INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**				
Course Code	BCSB01				
Programme	M.Tech				
Semester	I	CSE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. G. Sulakshana , Assistant Professor, CSE				
Course Faculty	Ms. G. Sulakshana, Assistant Professor, CSE				

I. COURSE OVERVIEW:

The course covers the concepts Probability theory, Sampling Techniques, Statistical Interface, Graph Theory and various applications of Mathematical and statistical concepts in different branches of Computer Science. This course helps the students in gaining the knowledge and apply the mathematical logics to many modern techniques of information technology like machine learning, programming language design etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB12	II	Probability and Statistics	3
UG	ACSB04	III	Discrete Mathematical Structures	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mathematical Foundations of Computer Science	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✘	Quiz	✘	Assignments	✔	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIE during the semester, marks are awarded by taking average of two session examinations.

Semester End Examination (SEE): The SEE shall be conducted for 70 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE UNITs and each UNIT carries equal weight age in terms of marks distribution. The question paper pattern shall be as defined below. Two full questions with 'either' 'or' choice will be drawn from each UNIT. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 4. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Technical Seminar and Term Paper	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one-mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply Analyze a problem, identify and define computing requirements, design and implement appropriate solutions	3	Seminar and Term paper
PO 2	Solve complex heterogeneous data intensive analytical based problems of real time scenario using state of the art hardware/software tools	2	Seminar and Guest Lectures
PO 3	Demonstrate a degree of mastery in emerging areas of CSE/IT like IoT, AI, Data Analytics, Machine Learning, cyber security, etc.	3	Term Paper
PO 4	Write and present a substantial technical report/document	2	Term paper
PO 5	Independently carry out research/investigation and development work to solve practical problems	2	Guest Lecturers
PO 7	Engage in life-long learning and professional development through self-study, continuing education, professional and doctoral level studies	1	MOOCs and Guest Lecturers

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
II	Understand and apply the mathematical logics to many modern techniques in information technology like machine learning, programming language design, and concurrency.
III	Studying of various sampling and classification problems.

VIII. COURSE OUTCOMES (COs):

Cos	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe various concepts of probability theory and Distributions.	CLO 1	Understand basic concepts probability theory, mass, density etc.
		CLO 2	Analyse various Distribution Functions and apply to real world problems.
		CLO 3	Identify importance of the Central Limit Theorem, Markov chains
CO 2	Demonstrate sampling distributions of estimators and methods of moments.	CLO 4	Apply random sampling theory and distribution of estimators to various computer science applications
		CLO 5	Describe Methods of Moments and Maximum Likelihood to solve problems
CO 3	Explore statistical inference techniques and apply regression, PCA etc. for classification problems.	CLO 6	Construct and evaluate Regression models for classification problems
		CLO 7	Analyse importance of Principal component analysis in developing predictive models and exploratory data analysis.

		CLO 8	Understand problem of over fitting model and choose correct model.
CO 4	Enrich the knowledge on applications of graph theory and combinatorial problems.	CLO 9	Analyze Euler's and Hamilton rule for a simple connected graph in NP-complete problems.
		CLO 10	Solve discrete probability and set problems using permutations and combination.
		CLO 11	Identify the solution for various combinatorial enumeration problems
CO 5	Identify the applications of mathematical and statistical techniques to emerging areas of Information Technology.	CLO 12	Apply various graph theory concepts in Network protocol design, web traffic analysis and distributed systems
		CLO 13	Understand the basic concepts of Software Engineering, Computer Architecture
		CLO 14	Analyze applications of Statistics in Data mining , machine learning and Bioinformatics
		CLO 15	Understand operating system and distributed system concepts principles.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCSB01.01	CLO 1	Understand basic concepts probability theory, mass, density etc.	PO 1, PO 2	2
BCSB01.02	CLO 2	Analyse various Distribution Functions and apply to real world problems.	PO 1, PO 2	3
BCSB01.03	CLO 3	Identify importance of the Central Limit Theorem, Markov chains	PO 3	3
BCSB01.04	CLO 4	Apply random sampling theory and distribution of estimators to various computer science applications	PO 1, PO 4	3
BCSB01.05	CLO 5	Describe Methods of Moments and Maximum Likelihood to solve problems	PO 1, PO 3	3
BCSB01.06	CLO 6	Construct and evaluate Regression models for classification problems	PO 2, PO 3, PO 7	2
BCSB01.07	CLO 7	Analyse importance of Principal component analysis in developing predictive models and exploratory data analysis.	PO 1, PO 3	3
BCSB01.08	CLO 8	Understand problem of over fitting model and choose correct model.	PO 2, PO 4	2
BCSB01.09	CLO 9	Analyze Euler's and Hamilton rule for a simple connected graph in NP-complete problems.	PO 2, PO 3	3
BCSB01.10	CLO 10	Solve discrete probability and set problems using permutations and combination.	PO 1, PO 3	3
BCSB01.11	CLO 11	Identify the solution for various combinatorial enumeration problems	PO 1	3
BCSB01.12	CLO 12	Apply various graph theory concepts in Network protocol design, web traffic analysis and distributed systems	PO 3, PO 4, PO 5	2
BCSB01.13	CLO 13	Understand the basic concepts of Software Engineering, Computer Architecture	PO 3, PO 7	2
BCSB01.14	CLO 14	Analyze applications of Statistics in Data mining , machine learning and Bioinformatics	PO 3, PO 4, PO 5, PO 7	2
BCSB01 .15	CLO 15	Understand operating system and distributed system concepts principles.	PO 3	2

