INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING**				
Course Title	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**				
Course Code	BCSD01				
Program	M.Tech				
Semester	I				
Course Type	Core				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Ch Srinivasulu, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHSD11	III	PROBABILITY AND STATISTICS

II COURSE OVERVIEW:

This course will discuss fundamental concepts in mathematics with emphasis on their applications to computer science. Topics include probability, distribution, multivariant statistical models, computer applications, trees and graphs. This course is appropriate for communications and networking, storage and retrieval of information.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Mathematical Foundation of Computer Science	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). Out of 40 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty

Table 3: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIA – I	CIA – II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. 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.

Assignment:

To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz:
It is online proctor based online examination conducted either at the end of the CIE1 or CIE2. The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.
Alternative Assessment Tool (AAT):
In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. The AAT may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.

VI COURSE OBJECTIVES:

The students will try to learn:

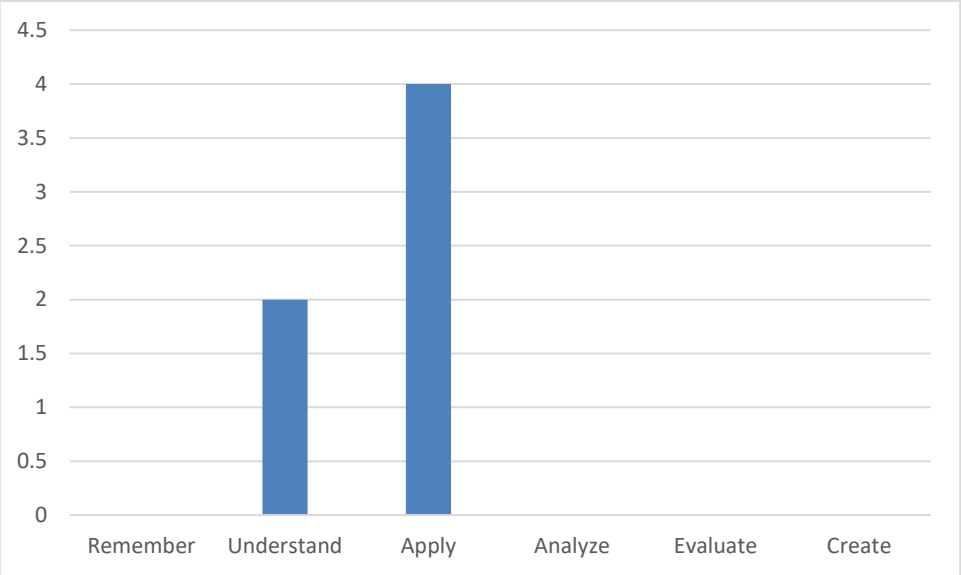
I	The mathematical fundamentals that are prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
II	The mathematical and logical basis to many modern techniques in information technology.
III	Gain knowledge about various sampling and classification problems.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	Make use of distribution theory for depicting the expected outcome of products based on data related to supply and demand.	Understand
CO 2	Apply Central Limit Theorem and Probability inequalities for estimating population parameters in the data generating process/experiment.	Apply
CO 3	Build statistical models based on random sampling data for getting unbiased estimates in performing data analysis.	Understand
CO 4	Examine regression and multivariate statistical models for solving classification and curve fitting problems in data analysis.	Apply
CO 5	Utilize appropriate techniques of graphs and combinatorial theory for finding solutions to shortest path and enumeration problems.	Apply
CO 6	Choose appropriate mathematical and statistical techniques for solving applications in emerging areas of Information Technology.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skillful at designing algorithms.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2	SEE/CIE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.	2	SEE/CIE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing algorithms.	1	SEE/CIE/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	SEE/CIE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓	-	✓	✓	✓	✓
CO 2	✓	-	✓	✓	✓	-
CO 3	✓	-	✓	✓	✓	-
CO 4	✓	-	✓	✓	✓	✓
CO 5	✓	-	✓	✓	✓	✓
CO 6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Apply probability and distribution models to forecast demand-supply behavior in real-world scenarios, solving practical analytical problems.	3
	PO 3	Demonstrate in-depth understanding of statistical theory relevant to data science applications.	2
	PO 4	Use advanced mathematical tools and programming skills to model and simulate distribution-based predictions.	3
	PO 5	Work effectively in interdisciplinary teams to interpret distribution models and their business implications.	2
	PO 6	Recognize and engage in lifelong learning to improve prediction models with emerging statistical techniques.	1
CO 2	PO 1	Apply core statistical theory (e.g., CLT, Chebyshev's inequality) to analyze and infer from real-world data distributions.	2
	PO 3	Demonstrate deep understanding of foundational probability concepts critical in higher-level statistical and data science work.	1
	PO 4	Use analytical tools and probabilistic models for solving est problems.	2

	PO 5	Collaborate in teams to design experiments and analyze po effectively.	2
	PO 6	Engage in continuous learning to keep pace with statistical advancements in data science and emerging computational approaches.	2
CO 3	PO 1	Students learn to apply statistical sampling techniques to solve real-world data problems.	3
	PO 3	Demonstrates mastery in constructing unbiased estimators, essential for specialized data analysis.	2
	PO 4	Apply statistical models using advanced computational tools to enhance analytical accuracy.	3
	PO 5	Collaborate in multi-disciplinary teams to interpret model o solutions.	2
CO 4	PO 1	Investigate and implement regression-based solutions for real-world problems.	3
	PO 3	Demonstrate strong command over classification and multivariate techniques aligned with the specialization.	2
	PO 4	Design advanced regression and curve-fitting models using tools.	3
	PO 5	Work in teams to solve classification problems in multidisciplinary environments.	2
	PO 6	Engage in self-driven learning for adapting new statistical modeling techniques.	1
CO 5	PO 1	Apply combinatorics and graph theory to analyze and solve problems.	3
	PO 3	Show command over discrete structures and their practical utility in advanced algorithm design.	1
	PO 4	Use graph algorithms and combinatorial logic using comput networks.	4
	PO 5	Function collaboratively to model and solve shortest path problems across domains.	2
	PO 6	Continuously enhance skills in discrete mathematics for application in emerging IT problems.	1

CO 6	PO 1	Identify and apply relevant math/stat techniques to real-w issues.	3
	PO 3	Demonstrate broad expertise across statistics and computation in solving advanced IT problems.	5
	PO 4	Employ modern tools and frameworks to solve statistical p fields.	2
	PO 5	Collaborate effectively in teams to develop data-centric sol challenges.	2
	PO 6	Recognize the need for continuous upskilling and learning i applications.	2

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	3	-	2	3	2	1
CO 1	2	-	1	2	2	-
CO 2	3	-	2	3	2	-
CO 3	3	-	2	3	2	1
CO 4	3	-	1	4	2	1
CO 5	3	-	2	4	2	1
CO 6	3	-	2	3	2	1

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – PO:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	3	10	9	10	5	8
CO 1	75	0	100	60	40	25
CO 2	50	0	50	40	40	0
CO 3	75	0	100	60	40	0
CO 4	75	0	100	60	40	25
CO 5	75	0	50	80	40	25
CO 6	75	0	100	80	40	25

XIII COURSE ARTICULATION MATRIX (PO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	3	2	1	1
CO 2	2	0	2	1	1	0
CO 3	3	0	3	2	1	0
CO 4	3	0	3	2	1	1
CO 5	3	0	2	3	1	1
CO 6	3	0	3	3	1	1
TOTAL	**17**	**0**	**16**	**13**	**6**	**4**
AVERAGE	**3**	**0**	**3**	**2.5**	**1**	**1**

XIV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XV SYLLABUS:

MODULE 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.
MODULE II	**RANDOM SAMPLES**
	RANDOM SAMPLES Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood.
MODULE III	**STATISTICAL INTERFACE**
	Statistical inference, Introduction to multivariate statistical models: regression and classification problems, Principal components analysis, The problem of over fitting model assessment.
MODULE IV	**GRAPH THEORY**
	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.
MODULE 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. .

TEXTBOOKS

1. John Vince, “Foundation Mathematics for Computer Science”, Springer 2015. .
2. K. Trivedi. “Probability and Statistics with Reliability, Queuing, and Computer Science Applications”. Wiley, 2016.

REFERENCE BOOKS:

1. Alan Tucker, “Applied Combinatorics”, Wiley, 2012.

XVI COURSE PLAN:

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

S.No	Topics to be covered	CO’s	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details
	CONTENT DELIVERY (THEORY)		
2	Probability mass, density	CO1	T1-3.1-3.2
3	cumulative distribution functions	CO1	T1-3.3-3.4
4	Parametric families of distributions	CO1	T1-3.3-3.4
5	Expected value	CO1	T1-3.7
6	variance	CO1	T1-3.5
7	conditional expectation	CO1	T1-3.6
8	Applications of the univariate and multivariate Central Limit Theorem	CO1	T1-5.1.1
9	Probabilistic inequalities Markov chains.	CO1	T1-.1.1,5.1.2
10	Random samples, sampling distributions of estimators,	CO2	T1-5.2
11	Methods of Moments	CO1	T1-7.10.2-3
12	Maximum Likelihood	CO1	T1-3.5
13	Statistical inference	CO3	T1-5.5
14	Introduction to multivariate statistical models	CO3	T1-7.1,7.2
15	regression and classification problems	CO3	T1-7.7.2
16	Principal components analysis	CO3	T1-7.3,7.4
17	The problem of over fitting model assessment.	CO3	T1-3.5
18	Graph Theory	CO4	T1-7.8
19	Isomorphism	CO4	T1-7.8.1,8.2
20	Planar graphs	CO4	T1-7.10,11
21	graph coloring	CO4	T1 7.10.3.3
22	Hamilton circuits	CO3	T1-5.3
24	Euler cycles	CO4	T1-7.10.
25	Permutations and Combinations with repetition	CO4	R3-P184
26	Permutations and Combinations with and without repetition	CO4	R3-P184
27	Permutations and Combinations	CO3	R3-P185

28	Interfacing Circuit of Switches & Keyboard Matrix	CO4	R3-P191
29	Specialized techniques	CO4	R3-P190
30	Specialized techniques to solve combinatorial enumeration problems. m	CO4	R3-P190
31	combinatorial enumeration problems. ,	CO 4	T1:5.1.1
32	Data mining	CO5	T1:7.3,7.4
33	Network protocols	CO5	T1:5.1.1
34	analysis of Web traffic	CO5	T1:4.2
35	Computer security	CO5	T1:1-7.8
36	Software engineering,	CO6	T1:7.4
37	Computer architecture	CO6	T1:7.2
38	operating systems	CO6	T17-7.2
39	distributed systems	CO6	T1:5.3.2
40	D Bioinformatics.	CO6	T1:4.2
41	Machine learning	CO6	T1:5.3
42	case study 1	CO6	R3:P185
43	case study 2	CO6	R3-P191
DISCUSSION OF QUESTION BANK			
44	Machine learning types	CO1	T1:4.6
45	analysis	CO2	T1:5.11
46	software	CO3	T1:7.1
47	foemulea development	CO4	T1: 7.10
48	CASE STUDIES	CO6	T1:4.2

Course Coordinator: **HOD, CSE**

Dr. Ch Sreenivasulu, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING**				
Course Title	**ADVANCED DATA STRUCTURES**				
Course Code	BCSD02				
Program	M.Tech				
Semester	I				
Course Type	Core				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. N Rajashekar, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	ACSC08	III	Data Structures

II COURSE OVERVIEW:

This course covers advanced data structures with an emphasis on their applications in computer science. Topics include trees, graphs, hashing, heaps, and algorithmic techniques for efficient data manipulation. It is essential for domains like networking, databases, and information retrieval..

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Advanced Data Structures	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). Out of 40 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty

Table 3: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. 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.

Assignment:

To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz:
It is online proctor based online examination conducted either at the end of the CIE1 or CIE2. The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.

Alternative Assessment Tool (AAT):
In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. The AAT may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.

VI COURSE OBJECTIVES:

The students will try to learn:

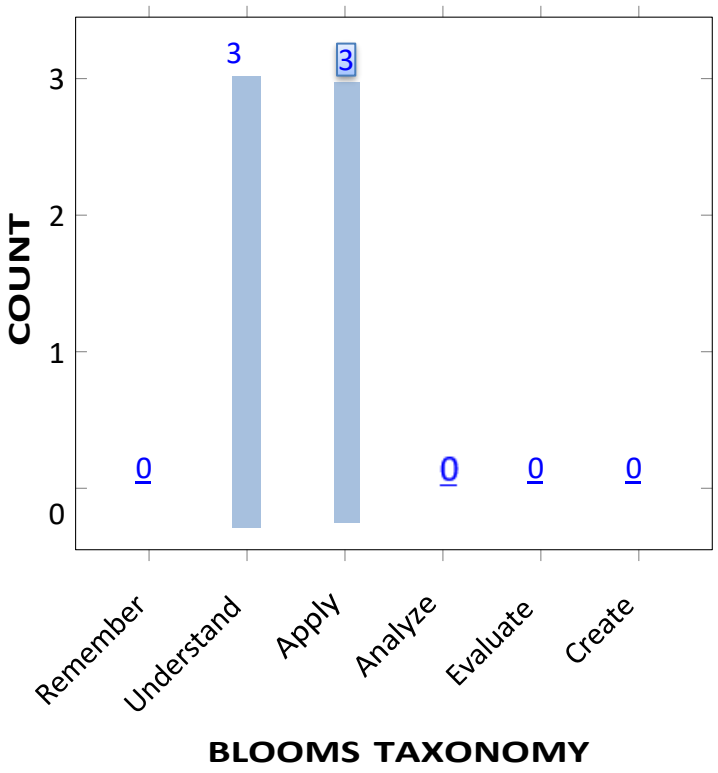
I	The mathematical fundamentals that are prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
II	The mathematical and logical basis to many modern techniques in information technology.
III	Gain knowledge about various sampling and classification problems.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	Analyze the performance of the algorithms using mathematical tools such as asymptotic notations.	Understand
CO 2	Select relevant data structures for developing real-time applications.	Apply
CO 3	Build hash tables by using an appropriate Hash Function for managing voluminous data .	Understand
CO 4	Make use of Trees and Graphs for solving shortest path applications	Apply
CO 5	Inspect the importance of balanced trees in maintaining the performance of time-critical applications.	Understand
CO 6	Apply the concepts of text compression and pattern matching to solve problems effectively.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing algorithms.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2	SEE/CIE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.	2	SEE/CIE/AAT

PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing algorithms.	1	SEE/CIE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	SEE/CIE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓	-	✓	✓	✓	-✓
CO 2	✓	-	✓	✓	✓	✓
CO 3	✓	-	✓	✓	✓	✓
CO 4	✓	-	✓	✓	✓	✓
CO 5	✓	-	✓	✓	✓	✓
CO 6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Students can independently analyze algorithm performance using Big-O, Big-Θ, and Big-Ω notations.	4
	PO 3	Demonstrates mastery over algorithm analysis beyond undergraduate level.	2
	PO 4	Applies advanced tools and techniques for performance estimation in algorithm design.	5
	PO 5	Collaborates in teams to evaluate and discuss algorithm efficiency for real-world systems.	4
	PO 6	Develops the ability to engage in lifelong learning on evolving performance analysis techniques and tools.	3
CO 2	PO 1	Students independently identify and implement appropriate data structures (e.g., stacks, queues, trees) for real-time needs.	4
	PO 3	Demonstrates in-depth knowledge of data structures by applying them to time-sensitive computing scenarios.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	Applies advanced design techniques and software tools to optimize performance in real-time applications.	5
	PO 5	Works efficiently in teams to build reliable real-time systems that depend on structured data management.	3
	PO 6	Continuously upgrades knowledge on the evolving usage of data structures in modern applications (e.g., IoT, AI).	3
CO 3	PO 1	Independently applies hash functions and collision resolution techniques to build efficient data storage mechanisms.	2
	PO 3	Demonstrates mastery in applying hashing techniques in real-world large data scenarios.	2
	PO 4	Uses advanced tools and methods to implement and test hash tables in software systems.	5
	PO 5	Works collaboratively to develop scalable data structures using hashing in interdisciplinary projects.	2
	PO 6	Keeps up-to-date with modern trends in data storage and retrieval using hashing.	2
CO 4	PO 1	Identifies appropriate tree/graph models for solving real-world routing and connectivity problems.	2
	PO 3	Demonstrates advanced understanding of graph traversal and optimization techniques.	2
	PO 4	Applies domain-specific algorithms (e.g., Dijkstra, BFS/DFS) to graph-based shortest path solutions.	5
	PO 5	Collaborates with team members in implementing tree/graph solutions for various industry and academic projects.	3
	PO 6	Pursues ongoing learning in modern applications of graph theory (like smart routing and AI navigation systems)	2
CO 5	PO 1	Independently evaluates the role of AVL/Red-Black trees in ensuring efficient time performance.	2
	PO 3	Demonstrates expertise in choosing appropriate balanced trees for different types of system requirements.	2

