Course code	Course Name	L-T-P - Credits	Year of Introduction
CS367	**Logic for Computer Science**	**3-0-0-3**	**2016**

Pre-requisites : **CS205** Data Structures

Course Objectives

- To introduce the concepts of mathematical logic and its importance.
- To discuss propositional, predicate, temporal and modal logic and their applications.

Syllabus

Propositional Logic, Resolution, binary decision diagrams, Predicate logic, resolution, temporal logic, deduction, program verification, modal logic.

Expected Outcome

The students will be able to

i. Gain the concept of logic and its importance.
ii. Understand fundamental concepts in propositional, predicate and temporal logic and apply resolution techniques.
iii. Apply the concept of program verification in real-world scenarios.
iv. Know the fundamental concepts in modal logic.

Text Books

1. Arindhama Singh, Logics for Computer Science, Prentice Hall India, 2004.
2. Modechai Ben-Ari, Mathematical Logic for Computer Science, Springer, 3/e, 2012.

Reference

1. Michael Huth, Mark Ryan, Logic in Computer Science: Modeling and Reasoning about Systems, Cambridge University Press, 2005.

Course Plan

Module	Contents	**Hours**	**End Sem. Exam Marks**
I	Introductory Concepts: Mathematical Logic, Propositional Logic, First Order Logic, Modal and Temporal logic, Program Verification. (**Reading: Ben-Ari, Chapter 1**) Propositional Logic: Formulae and interpretations, Equivalence, Satisfiability& Validity, Semantic Tableaux, Soundness and Completeness. (**Reading: Ben-Ari, Chapter 2 except 2.4, Additional Reading : Singh, Chapter 1**)	**06**	**15%**
II	The Hilbert Deductive System, Derived Rules, Theorems and operators, Soundness and Completeness, Consistency. (**Reading: Ben-Ari, Chapter 3 except 3.7 and 3.8, Additional Reading : Singh, Chapter 1**) Resolution in Propositional Logic: Conjunctive Normal form, Clausal form, resolution rule. (**Reading: Ben-Ari, Chapter 4.1, 4,2, 4.3, Additional Reading : Singh, Chapter 1**)	**06**	**15%**
FIRST INTERNAL EXAM			
III	Binary Decision Diagrams: Definition, Reduced and ordered BDD, Operators. **(Reading: Ben-Ari, Chapter 5.1 – 5.5)** Predicate Logic: Relations, predicates, formulae and interpretation, logical equivalence, semantic tableaux, soundness.**Reading: Ben-Ari, Chapter 7.1-7.6, Additional Reading : Singh, Chapter 2**)	**07**	**15%**

IV	The Hilbert deduction system for predicate logic. Functions, PCNF and clausal form, Herbrand model. Resolution in predicate logic: ground resolution, substitution, unification, general resolution. **Reading: Ben-Ari, Chapter 8.1-8.4, 9.1, 9.3, 10.1-10.4, Additional Reading : Singh, Chapter 2, Chapter 3**)	**08**	**15%**
SECOND INTERNAL EXAM			
V	Temporal logic: Syntax and semantics, models of time, linear time temporal logic, semantic tableaux. Deduction system of temporal logic. (**Reading: Ben-Ari, Chapter 13.1-13.5, 14.1-14.2**)	**07**	**20%**
VI	Program Verification: Need for verification, Framework for verification, Verification of sequential programs, deductive system, verification, synthesis. **(Reading: Ben-Ari, Chapter 15.1-15.4, Additional Reading : Singh, Chapter 5**) **Modal Logic:** Need for modal logic, Case Study: Syntax and Semantics of K, Axiomatic System KC, **(Reading: Singh, Chapter 6.1-6.3**)	**08**	**20%**
END SEMESTER EXAM			

Assignments: Some of the assignments can be given on an interactive theorem prover like Isabelle or Coq.

Question Paper Pattern

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
   a. Total marks : 12
   b. *Four* questions each having *3* marks, uniformly covering modules I and II; All*four* questions have to be answered.
3. Part B
   a. Total marks : 18
   b. *Three* questions each having *9* marks, uniformly covering modules I and II; *Two* questions have to be answered. Each question can have a maximum of three subparts.
4. Part C
   a. Total marks : 12
   b. *Four* questions each having *3* marks, uniformly covering modules III and IV; All*four* questions have to be answered.
5. Part D
   a. Total marks : 18
   b. *Three* questionseach having *9* marks, uniformly covering modules III and IV; *Two* questions have to be answered. Each question can have a maximum of three subparts
6. Part E
   a. Total Marks: 40
   b. *Six* questions each carrying 10 marks, uniformly covering modules V and VI; *four* questions have to be answered.
   c. A question can have a maximum of three sub-parts.

There should be at least 60% analytical/numerical questions.