Department of Applied Mathematics
and
Computational Sciences

PSG College of Technology

Coimbatore

Course File
Of
18XW31 MATHEMATICAL FOUNDATIONS OF COMPUTING

Name of the Faculty	N GEETHA
Course period	2020-2021-ODD SEMESTER
Semester no	3
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P S G College of Technology

Vision

PSG College of Technology aspires to be recognised as one of the leaders in engineering education, research and application of knowledge to benefit society.

Mission

Provide world-class Engineering Education, Foster Research and Development. Evolve innovative applications of Technology. Encourage Entrepreneurship. Ultimately mould young men and women capable of assuming leadership of the society for the betterment of the Country.

Department of Applied Mathematics
And
Computational Sciences

Vision

"Stay ahead and be relevant."

Mission

The fundamental objective of the department is to develop quality professionals by providing concept oriented subject knowledge through high quality teaching supplemented with practical training. Apart from specialized knowledge and skills, the programmes conducted by the Department aim to develop the personality of students by inculcating values of honesty, sincerity, team spirit and work culture.

M.Sc (Software Systems)

Programme Educational Objectives

PEO1	Graduates of the program will be employed in industry, government and entrepreneurial endeavours to have a successful professional career.
PEO2	Graduates of the program will pursue higher education and /or research.
PEO3	Graduates of the program will contribute to the society and human well-being by applying ethical principles.

Programme Outcome

PO01	Ability to apply knowledge of basic sciences, mathematics, probability and statistics to computer science and solve problems.
PO02	Ability to learn the fundamentals of computing systems, design and functionality of the hardware components and their underlying execution.
PO03	Ability to model, analyse, design, visualize and realize physical systems or processes of increasing size and complexity
PO04	Ability to learn and use new development tools, software framework, middleware, programming language or methodology to aid in the development of software projects.
PO05	Ability to define, assess and adhere to software quality practices, and software processes and methodologies.
PO06	Ability to be an effective member of a multi-disciplinary software project development team with an awareness of individual, professional and ethical responsibilities.
PO07	Ability to communicatetechnical concepts in a complete, concise, and correct manner,and prepare documentation and presentations; participate in team meetings, brainstorming session, code reviews or group discussions.
PO08	Ability to develop technical and managerial skills needed to be an effective leader as an entrepreneur or in a software concern.
PO09	Ability to pursue research in computer science area.
PO10	Ability to recognize the need and engage in life-long learning for professional growth.

18XW31 MATHEMATICAL FOUNDATIONS OF COMPUTING

3 2 0 4

PREREQUISITES

- 18XW11 CALCULUS AND ITS APPLICATIONS

Course objectives		**Course outcomes**		**Related program outcomes**
1	To understand calculus, different types of proofs, improve logical ability and solve problems	CO1	The students will be able to apply formal methods of symbolic logic (propositional and predicate) and to construct simple mathematical proofs and possess the ability to verify them.	PO01, PO02, PO03, PO04, PO09
2	To know the concepts of relations and functions in computer	CO2	The students will be able to understand how binary relations, n-ary relations and functions are used in data bases and programming languages	PO01, PO02, PO03,PO05, PO09
3	To understand the basic principles of counting, recurrence relations and solving recurrence relations using characteristic roots	CO3	Students will use elementary counting techniques to count simple finite structures that are either ordered or unordered, and also devising recurrence relations and solving them.	PO01, PO02, PO03, PO04, PO09
4	To understand formal languages, grammar, finite automata and equivalence of FA and RG	CO4	The students will be able to identify different formal language classes, their relationships, design grammars and recognizers for languages, prove language membership properties	PO02, PO03, PO04, PO09
5	To understand higher level machines like PDA and TM	CO5	The students will be able to design push down automata and Turing machine for various languages, to identify limitations of computational models	PO02, PO03, PO04, PO09

COURSE CONTENTS

LOGIC AND PROOF: Logic - Propositional Equivalences - Normal forms –Predicates and Quantifiers – Nested Quantifiers – Methods of Proof - Mathematical reasoning**:** Proof strategy – Mathematical Induction – Program correctness. **[CO1]** (T1, R1) (10+7)

RELATIONS AND FUNCTIONS: Relations and their properties – Representing relations – Closures of relations – Partial orderings. Functions-Definitions – Composition of functions – Inverse functions – Binary and n-ary operations – Characteristic functions – Hashing function. **[CO2]** (T1, R1) (6+4)

COUNTING: Permutation and Combination – Generalized Permutation and Combination – Generating Permutation and Combination - Advanced counting techniques - Recurrence relation, Solving recurrence relations using characteristic roots. **[CO3]** (T1, R1) (7+5)

FORMAL LANGUAGES: Four classes of grammars (Phrase Structure, Context sensitive, Context Free, Regular) - Context free languages: generation trees - ambiguity. **[CO4]** (T2, R2, R3) (3+2)

