Advanced Theory of Computation

Code	Credit Hours
CS-802	3-0

Course Description

This is a foundational course in computer science. As opposed to other courses in computer science, the purpose of this course is to ask very fundamental questions about computations.
The main questions addressed in this course are:
1. What is a computation?
2. What is the exact definition of an algorithm?
3. Which problems can be solved computationally?
4. Are there any problems that cannot be solved computationally?
5. How much resources are needed to solve a problem?
6. Can we identify problems that can be solved in principle (given a lot of resources) but cannot be solved in practice?
The theme of the course is to pose these problems in a mathematically precise way. Furthermore, we will answer these questions in a rigorous fashion.

Text Book:

Text book:

Theory of Computation, Author: Michael Sipser
ISBN: 978-81-315-0513-7

 Recommended book:

The Theory of Computation, Author: *Bernard M.E. Moret*
ISBN: 0-201-25828-5

Prerequisites

MECH 204 (Material Science and Engineering)

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Project	10%
Mid Terms	30%
ESE	40%

ASSESSMENT SYSTEM FOR LAB

	Lab Work and Report	**N/A for this Course**
	Lab ESE/Viva	**N/A for this Course**

Teaching Plan

Week No	Topics	Learning Outcomes
1-2	Motivation and overview, Preliminaries, pairing functions, Cantor's proof, Implication for Computability	
3-4	Regular Languages, Finite Automata, Non-determinism, Regular Expressions, Non-regular languages, Context Free Grammars, Pushdown Automata, Non-Context free languages.	
5-6	Turing Machines, Variants of Turing Machines, The definition of Algorithm, Hilbert's Tenth Problem. **OHT-1**	
7-8	Decidables languages, Arithmetization: Encoding a Turing Machine. Existence of Universal Turing Machines , Rice theorem and Recursion theorem, Degree of unsolvability. Halting Problem.	
9-10	Savitch's theorem, Complete Problems, NP-Completeness: Cook's Theorem, Space completeness, Provably intractable problems. **OHT-2**	

11-12	Hierarchy theorems. Relativization, Restrictions of Hard Problems, promise problems, Strong NP-Completeness.	
13-14	The complexity of Approximations, constant distance approximations, approximation schemes, No Guarantee unless P equal NP.	
15-17	Complexity theory frontiers, Average case complexity, Interactive proofs and Probabilistic proof checking	
18	**End Semester Exams**	

Practical: 3+0

	Not Applicable