	PO 4	Applies balancing techniques in real-time systems to ensure low time complexity.	5
	PO 5	Works in teams to benchmark tree performance and optimize them for enterprise systems.	2
	PO 6	Engages in continuous improvement in areas like memory balancing and tree rotations.	2
CO 6	PO 1	Independently applies Huffman coding, LZW, and pattern matching algorithms to compress and search data.	2
	PO 3	Demonstrates mastery in string processing and compression techniques relevant to large-scale applications.	2
	PO 4	Uses advanced string algorithms and tools to implement compression and search in software systems.	5
	PO 5	Collaborates in teams to implement efficient file management and search systems.	3
	PO 6	Pursues continuous learning in text analytics, data compression, and efficient pattern detection.	3

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4		2	5	4	3
CO 2	4		2	5	3	3
CO 3	2		2	5	2	2
CO 4	2		2	5	3	2
CO 5	2		2	5	2	2
CO 6	2		2	5	3	3

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – PO:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	3	10	9	10	5	8
CO 1	100	0	100	100	80	75
CO 2	100	0	100	100	60	75
CO 3	50	0	100	100	40	50
CO 4	50	0	100	100	60	50

CO 5	50	0	100	100	40	50
CO 6	50	0	100	100	60	75

XIV COURSE ARTICULATION MATRIX (PO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	3	3	3	3
CO 2	3	0	3	3	2	3
CO 3	2	0	3	3	1	2
CO 4	2	0	3	3	2	2
CO 5	2	0	3	3	1	2
CO 6	2	0	3	3	2	3
TOTAL	**14**	**0**	**18**	**18**	**11**	**15**
AVERAGE	**2.5**	**0**	**3**	**3**	**2.5**	**3**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI SYLLABUS:

MODULE I	**OVERVIEW OF DATA STRUCTURES**
	Algorithm analysis: Algorithms; Performance analysis: Time complexity and space complexity, asymptotic notation: Big Oh, omega and theta notations, complexity analysis examples; Data structures: Linear and nonlinear data structures, ADT concept, linear list ADT, stack and queue ADTs, array and linked list representations; Circular queue: Insertion and deletion, de queue ADT, priority queue ADT, implementation using heaps, insertion into a max heap, deletion from a max heap, singly linked lists, doubly linked lists, circular linked list.
MODULE II	**DICTIONARIES, HASH TABLES**
	Dictionaries: Linear list representation, operations insertion, deletion and searching, hash table representation, hash functions, collision resolution, separate chaining, open addressing, linear probing, quadratic probing, double hashing, rehashing, extendible hashing.
MODULE III	**TREES AND GRAPHS**
	Trees: Ordinary and binary tree terminology, properties of binary trees, binary tree ADT, representations, recursive and nonrecursive traversals, threaded binary trees. Graphs: Graphs terminology, graph ADT, representations, graph traversals; Search methods: DFS and BFS;

	Applications of Graphs: Minimum cost spanning tree using Kruskal's algorithm, Dijkstra's algorithm for single source shortest path problem.
MODULE IV	**SEARCH TREES I**
	Binary search tree: Binary search tree ADT, insertion, deletion, and searching operations, finding the parent of a given node, attaining a reference to a node, finding the smallest and largest values in the binary search tree; Balanced search trees: AVL trees, definition, height of an AVL tree; Operations: Insertion, deletion, and searching.
MODULE V	**SEARCH TREES II**
	Red-Black and Splay Trees; B trees: Definition, operations, and applications; R trees: Nearest neighbor query, join and range queries; Comparison of search trees; Text compression: Huffman coding and decoding; Pattern matching: KMP algorithm.. .

TEXTBOOKS

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Universities Press Private Limited, India, 2nd Edition, 2008.
2. G.A.V.Pai, "Data Structures and Algorithms", Tata McGraw Hill, NewDelhi,1st Edition,2008.
3. Reema Thareja, S. Rama Sree, Advanced Data Structures, Oxford University Press, 2018

REFERENCE BOOKS:

1. D. Samanta, "Classic Data Structures", Prentice Hall of India Private Limited, 2nd Edition, 2003.
2. Aho, Hop craft, Ullman, "Design and Analysis of Computer Algorithms", Pearson Education India, 1st Edition, 1998.
3. Goodman, Hedetniemi, "Introduction to the Design and Analysis of Algorithms", Tata McGraw Hill, New Delhi, India, 1st Edition, 2002.
4. Adam Drozdek, "Data Structures and Algorithms in C++", Thomson Course Technology, 3rd Edition, 2005.
5. Introduction to Algorithms, Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Third Edition, 2009, The MIT Press.
6. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson Education India. Fourth Edition, 2014,.

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details
CONTENT DELIVERY (THEORY)			
2	Algorithms Performance analysis time complexity and space complexity	CO1	T1-3.1-3.2
3	asymptotic notation Big Oh omega and theta notations	CO1	T1-3.3-3.4

4	complexity analysis examples; Data structures Linear and nonlinear data structures	CO1	T1-3.3-3.4
5	ADT concept, linear list ADT stack and queue ADTs array and linked list representations	CO1	T1-3.7
6	Circular queue: Insertion and deletion	CO1	T1-3.5
7	de queue ADT, priority queue ADT	CO1	T1-3.6
8	implementation using heaps	CO1	T1-5.1.1
9	Insertion into a max heap	CO1	T1-.1.1,5.1.2
10	deletion from a max heap, singly linked lists	CO2	T1-5.2
11	doubly linked lists	CO1	T1-7.10.2-3
12	circular linked list	CO1	T1-3.5
13	Dictionaries Linear list representation	CO3	T1-5.5
14	operations insertion deletion and searching	CO3	T1-7.1,7.2
15	hash table representation, hash functions	CO3	T1-7.7.2
16	collision resolution, separate chaining	CO3	T1-7.3,7.4
17	open addressing, linear probing, quadratic probing	CO3	T1-3.5
18	Trees Ordinary and binary tree terminology	CO4	T1-7.8
19	properties of binary trees	CO4	T1-7.8.1,8.2
20	binary tree ADT representations,	CO4	T1-7.10,11
21	recursive and nonrecursive traversals	CO4	T1 7.10.3.3
22	double hashing	CO3	T1-5.3
24	threaded binary trees	CO4	T1-7.10.
25	Graphs Graphs terminology	CO4	R3-P184
26	graph ADT representations, graph traversals	CO4	R3-P184
27	rehashing, extendible hashing	CO3	R3-P185
28	Search methods DFS and BFS	CO4	R3-P191
29	Applications of Graphs	CO4	R3-P190
30	Minimum cost spanning tree using Kruskal's algorithm	CO4	R3-P190
31	Dijkstra's algorithm for single source shortest path problem	CO 4	T1:5.1.1
32	Binary search tree ADT, insertion, deletion, and searching operations	CO5	T1:7.3,7.4
33	finding the parent of a given node, attaining a reference to a node	CO5	T1:5.1.1
34	finding the smallest and largest values in the binary search tree; Balanced search trees: AVL trees,	CO5	T1:4.2
35	height of an AVL tree; Operations Insertion, deletion, and searching.	CO5	T1:1-7.8
36	Red-Black and Splay Trees	CO6	T1:7.4
37	Red-Black and Splay Trees	CO6	T1:7.2
38	and applications R trees	CO6	T17-7.2

39	Nearest neighbor query	CO6	T1:5.3.2
40	join and range queries	CO6	T1:4.2
41	Comparison of search trees; Text compression	CO6	T1:5.3
42	Huffman coding and decoding	CO6	R3:P185
43	Pattern matching KMP algorithm	CO6	R3-P191
DISCUSSION OF QUESTION BANK			
44	Machine learning types	CO1	T1:4.6
45	analysis	CO2	T1:5.11
46	software	CO3	T1:7.1
47	foemulea development	CO4	T1: 7.10
48	CASE STUDIES	CO6	T1:4.2

Course Coordinator: **HOD, CSE**

Mr. N Rajashekar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING				
Course Title	SOFT COMPUTING				
Course Code	BCSD08				
Program	MTech				
Semester	I				
Course Type	Core				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Y. Mohan Roopa, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B Tech	ACSD26	V	Artificial Intelligence
MTech	BCSD13	II	Advanced Algorithms

II COURSE OVERVIEW:

This course covers the basics of intelligence techniques and methodologies of soft computing that differ from conventional artificial computations. This course is used for approximate calculations to provide imprecise but useable solutions to complex problems. This course includes intelligence systems, artificial neural network models, fuzzy logic and its inference system, and neuro-fuzzy systems. The applications are used in pattern recognition, image processing, computer vision, and information retrieval.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Soft Computing	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

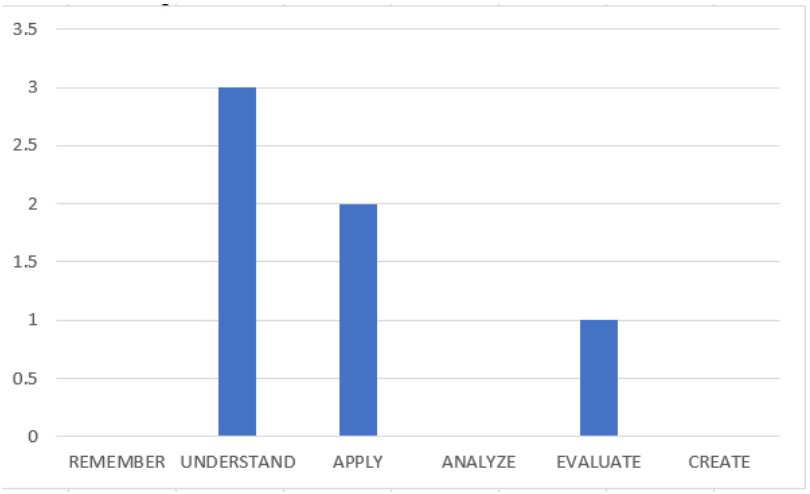
I	The fuzzy logic and reasoning for handling uncertainty in problem solving
II	Introduce the ideas of neural networks, and fuzzy logic.
III	The basics of intelligence techniques and methodologies of soft computing
IV	The design and analysis of problem-solving using concepts of neural networks, neuro modeling, neural network paradigms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** the importance of knowledge representation and processing in an intelligent system	Understand
CO 2	**Make use of** the characteristics and constituents of soft computing for decision-making systems.	Apply
CO 3	**Choose** a Relevant Model of an artificial neural system for supervised and unsupervised learning.	Apply
CO 4	**Experiment** with learning rules and their working principle for computer vision and image processing applications.	Understand
CO 5	**Compare** the importance of auto and hetero associative memories for distinct cases of neural network systems	Understand
CO 6	**Select** an appropriate genetic algorithm for soft computing-based systems.	Evaluate

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skillful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively, and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research/ investigation and development work to solve practical problems.	3	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics, and signal processing applications.	3	CIE/SEE/AAT
PO 5	Function in multidisciplinary environments by working cooperatively, creatively, and responsibly as a member of a team.	2	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	2	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s), PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	✓	✓	✓	✓
CO2	✓	-	✓	✓	✓	✓
CO3	✓	-	✓	✓	✓	✓
CO4	✓	-	✓	✓	✓	✓
CO5	✓	-	✓	✓	✓	✓
CO 6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	**PO 1**	**Apply** scientific reasoning to **analyze how knowledge** is represented and processed in intelligent systems.	**4**
	PO 3	Develop mastery in soft computing methods such as fuzzy logic and neural learning, beyond the UG level.	**2**
	PO 4	**Apply** soft computing techniques to design real-time embedded systems used in IoT and signal processing.	**4**
	PO 5	**Collaborate** in teams to design and implement soft computing-based solutions across interdisciplinary domains.	**3**
	PO 6	Explore and stay updated on evolving knowledge representation models through lifelong learning.	**3**
CO2	**PO 1**	**Investigate and implement** neural network models for supervised and unsupervised learning using scientific methods.	**2**
	PO 3	**Understand** fuzzy logic, neural networks, and evolutionary **computation for developing intelligent** decision-making systems.	**4**
	PO 4	**Apply** soft computing techniques to design real-time embedded systems used in IoT and signal processing.	**4**
	PO 5	**Collaborate** in teams to design and implement soft computing-based solutions across interdisciplinary domains.	**2**
	PO 6	**Engage** in continual learning to keep pace with advancements in intelligent decision-making systems**.**	**3**
CO3	**PO 1**	**Investigate and implement** neural network models for supervised and unsupervised learning using scientific methods.	**4**

	PO 3	**Demonstrate** expertise in neural architectures and learning paradigms for various engineering applications	**2**
	PO 4	**Apply** neural models to practical engineering fields like speech, signal, and medical data analysis.	**3**
	PO 5	**Collaborate** effectively in teams to design and evaluate neural system prototypes	**3**
	PO 6	Stay competent with advancing computer vision methods through continuous self-learning.	**2**
CO4	**PO 1**	**Research and** explore associative memory models and their role in intelligent recall and pattern storage.	**4**
	PO 3	**Develop** expertise in learning rules such as Hebbian and Delta rule for pattern-based processing.	**2**
	PO 4	**Use** these learning techniques in embedded vision systems and image processing hardware/software.	**3**
	PO 5	**Collaborate** effectively in teams to design and evaluate neural system prototypes	**3**
	PO 6	Stay competent with advancing computer vision methods through continuous self-learning.	**2**
CO5	**PO 1**	**Research and** explore associative memory models and their role in intelligent recall and pattern storage.	**4**
	PO 3	Gain advanced understanding of memory-based models used in deep learning and neural systems.	**2**
	PO 4	**Use** these learning techniques in embedded vision systems and image processing hardware/software.	**4**
	PO 5	**Collaborate** effectively in teams to design and evaluate neural system prototypes	**4**

	PO 6	Keep pace with new developments in neural memory models by engaging in continuous education.	**4**
CO 6	**PO 1**	Investigate and choose suitable evolutionary algorithms for solving real-world optimization problems.	**4**
	PO 3	Apply specialized knowledge of genetic algorithms for problem-solving in AI systems.	**2**
	PO 4	Implement genetic algorithms in embedded system design, signal processing, and IoT optimization tasks.	**4**
	PO 5	**Collaborate** effectively in teams to design and evaluate neural system prototypes	**4**
	PO 6	Learn and adopt advanced evolutionary strategies through lifelong learning.	**2**

Note: For Key Attributes refer **Annexure – I**

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAP-PING:

.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4	-	2	4	3	3
CO 2	3	-	2	4	2	3
CO 3	4	-	2	3	3	2
CO 4	4	-	2	3	4	3
CO 5	4	-	2	4	4	4
CO 6	4	-	2	4	4	2

