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No:- Date:

## CSX4191 Knowledge Representation & Reasoning

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

Prerequisite: Knowledge of formal languages, logic, and programming

### Objectives/Overview:

- The course introduces the field, focusing on decidable fragments of first-order logic that are well-suited for knowledge representation.
- Explores how first-order logic can be used to represent knowledge, identify relevant reasoning problems, and show how these can be used to support the task of constructing suitable representations.
- Also considers the computational properties of these logics, and study algorithms for solving the relevant reasoning problems.
- To discuss logics that depart from first order logic, such as non-monotonic logics.

### Course Outcomes:

At the end of the course, a student is able to:
CO1: Understand the fundamental principles of logic-based Knowledge Representation.
CO2: Model simple application domains in a logic-based language.
CO3: Understand the notion of a reasoning service.
CO4: Learn the fundamentals of the reasoning algorithms underlying current systems.
CO5: Understand the fundamental trade-off between representation power and computational properties of a logic-based representation language.
CO6: Familiar with several widely used knowledge representation languages.

**Course Outcomes–Cognitive Levels–Program Outcomes Matrix –**

**[H: High relation (3); M: Moderate relation (2); L: Low relation (1)]**

| Course Outcomes | Program Outcomes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 (Engineering knowledge) | PO-2 (Problem analysis) | PO-3 Design/development of solutions) | PO-4 (Conduct investigations of complex problems) | PO-5 (Modern tool usage) | PO-6 (The engineer and society) | PO-7 (Environment and sustainability) | PO-8 (Ethics) | PO-9 Individual and team work) | PO-10 Communication) | PO-11 (Project management and finance) | PO-12 (Life-long learning) |
| CO-1 | 3 | 3 | 2 | | | | | | | 2 | | 2 |
| CO-2 | 3 | 3 | 3 | | 2 | | | | | 2 | 2 | 2 |
| CO-3 | 3 | 3 | 2 | | 2 | | | | | 2 | 2 | 2 |
| CO-4 | 3 | 3 | 2 | 3 | 2 | | | | | 2 | 2 | 2 |
| CO-5 | 3 | 3 | 2 | 2 | 2 | | | | | 2 | 2 | 2 |
| CO-6 | 3 | 3 | 2 | | 2 | | | | | 2 | 2 | 2 |

PART 1: Knowledge Representation & Reasoning with propositional and first-order logic

Lectures: 12

- Introduction to knowledge-based technologies and knowledge representation
- Propositional Logic as a simple knowledge representation of language
- Representing Knowledge in First Order Predicate Logic
- Limitations of Propositional and First Order Predicate Logic

PART 2: Fragments Of First-Order Logic Lectures: 14

- Description Logics as Knowledge Representation Languages
- Reasoning in Description Logics
- Lightweight description logic.
- Horn Fragments of First Order Logic.
- Rule-based Knowledge Representation and Reasoning
- Ontologies and Ontology Languages.
- Other Decidable Fragments of First-Order Logic for Knowledge Representation

PART 3: Non-Monotonic Logics Lectures: 08

- Classical vs non-monotonic logic. Ways to achieve non-monotonicity.
- Stable Model Semantics

**Books:**


- An Introduction to Description Logic. Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler
- Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence, 2008.
- Foundations of Semantic Web Technologies. Chapman & Hall/ CRC Textbooks in Computing. Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph, 2009.
- Logic for Computer Scientists. Uwe Schoning. Modern Birkäuser Classics, Reprint of the 1989 edition.