3= High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 7
CO 1	3	2	3			
CO 2	3		3	2		
CO 3	3	3	2	2		1
CO 4	3		3			
CO 5			3		2	1

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 7
CLO 1	3	1				
CLO 2	2	3				
CLO 3			3			
CLO 4	3			2		
CLO 5	3		2			
CLO 6		3	2			1
CLO 7	3		2			
CLO 8		2		2		
CLO 9		2	3			
CLO 10	3		3			
CLO 11	3					
CLO 12			2	2	2	
CLO 13			3			1
CLO 14			2	3	2	2
CLO 15			3			1

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2, PO 3, PO5	SEE Exams	PO1, PO2, PO 3, PO5	Seminar and Term Paper	PO1, PO2, PO 3, PO 4, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

UNIT I

INTRODUCTION

Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains.

UNIT II

RANDOM SAMPLES

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood

UNIT III

STATISTICAL INTERFACE

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of over fitting model assessment.

UNIT IV

STATIST GRAPH THEORY ICAL INTERFACE

Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems

UNIT V

COMPUTER SCIENCE AND ENGINEERING APPLICATIONS

Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning. Analysis: Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor networks.

TEXT BOOKS:

1. John Vince, “Foundation Mathematics for Computer Science”, Springer
2. K Trivedi. “Probability and Statistics with Reliability, Queuing, and Computer Science Applications”. Wiley..
3. M. Mitzenmacher and E. Upfal.” Probability and Computing: Randomized Algorithms and Probabilistic Analysis”. Wiley
4. Alan Tucker, “Applied Combinatorics”, Wiley

WEB REFERENCES:

1. https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf
2. https://www.cs.bris.ac.uk/~flach/mlbook/.
3. http://mylovelibrabry.com/emylibraryus/free.php?asin=1466583282.

XV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Probability mass, density, cumulative distribution functions, Parametric families of distributions	CLO 1	T2:1,5
4-6	Expected value, variance, conditional expectation Applications of the univariate Central Limit Theorem	CLO 2	T2:4
7-8	Multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains	CLO 3	T2:7,8
9-13	Random samples, sampling distributions of estimators	CLO 4	T2:2,3
14-17	Methods of Moments and Maximum Likelihood	CLO 5	T2: 5,T3:3
18-21	Statistical inference, Introduction to multivariate statistical models: regression	CLO 6	T2:10
22-26	Regression and classification problems, Principal components analysis, The problem of over fitting model assessment.	CLO 8	T2:11, T1:2, T3:4
27-31	Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles	CLO 10	T4:1,2
32-36	Permutations and Combinations with and without repetition, Specialized techniques to solve combinatorial enumeration problems	CLO 12	T4:5,6
37-41	Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems	CLO 14	R1, R2
42-45	Bioinformatics, Machine learning. Analysis, Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor networks	CLO 15	R2, R3

XVI. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No.	Description	Proposed actions	Relevance with pos
1	Methods for principal components analysis.	Seminars/NPTEL	PO 2

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