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	100	-	100	80	60	75
CO 2	75	-	100	80	40	75
CO 3	100	-	100	60	60	50
CO 4	100	-	100	60	80	75
CO 5	100	-	100	80	80	100
CO 6	100	-	100	80	80	50

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation

1 -5 <C≤ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	3	3	2	3
CO 2	3	0	3	3	1	3
CO 3	3	0	3	2	2	2
CO 4	3	0	3	2	3	3
CO 5	3	0	3	3	3	3
CO 6	3	0	3	3	3	2
TOTAL	**18**	**0**	**18**	**16**	**14**	**16**
AVERAGE	**3**	**0**	**3**	**3**	**2**	**2.5**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**INTRODUCTION TO NEURAL NETWORKS**
	Introduction: Fundamental concept, the evolution of neural networks, models of artificial neural networks, important technologies, applications, McCulloch, Pitts Neuron, linear separability, Hebb network; Supervised learning network: Perception networks, adaptive linear neuron, multiple adaptive linear neurons, backpropagation network, radial basis function network.
MODULE II	**REVIEW OF COMPUTER SECURITY AND CYBERCRIME ISSUES**

	Public key cryptography, RSA, online shopping, payment gateways, unauthorized access to computers, computer intrusions, white collar crimes, viruses, malicious code, internet hacking and cracking, virus attacks, pornography, software piracy, intellectual property, mail bombs, exploitation, stalking and obscenity in the internet, digital laws and legislation, law enforcement roles and responses.
MODULE III	**FUZZY LOGIC**
	Fuzzy logic: Introduction to classical/crisp sets and fuzzy sets, classical/crisp relations and fuzzy relations, tolerance and equivalence relations, and non-iterative fuzzy sets. Membership functions: Fuzzification, methods of membership value assignments, defuzzification, and Lambda cuts for fuzzy sets and fuzzy relations, defuzzification methods
MODULE IV	**FUZZY ARITHMETIC**
	Fuzzy arithmetic and fuzzy measures: Fuzzy rule base and approximate reasoning, truth values and tables in fuzzy logic, fuzzy propositions, formation of rules, decomposition and aggregation of rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making, fuzzy logic control systems, fuzzy expert systems.
MODULE V	**GENETIC ALGORITHMS**
	Genetic algorithm and search space, general genetic algorithm, operators, generational cycle, stopping condition, constraints, classification, genetic programming, multilevel optimization; Applications: A fusion approach of multispectral images with SAR image for flood area analysis, optimization of traveling salesman problem using genetic algorithm approach, and genetic algorithm-based internet search technique, soft computing-based hybrid fuzzy controllers.

TEXTBOOKS

1. J.S.R.Jang,C.T.Sun,E.Mizutani, “Neuro,Fuzzy and Soft Computing”, Pearson Education, 1 st Edition, 2004.

2. S. N. Sivanandan, S. N. Deepa, “Principles of Soft Computing”, Wiley India, 2nd Edition, 2007.

REFERENCE BOOKS:

1. . S.Rajasekaran, G.A.V.Pai,“Neural Networks, Fuzzy Logic and GeneticAlgorithms”,PHI, 1 stEdition,2003

2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill, 3 rd Edition, 1997.

3. StamatiosV.Kartalopoulos“Understanding Neural Networks and Fuzzy Logic Basic Concepts and Applications”, IEEE Press, PHI, New Delhi, 2004.

COURSE WEB PAGE:

1. http://www.sctie.iitkgp.ernet.in/
2. http://www.rkala.in/softcomputingvideos.php
3. http://www.sharbani.org/home2/soft-computing-1

4. http://www.myreaders.info/html/soft_computing.html

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Introduction to Neural Networks, fundamental concepts	CO 1	T1: 1.1–1.2
3	Evolution of Neural Networks and Models	CO 1	T1: 3.2-3.5
4	Applications of Neural Networks	CO 1	T1:1.5
5	McCulloch–Pitts Neuron, Linear Separability.	CO 3	T1: 4.1-4.2
6	Hebbian Learning and Hebb Network	CO 3	T1: 4.2-4.3
7	Perceptron Networks – Architecture and Training	CO 3	T1: 4.3-4.4
8	ADALINE and MADALINE	CO 3	T1:5.1-5.2
9	Backpropagation Algorithm – Concepts and Training	CO 3	T1:5.2,5.5
10	Radial Basis Function Networks	CO 3	T1: 6.1-6.2
11	Auto-associative Memory Network	CO 5	T1: 6.1-6.2
12	Hetero-associative Memory Network	CO 5	T1: 7.1-7.2
13	Bidirectional Associative Memory	CO 5	T1: 7.1-7.2
14	Hopfield Networks and Stability Analysis	CO 5	T1: 7.4-7.5
15	Temporal Associative Memory Networks	CO 5	T1: 7.4-7.5
16	Kohonen Self-organizing Maps	CO 4	T2: 7.6-8.1
17	Learning Vector Quantization (LVQ)	CO 4	T2: 7.6-8.1
18	Adaptive Resonance Theory (ART)	CO4	T1: 4.4
19	Classical vs Fuzzy Sets	CO4	T2: 1.1
20	Crisp vs Fuzzy Relations	CO2	T2: 1.2
21	Tolerance & Equivalence Relations	CO2	T2: 1.3
22	Membership Functions, Fuzzification Methods	CO2	T2: 2.1
23	Defuzzification Methods	CO2	T2: 2.2
24	Lambda Cuts in Fuzzy Sets	CO2	T2: 2.3
25	Fuzzy Rule Base and Reasoning	CO2	T2: 3.1
26	Truth Tables in Fuzzy Logic	CO2	T2: 3.2
27	Fuzzy Propositions and Rule Aggregation	CO2	T2: 3.3

28	Fuzzy Inference Systems	CO4	T2: 4.1
29	Fuzzy Decision-Making Systems	CO4	T2: 4.2
30	Fuzzy Expert Systems and Control Application	CO4	T2: 4.3
31	Genetic Algorithm Introduction & Search Space	CO4	T2: 5.1
32	General GA Architecture and Operators	CO6	T2: 5.1
33	Generational Cycle, Stopping Criteria	CO6	T2: 5.3
34	Constraints Handling and Classification	CO6	T2: 5.4
35	Genetic Programming & Multilevel Optimization	CO6	T2: 5.5
36	GA for Multispectral Image Fusion	CO6	T2: 6.1
37	GA for TSP Optimization	CO6	T2: 6.2
38	GA-based Internet Search Techniques	CO6	T2: 6.3
39	Hybrid Fuzzy Controllers with GA	CO6	T2: 6.4
	PROBLEM SOLVING / CASE STUDIES		
40	Problem on pattern classification using Perceptron	CO3	T1: 2.3
41	problem on Memory Recall using Hopfield Network	CO5	T1: 3.2
42	Case study on Clustering using SOM	CO4	T1: 4.1
43	Simulation of Fuzzy Inference System	CO4	T1: 4.1
44	Fuzzy Controller Design for Temperature System	CO4	T1: 4.4
45	Optimization of TSP using Genetic Algorithm	CO6	T1: 4.3
46	Multimodal Optimization using Genetic Programming	CO6	R1: 6.3
	DISCUSSION ON DEFINITIONS AND TERMINOLOGY		
47	Neural Network & Learning Types	CO1	T1: 2.1
48	Perceptron & Linearly Separable Problems	CO3	T1: 3.1
49	Hebbian Rule and Unsupervised Learning	CO4	
50	Fuzzy Set, Membership Functions	CO2	
51	Genetic Algorithms and Fitness Function	CO6	
	DISCUSSION ON QUESTION BANK		
52	Neural Network Basics & Classification Models	CO1, CO3	
53	Associative Memory and Unsupervised Models	CO4, CO5	
54	Fuzzy Logic and Inference Systems	CO2	
55	Genetic Algorithm-based Optimization	CO6	
56	Application-Based Short Questions and MCQs	CO1-CO6	

Course Coordinator **HOD,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Branch	**Computer Science and Engineering**				
Course Title	**Research Methodology and IPR**				
Course Code	BHSD01				
Program	M.Tech				
Semester	I				
Course Type	Core				
Regulation	IARE - MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	2	-	-
Course Coordinator	Mr. M. Suryanarayana, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
M.Tech	-	-	-

II COURSE OVERVIEW:

This course provides the basic concepts on research methodology and intellectual property rights. This course emphasis on sampling techniques, data collection, writing Reports, Projects, Dissertations, thesis and articles for publication in academic journals, avail the intellectual property rights of the inventors or owners for their assets like patents on innovative design, copy rights on literary and artistic works, trademark on goods & services and geographical indications on products famous for specific geographical areas.This course makes use of the potential future economic benefits to the intellectual property owner or authorized user.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Research Methodology and IPR	60 Marks	40 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / three sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course.
The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Table 2: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	05 Marks	05 Marks		10 Marks
Alternative Assessment Tool (AAT)	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. The valuation and verification of answer scripts of CIE exams shall be completed within a week after the conduct of the Examination.

Assignment
To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz
It is online proctor based online examination conducted either at the end of the CIE1 or CIE2. The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.

Alternative Assessment Tool (AAT)
In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. The AAT

may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.

VI COURSE OBJECTIVES:

The students will try to learn:

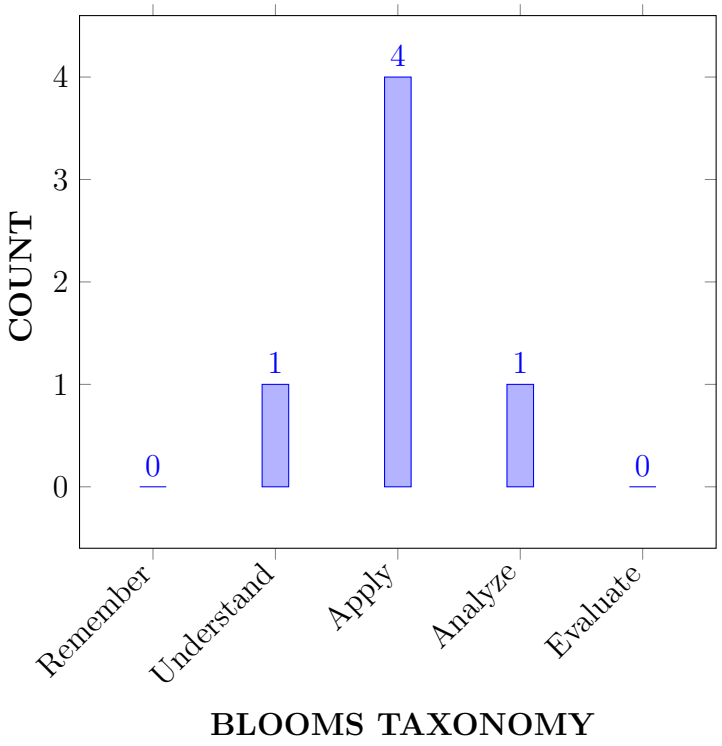
I	The knowledge on sources of research problem, data collection, analysis, and interpretation.
II	The importance of effective technical writing and analysis plagiarism.
III	The new developments in the law of intellectual property rights in order to bring progressive changes towards a free market society.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Interpret** the technique of determining a research problem for a crucial part of the research study	Understand
CO 2	**Examine** the way of methods for avoiding plagiarism in research	Analyze
CO 3	**Apply** the feasibility and practicality of research methodology for a proposed project	Apply
CO 4	**Make use of** the legal procedure and document for claiming patent of invention.	Apply
CO 5	**Identify** different types of intellectual properties, the right of ownership, scope of protection to create and extract value from IP	Apply
CO 6	**Defend** the intellectual property rights throughout the world with the involvement of World Intellectual Property Organization	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems
PO 2	Write and present a substantial technical report / document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems	2	CIE/SEE/AAT
PO 2	Write and present a substantial technical report / document.	2	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	1	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓	✓	-	-	-	✓
CO 2	✓	-	-	-	-	✓
CO 3	✓	✓	-		-	-
CO 4	✓	✓	-		-	-
CO 5	✓	-	-	-		✓
CO 6	-	✓	-	-	-	-

XI JUSTIFICATIONS FOR CO – PO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	**Describe** the steps involved in **problem identification for the research process** with **quality of work** and **demonstrate the solutions**	4
	PO 2	**Demonstrate and communicate** effectively in writing the **research problem** with **clarity** and **subject the knowledge while preparing report**	4
	PO 6	**Describe** the importance of **continuing education efforts through literature, personal development, meeting deadlines** and **producing solutions** in research study	4
CO 2	**PO 1**	**Explain** the methods for avoiding plagiarism in research work for improving the **quality of work, self driven** and **Independence** in research process	3
	PO 6	**Describe** the methods for avoiding plagiarism in research work by **continuing education efforts through literature, manage risk, meeting deadlines** and **producing solutions**	3
CO 3	**PO 1**	**Describe** the steps of **problem identification and implementation** in development of **independence, quality of work** by using research methodology	3
	PO 2	**Demonstrate and communicate effectively in writing** a proposed project with **clarity** and avoid the mistakes in terms of **grammar (writing)** to **subject knowledge while preparing report**	4
CO 4	**PO 1**	**Demonstrate the solutions** and **self driven, independence** in work for copyright and **quality of work** in document	4
	PO 2	**Demonstrate and communicate** effectively in Process of applying **presenting** Patent with clarity and **subject knowledge** of intellectual property management for claiming patent of invention	3
CO 5	**PO 1**	**Demonstrate the solutions** to attain the right of ownership and **independence and self driven** for scope of protection	3
	PO 6	**Continuing education efforts through literature, demonstrated ability to work well with a team, meeting deadlines and producing solutions** for licensing and transfer of technology in patent rights	4
CO 6	**PO 2**	**Demonstrate and communicate effectively** of the new Developments in IPR with considering **references** and **clarity** in **presentation**	4

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	6	6	9	10	7	8
CO 1	4	4	-	-	-	4
CO 2	3	-	-	-	-	3
CO 3	3	4	-	-	-	-
CO 4	4	3	-	-	-	-
CO 5	3	-	-	-	-	4
CO 6	-	4	-	-	-	-

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – PO

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	6	6	9	10	7	8
CO 1	66.6	66.6	-	-	-	50
CO 2	50	-	-	-	-	37.5
CO 3	50	66.6	-	-	-	-
CO 4	66.6	50	-	-	-	-
CO 5	50	-	-	-	-	50
CO 6	-	66.6	-	-	-	-

XIV COURSE ARTICULATION MATRIX (PO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	-	-	-	2
CO 2	2	-	-	-	-	1
CO 3	2	3	-	-	-	-
CO 4	3	2	-	-	-	-
CO 5	2	-	-	-	-	2
CO 6	-	3	-	-	-	-
Total	12	11	-	-	-	5
Average	2.4	2.75	-	-	-	1.7

XV ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
AAT	✓	5 Minutes Video	-	Open Ended Experiments	-
Assignments	-				

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**INTRODUCTION**
	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
MODULE II	**RESEARCH ETHICS**
	Effective literature studies approaches, analysis Plagiarism, Research ethics.
MODULE III	**RESEARCH PROPOSAL**
	Effective technical writing, how to write report, Paper Developing a Research Proposal. Format of research proposal, a presentation and assessment by a review committee
MODULE IV	**PATENTING**
	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT
MODULE V	**PATENT RIGHTS**
	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

TEXTBOOKS

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science and engineering students".
2. C R Kothari, "Research Methodology: Methods and techniques", New age international limited publishers, 1990 .
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

REFERENCE BOOKS:

1. Halbert, "Resisting Intellectual Property", Taylor and Francis Ltd , 2007.
2. Mayall , "Industrial Design", McGraw Hill, 1992.
3. Niebel , "Product Design", McGraw Hill, 1974.

