INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

AUTOMATED REASONING AND THEORM PROVING								
Semester: VI CSE (AI & ML)								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACAD18	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Basic Principles of Algebra and Calculus								

I. COURSE OVERVIEW:

This course covers the principles of automated reasoning/mechanical theorem proving. Using an automated reasoning system to check proof ensures that the user has not made a mistake in their calculations. Topics covered include propositional logic, predicate logic, skolem standard forms, various resolution principles and methods, and non-classical logics. They can lead to quicker and more consistent decisions, particularly in cases where a very large volume of data needs to be analyzed and decisions made very quickly. Advantages commonly attributed to automation include higher production rates and increased productivity, more efficient use of materials, better product quality, improved safety, shorter workweeks for labor, and reduced factory lead times.

II. COURSE OBJECTIVES:

The students will try to learn:

I Representing mathematical and other knowledge using the logical formalism

II The history of formalizing mathematical knowledge

III The advantages and limitations of the main approaches and techniques in automated reasoning of mathematical knowledge.

IV Apply different automated reasoning techniques to new problems and semantic information to guide proofs.

III.COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Understand mathematical and other knowledge using logical formalism.

CO 2 Summarize the internal structure of propositions to know variables, constants and the status of variables.

CO 3 Utilize the Resolution rule, Kowalski form and the paramodulation rule for Formalizing the Notion of Proof.

CO 4 Explain the concepts of the contribution of Logic, resolution proof and combinatorial explosion for Criticisms of Uniform Proof Procedures.

CO 5 Develop rewrite rules, rewrite rule sets, termination and important properties to guide search decision procedure for inequalities.

CO 6 Apply formalizing geometry, geometric proofs and construction using semantic information to guide proofs

IV.COURSE CONTENT:

MODULE - I: INTRODUCTION (10)

The historical perspective: Mathematical Logic, Psychological studies, Automatic theorem proving. Formal Notations: Arguments about Propositions, The Internal structure of propositions.

MODULE - II: ARGUMENTS ABOUT PROPOSITIONS (09)

Truth functional connectives, Propositional Formula. The internal structure of Propositions: Functions of Predicates, variables and constants, the status of variables, the meaning of formulae.

MODULE - III: UNIFORM PROOF PROCEDURES (10)

Formalizing the Notion of Proof: The Resolution rule, Hyper-Resolution and Sematic Resolution, Linear Resolution and Lock-Step Resolution, SLD-Resolution and SLG Resolution, Kowalski form, the paramodulation rule.

Criticisms of Uniform Proof Procedures: The contribution of Logic, A resolution proof and combinatorial explosion, attempt to guide search, analyzing human proofs, a new methodology.

MODULE – IV: GUIDING SEARCH DECISION PROCEDURE FOR INEQUALITIES (10)

Axioms for Inequalities, some human proofs, types, the sup-Inf method, variable elimination. Rewrite Rules: what is rewrite rules, some sample rewrite rule sets, termination, other important properties, applying rewrite rules.

MODULE – V: USING SEMANTIC INFORMATION TO GUIDE PROOFS (09)

Formalizing geometry, geometric proofs, construction. Applications of Artificial Mathematicians: Algebraic manipulation system, Automatic Theorem proving, computer-assisted instructions, Logic Programming.

V.TEXTBOOKS:

1. Bundy, Alan. The computer modelling of mathematical reasoning. Vol. 10. London: Academic Press, 1983.

VI. REFERENCE BOOKS:

1. Bundy, Alan. Artificial Mathematicians: The Computational Modelling of Mathematical Reasoning. The United Kingdom, Department of Artificial Intelligence, University of Edinburgh, 1981.
2. Huth, Michael, Ryan, Mark. Logic in Computer Science: Modelling and Reasoning about Systems. N.p., Cambridge University Press, 2004.
3. https://www.cl.cam.ac.uk/teaching/1617/L18/

VII. ELECTRONICS RESOURCES:

1. https://www.cs.unc.edu/~plaisted/atp/
2. https://www.cs.cmu.edu/~fp/courses/atp/handouts/atp.pdf
3. https://www.inf.ed.ac.uk/teaching/courses/ar/

VII.MATERIAL ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)