## Combinatorial Optimization (BHCS15C) Discipline Specific Elective - (DSE) Credit: 06

### Course Objectives

This course is designed to introduce the fundamentals of combinatorial optimization to the students in terms of both theory and applications, so as to equip them to explore the more advanced areas of convex and non-convex optimizations.

### Course Learning Outcomes

On successful completion of the course, students will be able to:

1. Model problems using linear and integer programs
2. Apply polyhedral analysis to develop algorithms for optimization problems
3. Use the concept of duality for design of algorithms

### Detailed Syllabus

**Unit 1**

Introduction to Combinatorial Optimization Problems, Linear and Integer Programs: LP Formulation, understanding integer programs, computational complexities of IP vs LP, using LP to find optimal or approximate integral solutions, concept of integrality gap.

**Unit 2**

**Theory of Linear Programming and Algorithmic Perspective to Simplex Method:** standard vs. equational form, basic feasible solutions, convexity and convex polyhedra, correspondence between vertices and basic feasible solutions, geometry of Simplex algorithm, exception handling (unboundedness, degeneracy, infeasibility), Simplex algorithm, avoiding cycles.

**Unit 3**

**Primal-Dual Algorithms:** interpretation of dual, optimality conditions for primal and dual, weak and strong duality, complementary slackness, primal-dual algorithm for the shortest path problem.

**Unit 4**

**Network Flows:** linear programming formulations for network flows and bipartite matching, totally unimodular matrices integral polyhedral.

**Tutorials**

Tutorials based on Theory

**References**

1. Matousek & Gartner (2007). *Understanding and Using Linear Programming*. Springer.

2. Papadimitriou, C.H. & Steiglitz, K. (1998). *Combinatorial Optimization: Algorithms and complexity*. Dover Publications.

**Additional Resources:**

1. Bazaraa, M.S., Jarvis, J.J., & and Sherali, H.D.(2008). *Linear Programming and Network Flows*. 2nd edition. Wiley.

2. Korte, B., & Vygen, J. (2006). *Combinatorial Optimization*. 5th edition. Springer.

**Course Teaching Learning Process**

- Use of ICT tools in conjunction with traditional class room teaching methods
- Interactive sessions
- Class discussions

Tentative weekly teaching plan is as follows:

| Week | Content |
|---|---|
| 1-2 | Introduction to Combinatorial Optimization Problems, Linear and Integer Programs: LP Formulation, understanding integer programs, computational complexities of IP vs LP, using LP to find optimal or approximate integral solutions, concept of integrality gap |
| 3-6 | Theory of Linear Programming and Algorithmic Perspective to Simplex Method: standard vs. equational form, basic feasible solutions, convexity and convex polyhedra, correspondence between vertices and basic feasible solutions, geometry of Simplex algorithm, exception handling (unboundedness, degeneracy, infeasibility), Simplex algorithm, avoiding cyc |
| 7-10 | Primal-Dual Algorithms: interpretation of dual, optimality conditions for primal and dual, weak and strong duality, complementary |

| | |
|---|---|
| | slackness, primal-dual algorithm for the shortest path problem. |
| 11-15 | Network Flows: linear programming formulations for network flows and bipartite matching, totally uni-modular matrices integral polyhedral |

**Assessment Methods**

Written tests, assignments, quizzes, presentations as announced by the instructor in the class.

**Keywords**

optimization problems, linear programming, integer programming, duality, network flow problems

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## Digital Image Processing (BHCS16A) Discipline Specific Elective - (DSE)

## Credit: 06

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**Course Objective**

This course introduces students to the fundamentals of digital image processing, and various image transforms, image restoration techniques, image compression and segmentation used in digital image processing.

**Course Learning Outcomes**

On successful completion of the course, students will be able to:

1. Describe the roles of image processing systems in a variety of applications;
2. Write programs to read/write and manipulate images: enhancement, segmentation, and compression, spatial filtering.
3. Develop Fourier transform for image processing in frequency domain.
4. Evaluate the methodologies for image segmentation, restoration

**Detailed Syllabus**

**Unit 1**