**COURSE OUTLINE**

**Course Code : CSE 461**

**Course Title: Algorithm Engineering**

**Level/Term : Level 4, Term 2 Section: A & B**

**Academic Session : January 2020**

**Course Teacher(s):**

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| **Name:** | **Office/Room:** | **E-mail and Telephone: (optional)** |
| Prof. Dr. Md. Saidur Rahman | 319 | saidurrahman@cse.buet.ac.bd |

**Course Outline :**

Computational complexity; Exact Algorithms; Parameterized complexity; Practical computing and heuristics; Approximation algorithms; LP based approximation algorithms; Randomized algorithms; On-line algorithms; Experimental algorithmics; Contemporary and state-of-the-art algorithms.

**Learning Outcomes/Objectives:**

After undergoing this course, students should be able to:

1. compare the complexities of computational problems,
2. design faster exact exponential algorithms for hard problems,
3. design approximation algorithms with guaranteed approximation ratios,
4. derive competitive ratios for on-line algorithms,
5. use randomization to enhance the power algorithms,
6. apply heuristics and metaheuristics to solve practical optimization problems, and
7. implement algorithms with low working memory.

**Assessment**

Class Tests/Assignments/ Projects: 20%

Attendance: 10 %

Term final : 70%

**Reference books:**

a. Jon Kleinberg and Eva Tardos, , Algorithm Design, Pearson, 2011.

b. Fedor V. Fomin and Dieter Kratsch, Exact Exponential Algorithms, Springer, 2010.

c. David P. Williamson and David B. Shmoys, The design of Approximation Algorithms, Cambridge, 2011.

d. Dennis Komm, An Introduction to Online Computation, Springer, 2016.

e. Allan Borodin and Ran El-Yaniv, Online Computation and Competitive Analysis, Cambridge, 1998.

f. Bastien Chopard and Marco Tomassini, An Introduction to Metaheuristics for Optimization, Springer, 2018.

**Weekly schedule :**

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| **Week** | **Topics** |
| Week 1 | Computational Complexity: Polynomial-time reductions, Vertex Cover Problem vs Independent set problem, Vetex Cover Problem vs Set Cover Problem, Independent Set vs Set Packing. |
| Week 2 | Classes P, NP, NP-hard, NP-complete, Co-NP, PSPACE, Satisfiability Problem and Cook’s Theorem. |
| Week 3 | Proving NP-completeness. |
| Week 4 | Exact Exponential Algorithms: Dynamic Programming for TSP and branching algorithm for Independent Set Problem. |
| Week 5 | Approximation Algorithms: 2-approximation algorithm for vertex cover, 2-approximation for simple knapsack, APX, APX-hard, PTAS, FPTAS. |
| Week 6 | FPTAS for Knapsack Problem, PTAS for independent set problem in planar graphs. |
| Week 7 | Approximability of TSP, 2-approxmation and 3/2 approximation for Metric TSP. |
| Week 8 | Linear programming and rounding for vertex cover problem. |
| Week 9 | |  | | --- | |  |   Randomized Algorithms: Shuffling Problem, Coupon Collector’s Problem, Median-Finding. |
| Week 10 | Heuristics and Metaheuristics: Local Search, Tabu Search. |
| Week 11 | Heuristics and Metaheuristics: Simulated Anneling, The Ant Colony Method, Performance and Limitations of Metaheuristics. |
| Week 12 | Online Algorithms: Ski-rental Problem, Linear List Search. |
| Week 13 | Online Algorithms: k-server problem, Paging. |
| Week 14 | Low memory algorithms. |

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| Prepared by : |
| Name: Prof. Dr. Md. Saidur Rahman  Signature: C:\Users\user\Dropbox\personal\Anonno\Sir Signature (300x80) 19.9 kb.jpg  Date: 18-02-2020 |