WEB REFERENCES:

1. Robert P. Merges, Peter S. Menell, Mark A. Lemley Age", 2016 , " Intellectual Property in New Technological Age", 2016
2. T. Ramappa, "Intellectual Property Rights Under WTO" S. Chand 2008
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR-Library of Congress

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=367

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Introduction, Definition, types of research	CO 1	T1:2.1
2	Meaning of research problem	CO 1	T1:2.1
3	Sources of research problem	CO 1	T1:2.3
4	Criteria characteristics of good research problem	CO 1	T1:2.3.1
5	Research process	CO 1	T1:7.2
6	Research design	CO 1	T1:7.3
7	Errors in selecting a research problem	CO 1	T1:7.4
8	Scope and objectives of research problem	CO 1	T1:2.3
9	Approaches of investigation of solutions for research problem	CO 1	T1:7.4
10	Data collection	CO 1	T1:8.1
11	Analysis and interpretation of data	CO 1	T1:8.1.1
12	Necessary instrumentation's	CO 1	T1:8.1.1
13	Effective literature studies approaches	CO 2	T1:8.2
14	Literature	CO 2	T1:8.2
15	Literature review	CO 2	T1:8.2
16	Literature review techniques	CO 2	T1:8.2
17	Literature studies	CO 2	T1:8.2
18	Introduction to ethics, Importance of ethics	CO 2	T1:8.2
19	Ethical issues in conducting research	CO 2	T1:8.3
20	Principles of research ethics	CO 2	T1:8.4

21	Analysis	CO 2	T1:8.5
22	Plagiarism- types of plagiarism	CO 2	T1:8.6
23	Tips to avoid plagiarism	CO 2	T1:9.1
24	Other ethical issues	CO 2	T1:9.2, 9.3
25	Interpretation, Interpretation Techniques and precautions	CO 2	T2:9.3.4
26	Writing of report and steps involved	CO 3	T2:7.1
27	Layout of research report	CO 3	T2:7.2
28	Types of reports	CO 3	T2:7.3
29	Paper developing a research proposal	CO 3	T2:7.4
30	Format of research proposal	CO 4	T2:8.3
31	Presentation of report	CO 4	T2:8.4
32	Summary of findings	CO 4	T3:8.5
33	Assessment by review committee	CO 4	T3:8.6
34	Technical appendixes	CO 4	T3:8.6
35	Logical analysis of the subject matter	CO 4	T3:8.6
36	Statement of findings and recommendations	CO 4	T3:8.6
37	Introduction, Nature of Intellectual Property	CO 5	T3:10.1-10.6
38	Types of intellectual Property rights	CO 5	T3:10.1-10.6
39	Patents	CO 5	T3:11.10
40	Designs	CO 5	T3:11.10
41	Trademarks and copyrights: Definition, classification of trademarks	CO 5	T3:11.10
42	Process of Patenting and Development	CO 5	T3:11.14
43	Technical research, innovation, patenting	CO 5	T3:11.15
44	Developments in patenting	CO 5	T3:11.17
45	Patent Trademark Organization	CO 5	T3:11.17
46	International Organization, Agencies and Treaties	CO 5	T3:11.17
47	International scenario, international cooperation on Intellectual property	CO 5	T3:11.19
48	Procedure for grant of patents	CO 5	T3:11.21
49	procedure of copyright	CO 5	T1:8.1-8.3; R2: 7.4-7.5
50	Patenting under PCT, Provisional patent application	CO 5	T1-8.1-8.1.7
51	Patent protection for the invention	CO 5	T1-8.1-8.1.7
52	Patent Rights	CO 6	T3:12.1
53	Scope of Patent Rights	CO 6	T3:12.1
54	Licensing and transfer of technology	CO 6	T3:12.1
55	Patent information and databases	CO 6	T3:12.4
56	Geographical Indications	CO 6	T3:12.4

57	New Developments in IPR: Administration of Patent System	CO 6	T3:12.7
58	New developments in IPR, IPR of Biological Systems and Computer Software etc	CO 6	T3:12.10
59	Traditional knowledge Case Studies	CO 6	T3:12.13
60	IPR and IITs.	CO 6	T3:12.15
DISCUSSION OF QUESTION BANK			
61	Module – I: Research problem	CO 1	T1:2.1-2.3
62	Module – II: Research ethics	CO 2	T1:8.2
63	Module – III: Research proposal	CO 3, CO 4	T3:8.3; R2: 7.4-7.5
64	Module – IV: Patenting	CO 5	T3:10.1-10.6
65	Module – V: Patent rights	CO 6	T3:12.1-12.15

Signature of Course Coordinator **HOD,CSE**
Mr. M. Suryanarayana ,Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING				
Course Title	DATA SCIENCE				
Course Code	BCSD03				
Program	M.Tech				
Semester	I				
Course Type	Core				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr.RM.Noorullah, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
1	AHSDO2	1	Matrices&Calculus

II COURSE OVERVIEW:

Data Science is a field of study that deals with the collection, analysis, and processing various data or information to extract solutions. It deals with the understanding of many structured and unstructured data with specialized knowledge to get the required insights. It is that part of science which also requires knowledge about business or commerce related fields.

MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Science	60 Marks	40 Marks	100

III DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

IV EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). **Semester End Examination (SEE):** The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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.

V COURSE OBJECTIVES:

The students will try to learn:

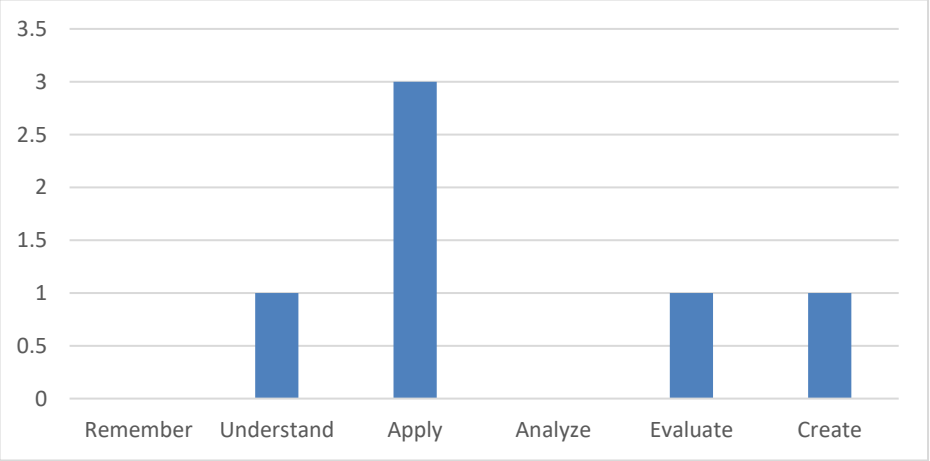
I	The fundamental knowledge on basics of data science and R programming
II	The fundamental knowledge on basics of data science and R programming. The programs in R language for understanding and visualization of data using statistical functions and plots.
III	How to apply hypotheses and data into actionable predictions.
IV	A range of machine learning algorithms along with their strengths and weaknesses.
V	The document and transfer the results and effectively communicate the findings using visualization techniques.

VI COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Outline the data science process by leveraging R's features and data preprocessing techniques	Understand
CO 2	Utilize R's data description functions to demonstrate key stages of the data science process	Apply
CO 3	Select a suitable interfacing package for handling SQL and NoSQL databases for performing data analysis	Apply
CO 4	Model an Artificial Neural Network for developing a learning model	Create
CO 5	Choose Documentation and visualization techniques for delivering results effectively.	Evaluate
CO 6	Select an appropriate genetic algorithm for soft computing-based systems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skillful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program	3	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skillful at designing embedded systems for effective use in communications, medical electronics and signal processing applications.	3	CIE/SEE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	CIE/SEE/AAT

IX MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	✓	✓	✓	✓
CO2	✓	-	✓	✓	✓	✓
CO3	✓	-	✓	✓	✓	✓
CO4	✓	-	✓	✓	✓	✓
CO5	✓	-	✓	✓	✓	✓
CO6	✓	-	✓	✓	✓	✓

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	PO1	Identify and solve practical problems in data preprocessing using R.	**4**
	PO3	Gain foundational knowledge to demonstrate mastery in data science practices.	**2**
	PO4	Apply R-based techniques and tools in real-world problem-solving.	**5**
	PO5	Collaborate using standard preprocessing workflows across teams.	**4**
	PO6	Embrace evolving R libraries and preprocessing practices for continuous learning.	**3**
CO2	PO1	Investigate and explain descriptive statistics using R functions.	**4**
	PO3	Demonstrate control over data understanding and visualization skills.	**2**
	PO4	Apply tools and methods to represent datasets in meaningful formats.	**5**
	PO5	Engage effectively in group data analysis discussions.	**3**
	PO6	Continuously improve data exploration techniques through self-learning.	**3**

CO3	**PO 1**	Solve practical integration problems in heterogeneous data environments.	**2**
	PO 3	Master database access using R in the context of modern data systems.	**2**
	PO 4	Utilize interfacing tools with SQL/NoSQL databases using R packages.	**5**
	PO 5	Apply collaborative approaches to real-time data retrieval and processing.	**2**
	PO 6	Stay updated on evolving database connectors and interfacing techniques.	**2**
CO4	**PO 1**	Assess real-world machine learning problems with analytical models.	**2**
	PO 3	Attain mastery in applying classification and clustering algorithms.	**2**
	PO 4	Use modern ML tools and metrics to evaluate model performance.	**5**
	PO 5	Work effectively in teams to build interpretable learning models.	**3**
	PO 6	Engage in lifelong learning through ML advancements.	**2**
CO5	**PO 1**	Develop models to solve complex learning problems.	**2**
	PO 3	Achieve mastery in ANN frameworks and training methodologies.	**2**

	PO 4	Implement neural networks using contemporary ML libraries.	**5**
	PO 5	Collaborate in building and testing ANN models.	**2**
	PO 6	Adapt to evolving AI models and methodologies.	**2**
CO6	**PO 1**	Document findings clearly in the data science workflow.	**2**
	PO 3	Demonstrate presentation skills using graphical output and insights.	**2**
	PO 4	Use appropriate visualization libraries like `ggplot2`, `plotly`, etc.	**5**
	PO 5	Share results in collaborative settings through dashboards or reports.	**3**
	PO 6	Develop documentation habits for continuous improvement and clarity.	**3**

Note: For Key Attributes refer **Annexure - I**

XI TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4	-	2	5	4	3
CO 2	4	-	2	5	3	3
CO 3	2	-	2	5	2	2
CO 4	2	-	2	5	3	2
CO 5	2	-	2	5	2	2
CO 6	2	-	2	5	3	3

.

XII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	100	0	100	100	80	75
CO 2	100	0	100	100	60	75
CO 3	50	0	100	100	40	50
CO 4	50	0	100	100	60	50

CO 5	50	0	100	100	40	50
CO 6	50	0	100	100	60	75

XIII COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation
1 -5 <C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	3	3	3	3
CO 2	3	0	3	3	2	3
CO 3	2	0	3	3	1	2
CO 4	2	0	3	3	2	2
CO 5	2	0	3	3	1	2
CO 6	2	0	3	3	2	3
TOTAL	**14**	**0**	**18**	**18**	**11**	**18**
AVERAGE	2.5	0	3	3	2.5	3

XIV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVI SYLLABUS:

MODULE I	**INTRODUCTION**
	Data science process, roles, stages in data science project, working with data from files, working with relational databases, exploring data, managing data, data cleaning and sampling for modeling. Introduction to R: Introduction to various data types, reading and writing datasets, working with different file types .txt, .csv, outliers, R functions and loops; Summary statistics: Summary, str, aggregate, subset, head, tail; Probability distribution.
MODULE II	**SQL, NOSQL AND DATA ANALYSIS**
	SQL using R, excel and R, introduction to No SQL, connecting R to No SQL databases, R with XML, JSON; Correlation analysis; Covariance analysis, ANOVA, forecasting, heteroscedasticity, autocorrelation; Regression analysis: Regression modeling, multiple regression..
MODULE III	**DATA ANALYSIS**
	Data analysis: Introduction, Terminology and concepts, Central tendencies and distributions, Variance, Basic machine learning algorithms, Linear regression, SVM Cluster analysis: K-means algorithm, Naive Bayes memorization methods ,evaluating clustering models and validating models.
MODULE IV	**ARTIFICIAL NEURAL NETWORKS**
	Artificial neural networks: Introduction, neural network representation, appropriate problems for neural network learning, perceptions, multilayer networks and the back propagation algorithm Evaluation hypotheses: Motivation, estimation hypothesis accuracy, basics of sampling theory, a general approach for deriving confidence intervals, difference in error of two hypothesis, comparing learning algorithms..
MODULE V	**DELIVERING RESULTS**
	Documentation and deployment, producing effective presentations, introduction to graphical analysis, plot() function, displaying multivariate data, matrix plots, multiple plots in one window, exporting graph, using graphics parameters, case studies..

TEXTBOOKS

1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 1stEdition, 2014.

2. William N. Venables, David M. Smith, “An Introduction to R”, Network Theory imited, 2nd Edition, 2009.

3. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Taylor & Francis CRC Press, 2nd Edition, 2011.

REFERENCE BOOKS:

1. G. Jay Kerns, "Introduction to Probability and Statistics Using R", Youngstown State University, USA, 1st Edition, 2011.

2. William W Hsieh, "Machine Learning Methods in the Environmental Sciences", Neural Networks, Cambridge University Press, 1st Edition, 2009.

3. Chris Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1st Edition, 1995.

4. Peter Flach, "Machine Learning", Cambridge University Press, 1st Edition, 2012.

COURSE WEB PAGE:

1. http://www.tutorialspoint.com/r/
2. 2. https://en.wikipedia.org/wiki/R_programming_language.
3. 3. http://www.r-bloggers.com/how-to-learn-r-2/#h.obx6jyuc9j7t.