FINITE AUTOMATA: Finite State Automata (DFA) - Non-deterministic Finite State Automata (NDFA) - Conversion of NDFA to DFA - Equivalence of regular grammar and FA. **[CO4]**(T2, R2, R3) (6+4)

PUSH DOWN AUTOMATA: Acceptance by final state and empty store, Equivalence of acceptance by final state and empty store, Equivalence of PDA's and CFL's. **[CO5]** (T2, R2) (7+5)

TURING MACHINES: Construction of simple Turing Machines - Universal Turing Machines - Halting problem. **[CO5]** (T2, R2) (6+3)

Total L: 45+T: 30=75

TEXT BOOKS:

T1. Kenneth H Rosen, “Discrete Mathematics and its Applications”, Tata McGraw Hill, 2011.
T2. John C Martin, "Introduction to Languages and the Theory of Computation", Tata McGraw Hill, 2014.

REFERENCES:

R1. Tremblay J P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill, 2011.
R2. John E Hopcroft, Rajeev Motwani and Jeffrey DUllman, "Introduction to Automata Theory, Languages and Computation", Pearson Education, 2014.
R3. Mishra K L P, Chandrasekaran N,“Theory of Computer Science: Automata Languages and Computation”, Prentice Hall, 2014.

Note: Due to unprecedented situation, only 1 hr for tutorial is scheduled.

DETAILED COURSE PLAN

Week No	Topics	Assign./ Tutorial	Test
1	Logic : Propositions – logical operators – truth tables – Equivalence rules		
2	Normal forms - Laws of logic - Methods of Inference		
3	Predicates – variables – Quantifiers - Standard Forms		
4	Inference in Predicate calculus – Problems	Tutorial 1	
5	Methods of proof, mathematical reasoning, proof strategy - Mathematical induction, program correctness	ASSG 1	
6	Relation and their properties,representing relations, Operations of relations - Closures of relations	ASSG 2	
7	Partial orderings; Function, definition of function, composition of functions,inverse functions, binary and n-ary operations - Characteristic function, hashing function	Tutorial 2	

8			TEST 1
9	Counting, permutation and combination		
10	generalized permutation and combination - generating permutation and combination	Tutorial 3	
11	advanced counting techniques - Recurrence relation, solving recurrence relations using characteristic roots	ASSG 3	
12	Formal languages, four classes of grammars, phrase structure, context sensitive, context free, regular, context free languages, generation trees, ambiguity		
13	Finite automata : deterministic finite state automata, non deterministic finite state automata	ASSG 4	
14	Conversion of NDFA to DFA, equivalence of regular grammar and finite automata		
15	Push down automata, acceptance by final state and empty store	ASSG 5	
16	Equivalence of acceptance by final state and empty store, Equivalence of PDA's and CFL's	Tutorial 4	
17	Turing machines, construction of simple turing machines – language recognizer, computing examples - Universal Turing Machine – Halting Problem	ASSG 6	
18			TEST 2

COURSE MATERIALS AND ONLINE LEARNING RESOURCES

1. MIT open course ware : https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-fall-2005/lecture-notes/
2. Automata and Formal Languages : http://www.eecs.wsu.edu/~ananth/CptS317/

TUTORIAL TOPICS

SNo	TOPIC
1	Propositional Inference and Resolution
2	Predicate Inference and Relations
3	Counting
4	Formal Languages & Automata

Note: 1. Separate Problem Sheets provided for each section.

ASSIGNMENT TOPICS

S.No	TOPIC
1	Proof Methods
2	n-ary Relations, Functions
3	Recurrence relations
4	FA problems
5	PDA and TM problems

Note: Separate Sheets provided for Assignment Presentation

Relationship between Course Outcomes (COs) and Programme Outcomes (POs)

Course Outcome	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
CO1	*	*	*	*					*	
CO2	*	*	*		*				*	
CO3	*	*	*	*					*	
CO4		*	*	*					*	
CO5		*	*	*					*	

Unit-wise Scope for Outcome and Bloom's Taxonomy

CO / Blooms Taxonomy	CO1	CO2	CO3	CO4	CO5	Relative Frequency of Scope (RF_i)	Weight W_i
Creating	*	*	*			3/5	6
Evaluating	*	*	*			3/5	5
Analysing	*	*	*	*	*	5/5	4
Applying			*	*	*	3/5	3
Understanding	*	*	*	*	*	5/5	2
Remembering			*	*	*	3/5	1

BTI = Bloom's Taxonomy Index: $BTI = \frac{\sum_i RF_i W_i}{\sum W_i} = \frac{(18+15+20+9+10+3)}{5\times\frac{6\times7}{2}} = \frac{75}{5\times21} = 0.71$

Level of the Course: HoT(Hint: BTI ≥ 0.5 HoT (Higher order Thinking),
BTI < 0.5 LoT (Lower order Thinking)