4: Project Management with CPM/PERT
Project network representation, CPM and PERT.

References:

1. Hillier, Frederick S., & Lieberman, Gerald J. (2017). *Introduction to Operations Research*, (10th ed.). McGraw Hill Education (India) Pvt. Ltd. New Delhi.
2. Taha, Hamdy A. (2007). *Operations Research*: *An Introduction* (8th ed.). Pearson Education India. New Delhi.

Additional Reading:

i. Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). *Linear Programming and Network Flows* (4th ed.). John Wiley & Sons.

Practicals to be done in the Computer Lab using a suitable Software:

Use TORA/Excel spreadsheet to solve transportation problem, Assignment problem, Traveling salesperson problem, Shortest-route problem, Minimum spanning tree algorithm, Maximum flow model, CPM and PERT calculations of exercises from the chapters 5 and 6 of [2].
[1] Case 9.1: Shipping Wood to Market, and Case 9.3: Project Pickings.

Teaching Plan (Theory of SEC-3: Transportation and Network Flow Problems):

Weeks 1 to 4: Transportation problem and its mathematical formulation, North West corner method, least cost method and Vogel's approximation method for determination of starting basic feasible solution. Algorithm for solving transportation problem.
[2] Chapter 5 (Sections 5.1, and 5.3).

Weeks 5 to 7: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, traveling salesperson problem.
[2] Chapter 5 (Section 5.4), and Chapter 9 (Section 9.3)

Weeks 8 to 11: Network models, minimum spanning tree algorithm, shortest-route problem, maximum flow model.
[2] Chapter 6 (Sections 6.1 to 6.4).

Weeks 12 to 14: Project network, CPM and PERT.
[2] Chapter 6 (Section 6.5).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Formulate and solve transportation problems.	(i) Topics to be explained using TORA/Excel. (ii) Students to be given homework/assignments. (iii) Students to be encouraged to look for new applications.	• Presentations and class discussions. • Assignments and class tests. • Mid-term examinations. • Practical examinations. • End-term examinations.
2.	Learn to solve assignment problems using Hungarian method. Solve travelling salesman problem.		
3.	Learn about network models and various network flow problems.		
4.	Learn about project planning techniques namely, CPM and PERT.		

Keywords: Transportation problem, Assignment problem, Traveling salesperson problem, Network flows, CPM, PERT.