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Introduction	CO 1	T1: 1.1-1.5
3	Data science process, roles, stages in data science project, working with data from files	CO 1	T1: 3.2-3.5
4	Exploring data, managing data, data cleaning and sampling for modeling.	CO 1	T1: 3.5-3.7
5	Introduction to R: Introduction to various data types, reading and writing datasets,.	CO 1	T1: 4.1-4.2
6	Working with different file types .txt, .csv, outliers, R functions and loops distribution. Web languages	CO 1	T1: 4.2-4.3
7	statistics: aggregate, subset, head, tail; Probability Database servers	CO 1	T1: 4.3-4.4

8	SQL, NOSQL AND DATA ANALYSIS	CO 2	T1:5.1-5.2
9	SQL using R, excel and R, introduction to No SQL, connecting R to No SQL databases,	CO 2	T1:5.2,5.5
10	R with XML, JSON; Correlation analysis	CO 2	T1: 6.1-6.2
11	Covariance analysis, ANOVA, forecasting, heteroscedasticity, autocorrelation; Regression	CO 2	T2: 6.1-6.2
12	analysis: Regression modeling, multiple regression	CO 2	T1: 7.1-7.2
13	Data analysis	CO 3	T2: 7.1-7.2
14	Introduction, Terminology and concepts, Central tendencies and distributions	CO 3	T3: 7.4-7.5
15	Variance, Basic machine learning algorithms, Linear regression,	CO 3	T1: 7.4-7.5
16	SVM Cluster analysis: K-means algorithm, Naive Bayes memorization methods ,	CO 3	T2: 7.6-8.1
17	evaluating clustering models and validating models	CO 3	T2: 7.6-8.1
18	Artificial neural networks	CO 4	T3: 8.2-8.5
19	Introduction, neural network representation, appropriate problems for neural network learning,	CO 4	T1:9.1-9.2
20	perceptions, multilayer networks and the back propagation algorithm Evaluation	CO 4	T1: 9.1-9.2
21	hypotheses: Motivation, estimation hypothesis accuracy,	CO 4	R2:8.4,8.10
22	basics of sampling theory, a general approach for deriving confidence intervals,	CO 4	R2:8.4- 10
23	difference in error of two hypothesis,	CO 4	R2:8.4
24	comparing learning algorithms Intellectual property	CO 4	R2: 8.14-8.16
25	Delivering results	CO 5	R2: 8.14-8.16
26	Documentation and deployment,	CO 5	R2: 8.16,8.17
27	producing effective presentations,	CO 5	R2:8.22
28	introduction to graphical analysis, plot() function,	CO 6	R2:8.27

29	displaying multivariate data, matrix plots, multiple plots in one window,	CO 6	R3:8.28
30	exporting graph, using graphics parameters, case studies.	CO 6	T2:2.1-2.2
31	Network security basics,	CO 6	T2:2.2-2.4
32	Firewalls, and IDS	CO 6	T2: 2.1-2.4
PROBLEM SOLVING/ CASE STUDIES			
47	Problems on Data science roles	CO 1	T1: 1.1-1.5
48	Problem on SQL, NOSQL and data analysis	CO 1	T1: 3.2-3.5
49	Problems on Probability Database servers	CO 2	T1: 7.1-7.2
50	Problems on neural network representation	CO 2	T1: 7.1-7.2
51	Problems on Data analysis	CO 3	R2:8.4,8.10
52	Problems on Artificial neural networks	CO 3	R2:8.4 - 10
53	Problems on multilayer networks	CO 4	T2: 2.1-2.4
54	Problems on Basic machine learning algorithms	CO 5	T2: 2.5-2.6
55	Problems on graphical analysis	CO 6	T2:13.11-12
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Data analysis	CO 1	T1: 1.1-1.5
57	Database servers	CO 2	T1: 7.1-7.2
58	Machine learning algorithms	CO 3	R2:8.4-10
59	Neural networks	CO 4	T2: 2.1-2.4
60	Regression	CO 5	T2: 2.5-2.6
DISCUSSION ON QUESTION BANK			
61	Introduction	CO 1	T1: 1.1-1.5
62	Review of Computer neural network representation	CO 2	T1: 7.1-7.2
63	R with XML, JSON; Correlation analysis	CO 3	R2:8.4-10
64	Basic machine learning algorithms	CO 4	T2: 2.1-2.4
65	Securing Databases	CO 5	T2: 2.5-2.6

Course Coordinator **HOD,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE ENGINEERING

COURSE DESCRIPTION

Course Title	**ADVANCED DATA STRUCTURES LABORATORY**				
Course Code	BCSD11				
Program	M.Tech				
Semester	I				
Course Type	Laboratory				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	4	2
Course Coordinator	Mr. N Rajashekar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
M.Tech	BSCD02	I	ADVANCED DATA STRUCTURES

II COURSE OVERVIEW:

The Advanced Data Structures Laboratory offers hands-on practice in implementing and analyzing complex data structures like trees, graphs, heaps, and hash tables. Students develop skills in designing efficient algorithms and solving real-world problems. The course prepares them to build high-performance applications in computing domains.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
ADVANCED DATA STRUCTURES LABORATORY	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). **Semester End Examination (SEE):** The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

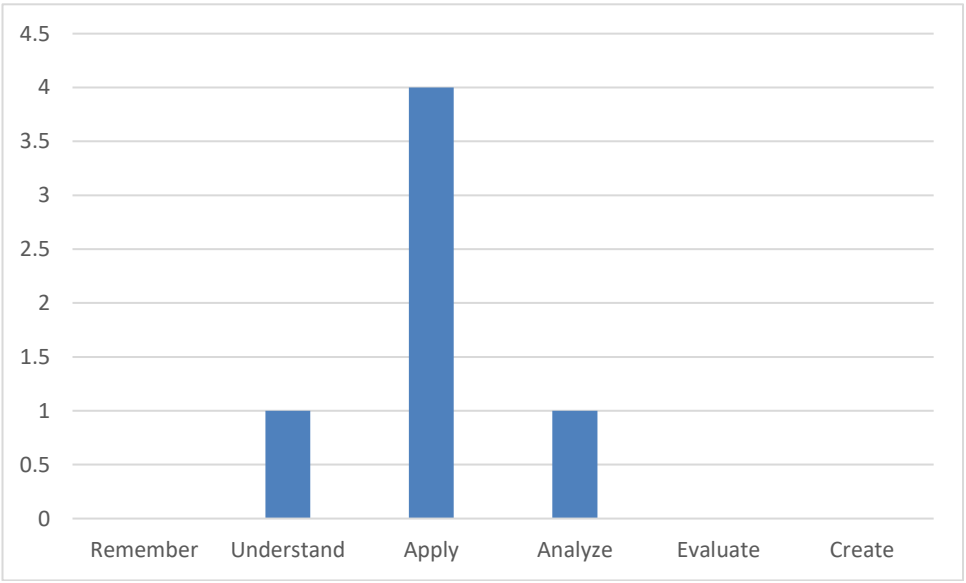
I	The linear and nonlinear data structures and their implementations.
II	Algorithms analysis based on their time and space complexity..
III	Appropriate data structure and algorithm design method for a specific application
IV	The graph traversals algorithms to solve real-world challenges such as finding the shortest paths onhuge maps and assembling genomes from millions of pieces

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Implement optimization problems by designing an algorithm using the greedy method.	Apply
CO 2	Apply hash, Red Block, and binary search tree data structures to various problems	Understand
CO 3	Utilize the divide and conquer method to design algorithms for challenging problems and analyze their performance.	Apply
CO 4	Implement dynamic programming techniques to solve complex problems and evaluate their performance	Analyze
CO 5	Apply Min-Max algorithms through flow-based concepts	Apply
CO 6	Design applications by applying substitution and recurrence-tree methods to solve recurrence relations.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research/investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report/document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	Independently carry out research/investigation and development work to solve practical problems.	3	Laboratory practices, student viva
PO2	Write and present a substantial technical report/document	2	Laboratory Practices, student viva
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3	Laboratory Practices, student viva
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.	3	Laboratory Practices, Mini-Project
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.	3	Laboratory Practices, Mini-Project
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.	3	Laboratory Practices, Mini-Project

3 = High; 2 = Medium; 1 = Low

X MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO4	PO 5	PO 6
CO 1	4	2	2	5	4	3
CO 2	4	2	2	5	3	3
CO 3	2	1	2	5	2	2
CO 4	2	2	2	5	3	2
CO 5	2	1	2	5	2	2
CO 6	2	1	2	5	3	3

XI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

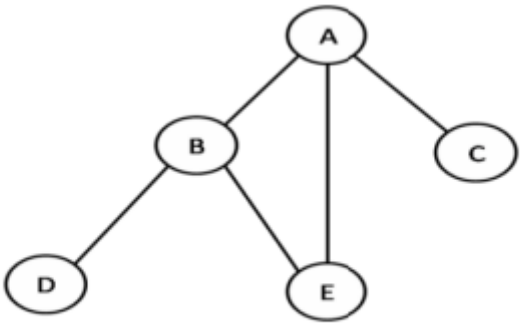
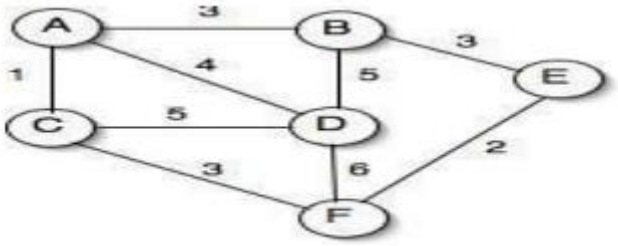
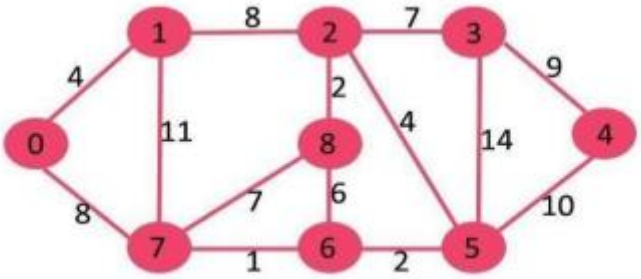
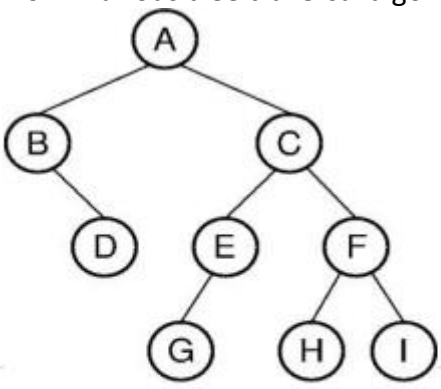
XII ASSESSMENT METHODOLOGY INDIRECT:

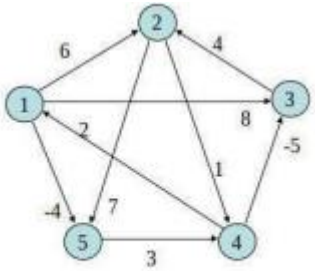
✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIII SYLLABUS:

WEEK I	**DIVIDE AND CONQUER – 1**
	a. Implement Quick Sort on 1D array of Student structure (contains student name, student_roll_no, total_marks), with key as student_roll_no and count the number of swap performed. b. Implement Merge Sort on 1D array of Student structure (contains student_name, student_roll_no, total_marks), with key as student_roll_no and count the number of swap performed
WEEK II	**DIVIDE AND CONQUER – 2**
	a. Design and analyze a divide and conquer algorithm for following maximum sub-array sum problem: given an array of integers find a sub-array [a contagious portion of the array] which gives the maximum sum. b. Design a binary search on 1D array of Employee structure (contains employee_name, emp_no, emp_salary), with key as emp_no and count the number of comparisons happened.
WEEK III	**IMPLEMENTATION OF STACK AND QUEUE**
	a. Implement 3 stacks of size 'm' in an array of size 'n' with all the basic operations such as Is Empty(i), Push(i), Pop(i), Is Full(i) where 'i' denotes the stack number (1,2,3), Stacks are not overlapping each other. b. Design and implement Queue and its operations using Arrays.
WEEK IV	**HASHING TECHNIQUES**
	Write a program to store k keys into an array of size n at the location computed

	using a hash function, loc = key % n, where k<=n and k takes valuesfrom [1 to m], m>n. To handle the collisions use the following collision resolution techniques a. Linear probing b. Quadratic probing c. Random probing d. Double hashing/rehashing
WEEK V	**APPLICATIONS OF STACK**
	Write C programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression.
WEEK VI	**BINARY SEARCH TREE**
	Write a program for Binary Search Tree to implement the following operations: a. Insertion b. Deletion i. Delete node with only child ii. Delete node with both children c. Finding an element d. Finding Min element e. Finding Max element f. The left child of the given node g. Right child of the given node h. Finding the number of nodes, leaves nodes, full nodes, ancestors, and descendants
WEEK VII	**DISJOINT SET OPERATIONS**
	a. Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph G(V,E) using the linked list representation with a simple implementation of Union operation. b . Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph G(V, E) using the linked list representation with a weighted-union heuristic approach.
WEEK VIII	**GRAPH TRAVERSAL TECHNIQUES**
	a. Print all the nodes reachable from a given starting node in a digraph using the Breadth First Search (BFS) method. b. b. Check whether a given graph is connected or not using the Depth First Search(DFS) method.

	
WEEK IX	**SHORTEST PATHS ALGORITHM**
	From a given vertex in a weighted connected graph, find shortest paths to other vertices usingDijkstra's algorithm. 
WEEK X	**MINIMUM COST SPANNING TREE**
	Find the Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm 
WEEK XI	**TREE TRAVESRSALS**
	Perform various tree traversal algorithms for a given tree. 

WEEK XII	**ALL PAIRS SHORTEST PATHS**
	Implement All-Pairs Shortest Paths Problem using Floyd's algorithm. 

	1	2	3	4	5
1	0	6	8	∞	-4
2	∞	0	∞	1	7
3	∞	4	0	∞	∞
4	2	∞	-5	0	∞
5	∞	∞	∞	3	0

REFERENCE BOOKS:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson Education India. Fourth Edition, 2014.
2. Reema Thareja, S. Rama Sree, Advanced Data Structures, Oxford University Press, 2018
3. G.A.V.Pai, “Data Structures and Algorithms”, Tata McGraw Hill, NewDelhi,1st Edition,2008
4. Lipschutz Seymour, “Data Structures Schaum's Outlines Series”, Tata McGraw Hill, 3 rdEdition, 2014.
5. Ellis Horowitz, Sartaj Sahni, Sagathevan Rajasekaran, “Fundamentals of Computer Algorithms”, Universities Press Private Limited, India, 2nd Edition, 2008.
6. Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Course Technology, 3rd Edition, 2005 Universities Press Private Limited, India, 2nd Edition, 2008. 6. Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Course Technology, 3rd Edition, 2005

WEB REFERENCES:

1. http://www.tutorialspoint.com/data_structures_algorithms
2. http://www.geeksforgeeks.org/data-structures/
3. http://www.studytonight.com/data-structures/
4. http://www.coursera.org/specializations/data-structures-algorithms

COURSE PLAN:

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

S.No	Topics to be covered	CO’s	Reference
1	a. Implement Quick Sort on 1D array of Student structure (contains student name, student_roll_no, total_marks), with key as student_roll_no and count the number of swap performed. b. Implement Merge Sort on 1D array of Student structure (contains student_name, student_roll_no, total_marks), with key as student_roll_no and count the number of swap performed	CO 1	T1:1.1,1.2
2	a. Design and analyze a divide and conquer algorithm for	CO 6	T1:1.1,1.3

	following maximum sub-array sum problem: given an array of integers find a sub-array [a contagious portion of the array] which gives the maximum sum. b. Design a binary search on 1D array of Employee structure (contains employee_name, emp_no, emp_salary), with key as emp_no and count the number of comparisons happened.		
3	a. Implement 3 stacks of size 'm' in an array of size 'n' with all the basic operations such as Is Empty(i), Push(i), Pop(i), Is Full(i) where 'i' denotes the stack number (1,2,3), Stacks are not overlapping each other. b. Design and implement Queue and its operations using Arrays.	CO 2	T1:9,1.4
4	Write a program to store k keys into an array of size n at the location computed using a hash function, loc = key % n, where k<=n and k takes valuesfrom [1 to m], m>n. To handle the collisions use the following collision resolution techniques a. Linear probing b. Quadratic probing c. Random probing d. Double hashing/rehashing	CO 4	T1:10.1,1.3
5	Write C programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression.	CO 2	T1:11.1,1.5
6	Write a program for Binary Search Tree to implement the following operations: a. Insertion b. Deletion i. Delete node with only child ii. Delete node with both children c. Finding an element d. Finding Min element e. Finding Max element f. The left child of the given node g. Right child of the given node h. Finding the number of nodes, leaves nodes, full nodes, ancestors, and descendants.	CO 3	T1:10.1,1.3
7	a. Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph G(V,E) using the linked list representation with a simple implementation of Union operation. b. Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph G(V, E) using the linked list representation with a weighted-union heuristic approach.	CO 2	R1:11.2-11.4
8	a. Print all the nodes reachable from a given starting node in a digraph using the Breadth First Search (BFS) method. b. Check whether a given graph is connected or not using the	CO 2	R2:9.1,1.6

