NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Computer Science and Engineering
Course Code:	2CSDE94
Course Title:	Approximation Algorithms
Course Type:	Departmental Elective
Year of Introduction:	2021-22

Credit Scheme

L	T	Practical Component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. explain importance of approximation algorithms with various approximation schemes
2. choose appropriate approximation scheme for combinatorial algorithms
3. develop Linear Programming based approximation algorithms for various graph problems
4. estimate hardness of approximation algorithms for classical NP-hard problems

Syllabus: **Total Teaching hours: 30**

Unit	Syllabus	Teaching hours
Unit-I	**Introduction to Approximation Algorithms:** Absolute Approximations, ϵ-Approximations, Polynomial time approximation schemes, Fully polynomial time approximation schemes, Probabilistically good algorithms	08
Unit-II	**Combinatorial Algorithms:** Set Cover, Steiner Tree and TSP, Multiway Cut and k-cut, k-Center, Feedback Vertex Set, Shortest Superstring, Knapsack, Bin Packing, Minimum Makespan Scheduling, Euclidean TSP	07
Unit-III	**LP-Based Algorithms:** Introduction to LP-Duality, Set Cover via Dual Fitting, Rounding applied to Set Cover, Set Cover via the Primal-Dual Schema, Maximum Satisfiability, Scheduling on unrelated parallel machines, Multicut and Integer Multicommodity Flow in Trees, Multiway Cut, Multicut in General Graphs, Sparsest Cut, Steiner Forest, Steiner Network, Facility Location, k-Median, Semidefinite Programming	08
Unit-IV	**Hardness of Approximation:** Reductions, gaps and hardness factors, PCP theorem, Hardness of MAX-3SAT, Hardness of vertex cover and Steiner tree, Hardness of clique and set cover	07

Self-Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents

Suggested Readings/ References:

1. Vijay V. Vazirani, Approximation Algorithms, Springer
2. Ellis Horowitz and Sartaj Sahni, Fundamentals of Computer Algorithms
3. Bernd Gartner and Jiri Matousek, Approximation Algorithms and Semidefinite Programming, Springer
4. Dorit S. Hochbaum, Approximation Algorithms for NP-Hard Problems, Thomson Brooks/Cole

Suggested List of Experiments:

Sr. No.	Practical Title	Hours
1	To implement the Set Cover algorithm	02
2	To implement the Steiner tree along with all its operations	02
3	To implement the algorithm to solve the k-Centre problem	02
4	To implement the algorithm for computing the shortest superstring of the given string	02
5	To implement the algorithm for solving Maximum Satisfiability problem	04
6	To implement the algorithm for solving k-median problem	04
7	To implement the algorithm for solving k-clique problem	04
8	To implement approximation algorithm for graph coloring problem	02
9	To implement approximation algorithm for scheduling problem	04
10	To implement approximation algorithm for travelling salesperson problem	04

Suggested Case List: -NA-