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***CSX455 Approximation Algorithms***

**L-T-P-Cr:3-0-0-3**

**Pre-requisites:** Fundamental knowledge of AI, linear algebra, probability & statistics, and algorithms

**Objectives/Overview:**

* Students will learn the basic definitions of approximation algorithms: combinatorial and LP- based algorithms.
* Students will learn basic algorithmic techniques used to design approximation algorithms.
* Students will learn the limits of approximation, and the basic ways of proving hardness of approximation.

**Course Outcomes:**

Understand the essential techniques to design and analyze approximation algorithms, including the following:

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| **Sl. No.** | **Outcome** | **Mapping to POs** |
|  | Basic concepts and terminology used in approximation algorithms lower bound, upper bound,  Familiar with combinatorial optimization problem. | PO2 |
|  | How to characterize a problem and design approximation algorithm and analyze its performance. | PO1, PO2,PO3 |
|  | How to formulate Linear programming  Problem. | PO3 |
|  | How to use rounding technique to find approximation algorithms | PO2,PO3 |
|  | How to use Primal-dual and relaxation methods to find approximation algorithms | PO1, PO2 |

**UNIT I: Introduction Lectures: 4**

Lower bounding, Vertex cover problem, (2-approx), Greedy set cover problem (log(n)-approximation), and its applications.

**UNIT II: Combinatorial Algorithms Lectures: 16**

Minimum Steiner tree, Travelling salesman problem, Metric Travelling salesman problem (2-approx and 1.5-approx), Euclidean TSP, and its Applications; k-centering Problem, and its Applications; Minimum Makespan Scheduling (2-approx); Knapsack problem 2-approximation, FPTAS and its applications Shortest superstring, Multiway Cut and k-Cut, Feedback Vertex Set,

**UNIT III: LP-Based Algorithms Lectures: 16**

Introduction to LP-Duality, LP-relaxation &Rounding applied to vertex cover and set cover, Set Cover via the Primal-Dual Schema, Maximum Satisfiability, Randomize approximate MAX-3-CNF Satisfiability, Scheduling on Unrelated Parallel Machines, Finding global MIN-CUTMulticut and Integer Multicommodity Flow in Trees, Multiway Cut, Multicut in General Graphs, Sparsest Cut, Steiner Forest, Steiner Network, Facility Location, k-Median, Semidefinite Programming,

**UNIT IV: Hardness of Approximation Lectures: 4**

Reductions, gaps, and hardness factors, The PCP theorem, Hardness of MAX-3SAT, Hardness of vertex cover and Steiner tree, Hardness of set cover 322

**Text/Reference Books**

1. *Approximation Algorithms:*Vijay Vazirani,  Springer-Verlag, 2001, ISBN: 3-540-65367-8