	Depth First Search(DFS) method.		
9	From a given vertex in a weighted connected graph, find shortest paths to other vertices usingDijkstra's algorithm.	CO 2	R3:10.2-11.4
10	Find the Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.	CO 2	R2:9.2-11.4
11	Perform various tree traversal algorithms for a given tree.	CO 4	T1:12,1.9
12	Implement All-Pairs Shortest Paths Problem using Floyd's algorithm..	CO 5	T1:1.1,1.5

XIV EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Cryptography & Encryption
1	Implementation of Stack, Queue, and Deque using Arrays and Linked Lists
2	Binary Search Tree (BST): Insertion, Deletion, and Traversal
3	AVL Tree: Rotations and Balancing Operations
4	Red-Black Tree: Insertion and Deletion
5	Graph Representations: Adjacency Matrix and List, BFS and DFS Traversals

Signature of Course Coordinator **HOD,CSE**
Mr. N Rajashekar Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE ENGINEERING

COURSE DESCRIPTION

Course Title	DATA SCIENCE LABORATORY				
Course Code	BCSD12				
Program	M.Tech				
Semester	I				
Course Type	Laboratory				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	4	2
Course Coordinator	Dr. R M Noorullah, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC08	III	Advanced Data Structures

II COURSE OVERVIEW:

The course covers the basics of data analytics and R programming. Data analysis with statistical programming, analysis, and visualization of processed data is implemented using R programming. It includes the basics of mathematics, probability and statistical methods, and data communication. It also teaches students how to interpret large datasets and identify patterns to create predictive models.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Science Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). **Semester End Examination (SEE):** The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

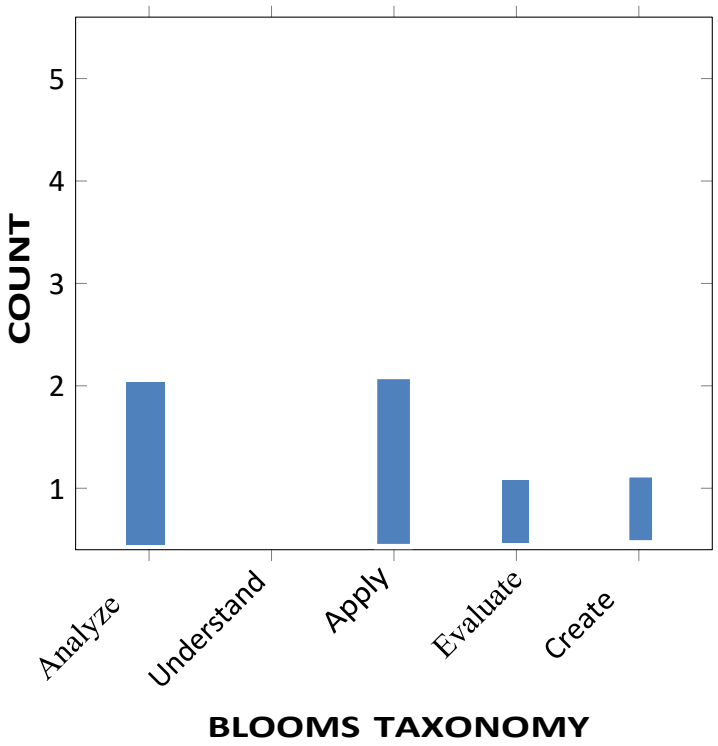
I.	The concept of R objects.
II.	Make use of different types of datasets for analysis using R.
III.	Relations among variables using statistical analysis.
IV.	The different data models for predictions using R

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Make Use of the container Data types to display the functional values.	Apply
CO 2	Implement reading and writing operations on web and disk data, and analyze their performance and reliability.	Apply
CO 3	Analyze data by interpreting visualizations that reveal the nature and relationships within datasets	Analyze
CO 4	Evaluate the application of linear models to understand patterns during data exploration	Evaluate
CO 5	Develop classification and clustering models to categorize and label data effectively	Create
CO 6	Analyze the importance of effective data management and evaluate best practices in documentation skills	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research/investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report/document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	Independently carry out research/investigation and development work to solve practical problems.	2	Laboratory practices, student viva
PO2	Write and present a substantial technical report/document	2	Laboratory Practices, student viva
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3	Laboratory Practices, student viva
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.	3	Laboratory Practices, Mini-Project
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.	2	Laboratory Practices, student viva
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.	3	Laboratory Practices, student viva

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH P0(S):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	✓

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO4	PO 5	PO 6
CO 1	4	2	2	5	4	3
CO 2	4	2	2	5	3	3
CO 3	2	1	2	5	2	2
CO 4	2	2	2	5	3	2
CO 5	2	1	2	5	2	2
CO 6	2	1	2	5	3	3

XII. PERCENTAGE OF KEY COMPETENCIES FOR CO – PO:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	100	100	100	100	80	75
CO 2	100	100	100	100	60	75
CO 3	50	50	100	100	40	50
CO 4	50	100	100	100	60	50
CO 5	50	50	100	100	40	50
CO 6	50	50	100	100	60	75

XIII. COURSE ARTICULATION MATRIX (PO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	2	3
CO 3	2	2	3	3	1	2
CO 4	2	3	3	3	2	2
CO 5	2	2	3	3	1	2

CO 6	2	2	3	3	2	3
TOTAL	**14**	**15**	**18**	**18**	**11**	**15**
AVERAGE	2.5	2.5	3	3	2.5	3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**R AS CALCULATOR APP LICATION**
	a. Using with and without R objects on console b. Using mathematical functions on console c. Write an R script, to create R objects for the calculator application and save them in a specified location in the disk
WEEK II	**DESCRIPTIVE STATISTICS IN R**
	a. Write an R script to find basic descriptive statistics using summary, str, and quartile functions on mtcars and cars data sets. b. Write an R script to find a subset of the dataset by using subset (), and aggregate () functions on the iris dataset.
WEEK III	**READING AND WRITING DIFFERENT TYPES OF DATASETS**
	a. Reading different types of data sets (.txt, .csv) from the web and disk and writing in files in specific disk locations. b. Reading Excel data sheet in R. Readin g XML dataset in R.
WEEK IV	**VISUALIZATIONS**
	a. Find the data distributions using box and scatter plot. b. Find the outliers using plot. c. Plot the histogram, bar chart and pie chart on sample data.

WEEK V	**CORRELATION AND COVARIANCE**
	a. Find the correlation matrix. b. Plot the correlation plot on the dataset and visualize giving an overview of relationships among data on iris data. c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.
WEEK VI	**REGRESSION MODEL**
	Import data from web storage. Name the dataset and now do Logistic Regression to find out the relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained, and rank of the student. Also check whether the model is fit or not. require (foreign), require(MASS).
WEEK VII	**MULTIPLE REGRESSION MODEL**
	Apply multiple regressions, if data have a continuous independent variable. Apply on the above dataset.
WEEK VIII	**REGRESSION MODEL FOR PREDICTION**
	Apply regression Model techniques to predict the data on the above dataset.
WEEK IX	**IMPLEMENT SVM CLASSIFICATION MODEL**
	a. Install relevant package for classification. b. Choose a classifier for the classification problem. c. Evaluate the performance of the classifier.
WEEK X	**IMPLEMENT NAÏVE BAYES CLASSIFICATION MODEL**
	a.Install relevant package for classification. b. Choose a classifier for the classification problem c.Evaluate the performance of the classifier.
WEEK XI	**IMPLEMENT DECISION TREE CLASSIFICATION MODEL**
	a. Install relevant package for classification. b. Choose a classifier for the classification problem. c. Evaluate the performance of the classifier.
WEEK XII	**IMPLEMENT ENSEMBLE CLASSIFICATION MODEL**
	a. IInstall relevant package for classification. b. Choose a classifier for the classification problem. c. Evaluate the performance of the classifier
WEEK XIII	**IMPLEMENT K-MEANS CLUSTERING MODEL**
	a. Clustering algorithms for unsupervised classification. b. Plot the cluster data using R visualizations.

WEEK XIV	**IMPLEMENT DBSCAN CLUSTERING MODEL**
	a. Clustering algorithms for unsupervised classification. b. Plot the cluster data using R visualizations

XV. TEXTBOOKS

1. Yanchang Zhao, "R and Data Mining: Examples and Case Studies", Elsevier, 1st edition, 2012.

XVI. WEB REFERENCE :

1. http://www.r-bloggers.com/how-to-perform-a-logistic-regression-in-r/
2. http://www.ats.ucla.edu/stat/r/dae/rreg.html
3. http://www.coastal.edu/kingw/statistics/R-tutorials/logistic.html
4. http://www.ats.ucla.edu/stat/r/data/binary.csv

XII. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	R AS CALCULATOR ALICATION	CO 1	T1:1.1,1.2
2	DESCRIPTIVE STATISTICS IN R	CO 1	T1:1.1,1.3
3	READING AND WRITING DIFFERENT TYPES OF DATASETS	CO 1	T1:9,1.4
4	VISUALIZATIONS	CO 1	T1:10.1,1.3
5	CORRELATION AND COVARIANCE	CO 2	T1:11.1,1.5
6	REGRESSION MODEL	CO 2	T1:10.1,1.3
7	MULTIPLE REGRESSION MODEL	CO 2	R1:11.2-11.4
8	REGRESSION MODEL FOR PREDICTION	CO 3	R2:9.1,1.6
9	IMPLEMENT SVM CLASSIFICATION MODEL	CO 3	R3:10.2-11.4
10	IMPLEMENT NAÏVE BAYES CLASSIFICATION MODEL	CO 3	R2:9.2-11.4
11	IMPLEMENT DECISION TREE CLASSIFICATION MODEL	CO 4	T1:12,1.9
12	IMPLEMENT ENSEMBLE CLASSIFICATION MODEL	CO 4	T1:1.1,1.5
13	IMPLEMENT K-MEANS CLUSTERING MODEL	CO 5	R2:8.2-11.4
14	IMPLEMENT DBSCAN CLUSTERING MODEL.	CO 6	R3:13.2-11.4

XV EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Substitution Method for Solving Recurrences
2	implementation of the recurrence-tree method for Solving Recurrences
3	Implement the Bellman-Ford Algorithm for solving the Single-Source Shortest Path algorithm
4	implementation of the Floyd-Warshall algorithm using dynamic programming. .
5	implementation of the greedy selection criteria for the Knapsack Problem.

Signature of Course Coordinator **HOD,CSE**
Dr. R M Noorullah, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Computer Science and Engineering**				
Course Title	**Advanced Algorithms**				
Course Code	BCSD13				
Program	M.Tech				
Semester	II				
Course Type	Core				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. N Rajashekhar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC13	IV	Design and analysis of algorithms

II COURSE OVERVIEW:

This course typically aims to equip students with a deep understanding of fundamental algorithmic techniques, their analysis, and their applications in solving complex computational problems. This course includes graph theory, flow networks, and linear programming. Gain an understanding of a wide range of advanced algorithmic problems, and their application to real-world problems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Advanced Algorithms	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

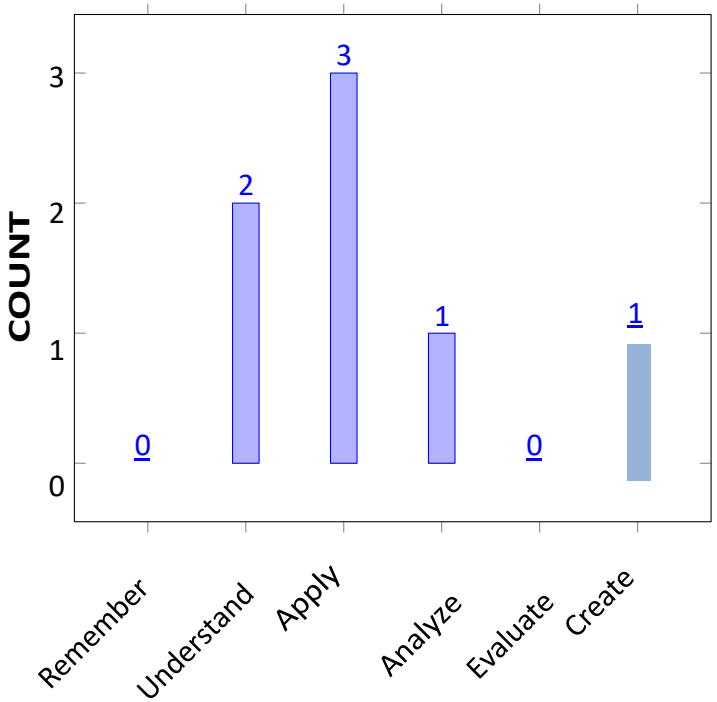
I	The advanced methods of designing and analyzing algorithms.
II	The student should be able to choose appropriate algorithms and use it for a specific problem.
III	Students should be able to understand different classes of problems concerning their computation difficulties.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Make use of appropriate tools and methods to analyze algorithms for optimized solutions	Apply
CO 2	Select appropriate data structures for solving complex algorithmic problems effectively	Apply
CO 3	Apply dynamic programming and greedy techniques to design efficient algorithms for solving optimization challenges, and flow algorithms	Apply
CO 4	Develop solutions for network flow problems using flow network models and techniques	Understand
CO 5	Build solutions to real-world problems using a variety of shortest path and linear programming algorithms	Create
CO 6	Analyze problems into P, NP, NP-Hard, and NP-Complete classes using principles of complexity	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems..
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development
PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments
PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2-	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development	-3	CIE/SEE/AAT
PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.	-3	CIE/SEE/AAT
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	1	CIE/SEE/AAT
PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	2	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	✓	✓	✓	✓
CO2	✓	-	✓	✓	✓	✓
CO3	✓	-	✓	✓	✓	✓
CO4	✓	-	✓	✓	✓	✓
CO5	✓	-	✓	✓	✓	✓
CO6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	**PO 1**	Independently carry out research / investigation and development work to solve practical problems.	**4**
	PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development	**2**
	PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.	**3**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	**2**
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**1**
CO2	**PO 1**	Independently carry out research / investigation and development work to solve practical problems.	**4**
	PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development,	**2**
	PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.	**2**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary	**2**

		environments	
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**2**
CO3	**PO 1**	Independently carry out research / investigation and development work to solve practical problems.	**4**
	PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development,	**2**
	PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.	**3**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	**2**
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**3**
CO4	**PO 1**	Finding the solution of complex engineering problems and extend the efficiencies of same problem using different algorithms in engineering disciplines..	**3**
	PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development,	**2**
	PO 4	Apply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.	**3**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	**2**
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**2**
CO5	**PO 1**	Choose (Pick) greedy algorithms for finding solutions of minimization and maximization problems to support study of their own engineering discipline and methodologies..	**4**

	PO 3	Demonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development,	**2**
	PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	**4**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	**2**
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**2**
CO6	**PO 1**	Apply the knowledge of dynamic programing algorithms for calculating optimized solution of complex Engineering problems by understanding mathematical principles and computer science methodologies	**2**
	PO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies. ,	**2**
	PO 4	Understand the given problem and choose appropriate technique of dynamic programing algorithms for solving the given problem from the provided Information and data in reaching substantiated conclusions by the interpretation of results	**4**
	PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments	**2**
	PO 6	Engage in life-long learning for continuing education in doctoral level studies and professional development.	**2**

Note: For Key Attributes refer **Annexure - I**

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	4		2	3	2	1
CO 2	4		2	2	2	2
CO 3	4		2	3	2	3
CO 4	3		2	3	2	2
CO 5	4		2	4	2	2
CO 6	2		2	4	2	2

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	100	0	100	60	40	25
CO 2	100	0	100	40	40	50
CO 3	100	0	100	60	40	75
CO 4	75	0	100	60	40	50
CO 5	100	0	100	80	40	50
CO 6	50	0	100	80	40	50

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation
1 -5 <C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	3	2	1	1
CO 2	3	0	3	1	1	2
CO 3	3	0	3	2	1	3
CO 4	3	0	3	2	1	2
CO 5	3	0	3	3	1	2
CO 6	2	0	3	3	1	2
TOTAL	**17**	**0**	**18**	**13**	**6**	**12**
AVERAGE	**2.5**	**0**	**3**	**2**	**1**	**2**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**ROLE OF ALGORITHMS IN COMPUTING**
	Role of algorithms in computing ,Analyzing algorithms, Designing Algorithms growth of Functions, Divide and Conquer - The maximum-subarray problem, Strassen's algorithms for matrix multiplication, The substitution method for solving recurrences, The recurrence-tree method for solving recurrence, The master method for solving recursions, Probabilistic analysis, and random analysis
MODULE II	**REVIEW OF DATA STRUCTURES**
	Review of Data Structures- Elementary Data Structures, Hash Tables, Binary Search Trees, and RedBlack Trees.
MODULE III	**ELEMENTS OF DYNAMIC PROGRAMMING**
	Elements of dynamic programming, - Matrix-chain multiplication, Longest common subsequence,Greedy Algorithms - Elements of the greedy strategy, Huffman codes, Amortized Analysis - Aggregate analysis, The accounting method, The potential method, Dynamic tables.
MODULE IV	**FLOW NETWORKS**
	Flow-Networks: Maxflow-min-cut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.
MODULE V	**SHORTTEST PATH IN GRAPHS**
	Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. Linear Programming: Geometry of the feasibility region and Simplex algorithm NP-completeness: Examples, proof of NP-hardness and NP-completeness.

TEXTBOOKS

1. Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithms". The MIT Press, 4 th edition, 2022.
2. Aho, Hopcroft, Ullman "The Design and Analysis of Computer Algorithms", Pearson Education, 7 th edition, 2018..

REFERENCE BOOKS:

1. Kleinberg and Tardos "Algorithm Design", Pearson Education, 2 nd edition, 2016.

WEB REFERENCES

1. https://www.personal.kent.edu/ rmuhamma/Algorithms/algorithm.html

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Role of algorithms in computing,	CO 1	T1: 1.1-1.5
3	Analyzing algorithms	CO 1	T1: 3.2-3.5
4	Designing Algorithms	CO 1	T1: 3.5-3.7
5	Growth of Functions	CO 1	T1: 4.1-4.2
6	Divide and Conquer	CO 1	T1: 4.2-4.3
7	The maximum-subarray problem	CO 1	T1: 4.3-4.4
8	Strassen's algorithms for matrix multiplication	CO 1	T1:5.1-5.2
9	The substitution method for solving recurrences	CO 1	T1:5.2,5.5
10	The recurrence-tree method for solving recurrence	CO 1	T1: 6.1-6.2
11	The master method for solving recursions	CO 1	T1: 6.1-6.2
12	Probabilistic analysis, and random analysis	CO 1	T1: 7.1-7.2
13	Review of Data Structures	CO 2	T1: 7.1-7.2
14	Elementary Data Structures	CO 2	T1: 7.4-7.5
15	Hash Tables	CO 2	T1: 7.4-7.5
16	Binary Search Trees	CO 2	T2: 7.6-8.1
17	and Red Black Trees.	CO 2	T2: 7.6-8.1
18	Elements of dynamic programming	CO 3	T1: 8.2-8.5
19	Matrix-chain multiplication,	CO 3	T1:9.1-9.2
20	Longest common subsequence	CO 3	T1: 9.1-9.2
21	Greedy Algorithms	CO 3	R1:8.4,8.10

22	Elements of the greedy strategy	CO 3	R1:8.4- 10
23	Huffman codes,	CO 3	R1:8.4
24	Amortized Analysis	CO 3	R1: 8.14-8.16
25	Aggregate analysis	CO 3	R1: 8.14-8.16
26	The accounting method	CO 3	R1: 8.16,8.17
27	The potential method	CO 4	R1:8.22
28	Dynamic tables.	CO 4	R1:8. 27
29	Flow-Networks:	CO 4	R1:8. 28
30	Maxflow-min-cut theorem,	CO 4	T2: 2.1-2.2
31	Ford-Fulkerson Method to compute maximum flow	CO 4	T2:2.2-2.4
32	Shortest Path in Graphs	CO 5	T2: 2.1-2.4
33	Floyd-Warshall algorithm and introduction to dynamic programming paradigm.	CO 5	T2:3.1-2.1
34	More examples of dynamic programming.	CO 5	T2: 2.5
35	Linear Programming	CO 5	T2: 2.5
36	Geometry of the feasibility region and Simplex algorithm	CO 5	T2: 2.5,13.4
37	NP-completeness	CO 6	T2: 2.5,13.4
38	Examples,	CO 6	T2: 2.5-2.6
39	proof of NP-hardness and NP-completeness.	CO 6	T2: 13.3
PROBLEM SOLVING/ CASE STUDIES			
47	Analyzing algorithms	CO 1	T1: 1.1-1.5
48	Designing Algorithms	CO 1	T1: 3.2-3.5
49	Flow-Networks:	CO 2	T1: 7.1-7.2
50	Maxflow-min-cut theorem,	CO 2	T1: 7.1-7.2
51	Problems on White collar crimes	CO 3	R2:8.4,8.10
52	Divide and Conquer	CO 3	R2:8.4 - 10
53	The maximum-subarray problem	CO 4	T2: 2.1-2.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Role of algorithms in computing	CO 1	T1: 1.1-1.5
57	Review of Data Structures	CO 2	T1: 7.1-7.2
58	Flow-Networks	CO 3	R2:8.4-10
59	Elements of the greedy strategy	CO 4	T2: 2.1-2.4
60	Shortest Path in Graphs	CO 5	T2: 2.5-2.6

DISCUSSION ON QUESTION BANK			
61	Introduction	CO 1	T1: 1.1-1.5
62	Review of Computer Security and Cybercrime Issues	CO 2	T1: 7.1-7.2
63	Web Hacking Basics and Investigation	CO 3	R2:8.4-10
64	Digital Certificates and Digital Forensics	CO 4	T2: 2.1-2.4
65	Securing Databases, Laws and Acts	CO 5	T2: 2.5-2.6

Course Coordinator
Mr. N Rajashekhar, Assistant Professor

HOD,CSE

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING				
Course Title	ADVANCED COMPUTER ARCHITECTURE				
Course Code	BCSD14				
Program	M.Tech				
Semester	II Semester: CSE				
Course Type	CORE				
Regulation	IARE – MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	0	0
Course Coordinator	Dr. Y Mohana Roopa , Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC07	III	Computer Organization and Architecture

II COURSE OVERVIEW:

This course is designed to provide students with in-depth knowledge of the design principles, organization, and performance evaluation of modern computer systems. It covers the concepts related to modern processor architectures, including pipelining, superscalar processors, out-of-order execution, speculation, and advanced instruction-level parallelism. Equip students for roles in computer engineering, hardware design, system optimization, research, and development in the ever-evolving field of computer systems and architecture.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Advanced Computer Architecture	60 Marks	40 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	White Board	✓	Assignments	✓	MOOC
X	Open Ended Experiments	X	Seminars	X	Mini Project	✓	Videos
✓	Others : Quiz						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). Out of 40 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty

Activities	CIA-I	CIA-II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 marks	10 marks	-	20 marks
Assignment / Quiz	5 marks	5 marks	-	10 marks
Alternative Assessment Tool (AAT)	5 marks	5 marks	-	10 marks
Semester End Examination (SEE)	-	-	60 marks	60 marks
Total Marks				100

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. 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.

Assignment:

To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz:

It is online proctor based online examination conducted either at the end of the CIE1 or CIE2. The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.

Alternative Assessment Tool (AAT):

In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. The AAT may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.

VI COURSE OBJECTIVES:

The students will try to learn:

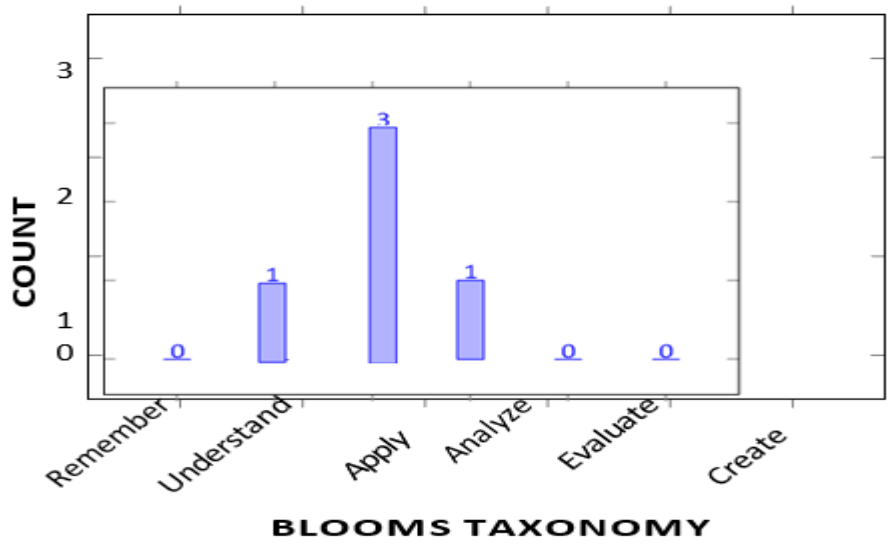
I	The concepts and principles of parallel and advanced computer architectures.
II	The design techniques of Scalable and multithreaded architectures.
III	The concepts and techniques of parallel and advanced computer architectures to design modern computer systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Compare various parallel computer models and program control flows to enable parallel execution.	Understand
CO 2	Utilize the challenges of implementing various forms of parallelism and leverage them to enhance system performance	Apply
CO 3	Apply the concept of memory hierarchy for efficient memory design and virtual memory to overcome the memory wall	Apply
CO 4	Analyze the functioning of pipelining and instruction-level parallelism using static, dynamic, and advanced techniques of scheduling	Analyze
CO 5	Apply parallel and scalable architecture concepts to design and analyze efficient multiprocessor and multicomputer systems	Apply
CO 6	Make use of vector processing techniques to develop efficient computational solutions	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research/investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report/document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO 4	Apply advanced-level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	Independently carry out research/investigation and development work to solve practical problems.	3	CIE/SEE
PO 4	Apply advanced-level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas	2	CIE/SEE
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.	1	CIE/SEE
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.	1	CIE/SEE

3 = High; 2 = Medium; 1 = Low

MAPPING OF EACH CO WITH PO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	-	✓	✓	✓
CO2	✓	-	-	✓	✓	✓
CO3	✓	-	-	✓	✓	✓
CO4	✓	-	-	✓	✓	-
CO5	✓	-	-	✓	✓	-
CO6	✓	-	-	✓	✓	✓

X JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Explain the various functional units of Computer with computer science principles.	3
	PO 4	Evaluate the instruction set architecture based on the cost drivers, integration, manage design process and understand customer needs.	3
	PO 5	Uses simulators/tools to compare models like SIMD, MIMD.	2
	PO 6	Enables scalable system design beneficial in healthcare, weather systems, etc.	1
CO 2	PO 1	Applies foundational knowledge to understand bottlenecks in parallel execution.	3
	PO 4	Focus on improving software reliability, network security or information retrieval systems.	2
	PO 5	Leverages tools like OpenMP, CUDA to improve computation.	2
	PO 6	Addresses societal-scale problems by improving system throughput and responsiveness.	1
CO 3	PO 1	Select appropriate addressing mode for finding effective address of operand using mathematical and computer science principles	3
	PO 4	Utilize Instruction set architecture of processors for designing assembly language programs through laboratory skills and technical literature.	3
	PO 5	Uses architectural simulators or tools to optimize memory usage.	2
	PO 6	Optimizes systems in healthcare, transport, and smart cities using efficient memory techniques.	1
CO 4	PO 1	Explain the concept of data representation by applying mathematical and computer science principles.	2
	PO 4	Communicate effectively in orally and written by comprehend and write effective reports and design documentation with the engineering community by having major focus on clarity on content, Grammar/Punctuation, appropriate References, good Speaking style and depth in subject matter.	3
	PO 5	Uses simulators to visualize and enhance instruction flow.	2

CO 5	**PO 1**	Design control unit by considering various issues and types risk assessment and analysis activity to identify and analyze root causes using computer science principles.	2
	PO 4	Utilize micro instructions for designing assembly language programs through laboratory skills, technical literature, technical uncertainty and quality issues.	3
	PO 5	Uses tools like MPI, system-level simulators for performance tuning.	2
CO 6	**PO 1**	Understands SIMD, vectorization concepts in scientific computing.	3
	PO 4	Analyzes and investigates efficiency in large datasets (e.g., matrices).	2
	PO 5	Implements algorithms using modern tools like Intel AVX, GPUs.	2
	PO 6	Helps in fields like image processing, AI, and climate modeling—impacting society.	1

XI TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
	4	2	2	5	5	4
CO 1	3			3	2	1
CO 2	3			2	2	1
CO 3	3			3	2	1
CO 4	2			3	2	
CO 5	2			3	2	
CO 6	3			2	2	1

XII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
	4	2	2	5	5	4
CO 1	75	0	0	60	40	25
CO 2	75	0	0	40	40	25
CO 3	75	0	0	60	40	25
CO 4	50	0	0	60	40	0
CO 5	50	0	0	60	40	0
CO 6	75	0	0	40	40	25

XIII COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0≤ C≤ 5% – No correlation
1 - 5<C≤ 40% – Low/ Slight
2-40 <C< 60% – Moderate.
3-60 ≤C≤ 100% –Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	0	0	2	1	1
CO 2	3	0	0	1	1	1
CO 3	3	0	0	2	1	1
CO 4	2	0	0	2	1	0
CO 5	2	0	0	2	1	0
CO 6	3	0	0	1	1	1
TOTAL	**16**	**-**	**6**	**10**	**6**	**4**
AVERAGE	**3**	**-**	**0**	**1.5**	**1**	**1**

XIV ASSESSMENT METHODOLOGY DIRECT:

CIA Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	case study	-
Assignments	-	Open Ended Experiments	✓		

XV ASSESSMENT METHODOLOGY INDIRECT:

-	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

XVI SYLLABUS:

MODULE I	**INTRODUCTION**
	Theory of Parallelism, Parallel computer models, The State of Computing, Multiprocessors and multicomputers, Multivector and SIMD Computers, PRAM and VLSI models, Architectural development tracks, Program and network properties, Conditions of parallelism, Program partitioning and Scheduling, Program flow Mechanisms, System interconnect Architectures.
MODULE II	**PRINCIPLES OF SCALABLE PERFORMANCE**
	Principles of Scalable performance, Performance metrics and measures, Parallel Processing applications, Speed up performance laws, Scalability Analysis and Approaches, Hardware Technologies, Processes and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors.
MODULE III	**SHARED MEMORY ORGANIZATIONS**

	Shared-memory organizations, Sequential and weak consistency models, Pipelining and superscalar techniques, Linear Pipeline Processors, Non-Linear Pipeline Processors, Instruction Pipeline design, Arithmetic pipeline design, superscalar pipeline design.
MODULE IV	**PARALLEL AND SCALABLE ARCHITECTURES**
	Parallel and Scalable Architectures, Multiprocessors and multicomputers, Multiprocessor system interconnects, cache coherence and synchronization mechanism, Three Generations of Multicomputer, Message-passing Mechanisms, Multivector and SIMD computers.
MODULE V	**VECTOR PROCESSING PRINCIPLES**
	Vector Processing Principles, Multivector Multiprocessors, Compound Vector processing, SIMD computer Organizations, The connection machine CM-5.

TEXTBOOKS

Kai Hwang "Advanced Computer Architecture" Third Edition, Tata McGraw-Hill, 2016.

REFERENCE BOOKS:

1. Computer Architecture, J.L. Hennessy and D.A. Patterson, 4th Edition, ELSEVIER.
2. Advanced Computer Architectures, S.G.Shiva, Special Indian edition, CRC, Taylor & Francis.
3. Introduction to High-Performance Computing for Scientists and Engineers, G. Hager and G. Wellein, CRC Press, Taylor & Francis Group.
4. Advanced Computer Architecture, D. Sima, T. Fountain, P. Kacsuk, Pearson education.
5. Computer Architecture, B. Parhami, Oxford Univ.Press.

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	
CONTENT DELIVERY (THEORY)			
1	Theory of Parallelism	CO 1	T1:3.1 – 3.3
2	Parallel computer models	CO1	T1:3.4-3.9
3	The State of Computing	CO 1	T1:3.12
4	Multiprocessors and multicomputers	CO 1	T1:3.15
5	Multivector and SIMD Computers, PRAM and VLSI models	CO 2	T1: 4.1 – 4.8
6	Architectural development tracks	CO 3	T1:3.15
7	Program and network properties	CO 3	T1:3.15
8	Conditions of parallelism	CO 3	T1:3.15
9	Program partitioning and Scheduling	CO 3	T1:3.15

10	Program flow Mechanisms, System interconnect Architectures.	CO 4	T1: 6.1 – 6.8
11	Principles of Scalable performance	CO 5	T1:5.1 – 5.5
12	Performance metrics and measures	CO 5	T1:5.6 – 5.8
13	Parallel Processing applications	CO 6	T1 : 9.1 – 9.3
14	Speed up performance laws	CO 6	T1: 9.2 – 9.4
15	Scalability Analysis and Approaches, Hardware Technologies	CO 6	T1:9.5 – 9.7
16	Processes and Memory Hierarchy, Advanced Processor Technology	CO 6	T1:9.8 – 9.13
17	Superscalar and Vector Processors.	CO 6	T1: 10.1-10.3
18	Shared-memory organizations, Sequential and weak consistency models	CO 6	T1:9.8 – 9.13
19	Pipelining and superscalar techniques, Linear Pipeline Processors	CO 6	T1:9.8 – 9.13
20	Non-Linear Pipeline Processors, Instruction Pipeline design, Arithmetic pipeline design, superscalar pipeline design.	CO 6	T1:9.8 – 9.13
21	Parallel and Scalable Architectures, Multiprocessors and multicomputers	CO 5	T1:5.1 – 5.5
22	Multiprocessor system interconnects, cache coherence and synchronization mechanism	CO 5	T1:5.6 – 5.8
23	Three Generations of Multicomputer, Message-passing Mechanisms, Multivector and SIMD computers.	CO 6	T1 : 9.1 – 9.3
24	Vector Processing Principles, Multivector Multiprocessors	CO 6	T1: 9.2 – 9.4
25	Compound Vector processing, SIMD computer Organizations, The connection machine CM-5.	CO 6	T1:9.5 – 9.7
DISCUSSION OF QUESTION BANK			
1	Unit – I: Fundamentals of Multiprocessors and multicomputers	CO 1	T1:3.1-3.3
2	Unit – II: Principles Of Scalable Performance	CO 1	T1:3.5-3.7
3	Unit – III: Shared Memory Organizations	CO 3	T1:8.2-8.6
4	Unit – IV: Parallel And Scalable Architectures	CO 4	T1:6.1-6.3
5	Unit – V: Vector Processing Principles	CO 6	T1:9.1-9.3

Course Coordinator

Dr. Y Mohana Roopa, Professor **HOD,CSE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING**				
Course Title	**CYBER SECURITY**				
Course Code	BCSD15				
Program	M.Tech				
Semester	II				
Course Type	Core				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	J.Thirupathi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITD04	IV	Computer Networks

II COURSE OVERVIEW:

This course focuses on effectively applying analytical and critical thinking to plan and execute security measures to shield an organization's computer systems, networks, and network devices from infiltration and cyber-attacks. Cyber Security course covers topics such as an overview of cybercrimes, computer security, cryptography algorithms, internet hacking and cracking, web hacking, cybercrime investigation, digital forensics and certificates, securing databases, laws, and acts. Provide career opportunities as Cyber Security Analyst, Cyber Security Practitioner, Cyber Defense Analyst, and Information Security Engineer in leading IT and Governmental Organizations.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Cyber Security	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	**x**	MOOC
x	Open Ended Experiments	✓	Seminars	**x**	Mini Project	**x**	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

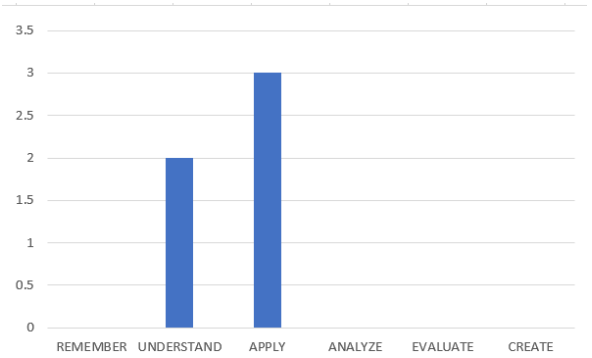
I	Preventing, monitoring, and responding to data breaches and cyber-attacks
II	The core information of assurance principles.
III	The key components of cyber security network architecture.
IV	The cyber security architecture principles

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Choose** relevant web security techniques to prevent and mitigate cyber crime	Understand
CO 2	**Make** use of cryptographic techniques to safeguard systems against unauthorized access and ensure information security**.**	Apply
CO 3	**Demonstrate** cybercrime investigation tools for detecting and recovering the loss in the web domain	Apply
CO 4	**Implement** digital security policies and procedures to effectively handle organizational security risks**.**	Understand
CO 5	**Utilize** cyber laws and regulations to support lawful electronic communication practices	Apply
CO 6	**Implement** secure JDBC and Cyber laws to ensure ethical and legal compliance in cybersecurity	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	3	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program	3	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.	3	CIE/SEE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	✓	✓	✓	✓
CO2	✓	-	✓	✓	✓	✓
CO3	✓	-	✓	✓	✓	✓
CO4	✓	-	✓	✓	✓	✓
CO5	✓	-	✓	✓	✓	✓

CO6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	**PO 1**	**Understand** the concepts of Web Security by applying **Scientific principles and methodology,** identify **types of cybercrime attacks** for interfacing **problems.**	**2**
	PO 3	Analyze the given **problem statement** and **formulate** the attacks in cybercrime and **use creativity** to establish **innovative solutions** for cybercrime attacks, **Interpret** the result on various applications	**2**
	PO 4	**Develop** Cyber Crime investigation tools **Problems** in preprocessors, **implement** advanced arm processor for real time applications	**5**
	PO 5	Work collaboratively in teams to design effective web s multidisciplinary environments.	**4**
	PO 6	Recognize the need for continuous learning in evolving web security techniques and cybercrime trends.	**4**
CO2	**PO 1**	Apply scientific methods to understand cybercrime investigation tools for detecting and recovering losses in the web domain.	**4**
	PO 3	Analyze digital evidence, identify crime patterns, and design investigation approaches using	**2**
	PO 4	Illustrate the concept(knowledge) of Public key cryptography to the solutions of Engineering problems	**4**
	PO 5	Collaborate on cryptographic solutions development in team-based environments, applying professional responsibility.	**5**
	PO 6	Engage in lifelong learning to keep pace with evolving encryption standards and technologies.	**3**
CO3	**PO 1**	**Understand** the concepts of cybercrime investigation tools by applying **Scientific principles and methodology, for detecting and recovering the loss in the web domain.**	**4**
	PO 3	Analyze the given **problem statement** and **formulate** the attacks in cybercrime and **use creativity** to establish **innovative solutions** for cybercrime investigation tools , **Interpret** the result on various applications	**2**

	PO 4	Illustrate the concept(knowledge) of HTTP and HTTPS URL to the solutions of Engineering problems	**4**
	PO 5	Collaborate on cryptographic solutions development in team-based environments, applying professional responsibility.	**4**
	PO 6	Recognize the importance of ongoing education in secure coding, data protection regulations, and ethical cybersecurity practices	**4**
CO4	**PO 1**	Understand the concepts of hashing by applying Scientific principles and methodology , identify types of cybercrime attacks for interfacing problems.	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge.	**2**
	PO 4	Utilize knowledge of HTTP/HTTPS and secure protocols to solve investigation-related problems in cybersecurity.	**5**
	PO 5	Participate as a responsible team member in implementing security policies across departments or organizations.	**4**
	PO 6	Stay updated with tools, laws, and techniques in cyber forensics and investigation through continuous learning	**4**
CO5	**PO 1**	**Understand** the concepts of secure JDBC by applying **Scientific principles and methodology** , identify **types of cybercrime attacks** for interfacing **problems.**	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge.	**2**
	PO 4	Apply technical knowledge in developing secure systems integrating legal standards, JDBC, and compliance protocols.	**5**
	PO 5	Coordinate across IT and legal teams to develop cybersecurity solutions that are technically sound and legally compliant.	**4**
	PO 6	Illustrate the concept(knowledge) of secure JDBC to the solutions of Engineering problems	**3**

CO 6	**PO 1**	Apply legal knowledge and security concepts to ensure lawful electronic communication practices.	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge	**2**
	PO 4	Apply technical knowledge in developing secure systems integrating legal standards, JDBC, and compliance protocols.	**4**
	PO 5	Coordinate across IT and legal teams to develop cybersecurity solutions that are technically sound and legally compliant.	**4**
	PO 6	Recognize the importance of ongoing education in secure coding, data protection regulations, and ethical cybersecurity practices	**3**

Note: For Key Attributes refer **Annexure - I**

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	2	-	2	5	4	4
CO 2	4	-	2	4	5	3
CO 3	4	-	2	4	4	4
CO 4	4	-	2	5	4	4
CO 5	4	-	2	5	4	3
CO 6	4		2	4	4	3

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	50	-	100	100	80	100
CO 2	100	-	100	80	100	75
CO 3	100	-	100	80	80	100
CO 4	100	-	100	100	80	100
CO 5	100	-	100	100	80	75
CO 6	100		100	80	80	75

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being

the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.
0 - 0 ≤ C≤ 5% – No correlation
1 -5 <C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	-	3	3	3	3
CO 2	3	-	3	3	3	3
CO 3	3	-	3	3	3	3
CO 4	3	-	3	3	3	3
CO 5	3	-	3	3	3	3
CO 6	3	-	3	3	3	3
AVERAGE	**2.5**	**-**	**3**	**3**	**3**	**3**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**INTRODUCTION**
	A web security forensic lesson, web languages, introduction to different web attacks, overview of n-tier web applications. Web servers: Apache, IIS, database servers, introduction and overview of cybercrime, nature and scope of cybercrime, types of cybercrime: social engineering, categories of cybercrime, property cybercrime.
MODULE II	**REVIEW OF COMPUTER SECURITY AND CYBERCRIME ISSUES**
	Public key cryptography, RSA, online shopping, payment gateways, unauthorized access to computers, computer intrusions, white collar crimes, viruses, malicious code, internet hacking and cracking, virus attacks, pornography, software piracy, intellectual property, mail bombs, exploitation, stalking and obscenity in the internet, digital laws and legislation, law enforcement roles and responses.
MODULE III	**WEB HACKING BASICS AND INVESTIGATION**

	Web hacking basics HTTP and HTTPS URL, web under the cover overview of java security reading the HTML source, applet security, servlets security, symmetric and asymmetric encryptions, network security basics, firewalls, and IDS. Investigation: Introduction to cybercrime investigation, investigation tools, e-discovery, digital evidence collection, evidence preservation, e-mail investigation, e-mail tracking, IP tracking, e-mail recovery, hands-on case studies; Encryption and Decryption methods, search and seizure of computers, recovering deleted evidence, password cracking. UART and other serial interfaces, PWM, RTC, WDT.
MODULE IV	**DIGITAL CERTIFICATES AND DIGITAL FORENSICS**
	Digital certificates, hashing, message digest, and digital signatures. Digital forensics: Introduction to digital forensics, forensic software and hardware, analysis and advanced tools, forensic technology and practices, forensic ballistics and photography, face, iris, and fingerprint recognition, audio video analysis, windows system forensics, Linux system forensics, network forensics.
MODULE V	**SECURING DATABASES, LAWS AND ACTS**
	Basics, secure JDBC, securing large applications, cyber graffiti; Laws and acts: Laws and ethics, digital evidence controls, evidence handling procedures, basics of Indian Evidence Act IPC and CrPC, electronic communication privacy act, legal policies.

TEXTBOOKS

1. Mc Clure, Stuart, Saumil Shah, Shreeraj Shah, “Web Hacking: Attacks and Defense”, AddisonWesley Professional, Illustrated Edition, 2003.
2. Garms, Jess, Daniel Somerfield, “Professional Java Security”, Word Press, Illustrated Edition, 2001.

REFERENCE BOOKS:

1. Nelson Phillips, Enfinger Steuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi,2009.
2. Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response and Computer Forensics”, Tata McGraw Hill,2009
3. Robert M Slade, “Software Forensics”, Tata McGraw Hill, New Delhi, 1st Edition,2005.

COURSE WEB PAGE:

1. http://www.mail.nih.gov/user/faq/tlsssl.htm
2. http://www.openssl.org/
3. http://www.ntsecurity.net/

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Introduction to web security forensic lesson	CO 1	T1: 1.1-1.5
3	Web languages	CO 1	T1: 3.2-3.5
4	Introduction to different web attacks,	CO 1	T1: 3.5-3.7
5	Overview of n tier web applications.	CO 1	T1: 4.1-4.2
6	Introduction to Apache, IIS	CO 1	T1: 4.2-4.3
7	Database servers,	CO 1	T1: 4.3-4.4
8	Introduction and overview of cybercrime	CO 1	T1:5.1-5.2
9	Nature and scope of cybercrime	CO 1	T1:5.2,5.5
10	Types of cybercrime	CO 1	T1: 6.1-6.2
11	Public key cryptography	CO 1	T1: 6.1-6.2
12	Unauthorized access to computers	CO 2	T1: 7.1-7.2
13	Computer intrusions	CO 2	T1: 7.1-7.2
14	White collar crimes,	CO 2	T1: 7.4-7.5
15	Internet hacking and cracking	CO 2	T1: 7.4-7.5
16	Virus attacks	CO 2	T2: 7.6-8.1
17	Software piracy	CO 2	T2: 7.6-8.1
18	Intellectual property	CO 2	T1: 8.2-8.5
19	Digital laws and legislation	CO 2	T1:9.1-9.2
20	Law enforcement roles and responses.	CO 2	T1: 9.1-9.2
21	Web hacking basics HTTP and HTTPS URL	CO 3	R2:8.4,8.10
22	Web under the cover overview of java security reading the HTML source	CO 3	R2:8.4- 10
23	Applet security	CO 3	R2:8.4
24	Servlets security	CO 3	R2: 8.14-8.16
25	Symmetric and asymmetric encryptions	CO 3	R2: 8.14-8.16
26	Network security basics,	CO 3	R2: 8.16,8.17
27	Firewalls, and IDS	CO 3	R2:8.22
28	Introduction to cybercrime investigation	CO 3	R2:8. 27

29	Digital evidence collection	CO 3	R2:8. 28
30	Encryption and Decryption methods,	CO 4	T2: 2.1-2.2
31	Digital certificates, hashing, message digest, and digital signatures	CO 4	T2:2.2-2.4
32	Introduction to digital forensics	CO 4	T2: 2.1-2.4
33	Forensic software and hardware	CO 4	T2:3.1-2.1
34	Analysis and advanced tools	CO 4	T2: 2.5
35	Forensic technology and practices,	CO 4	T2: 2.5
36	Forensic ballistics and photography	CO 4	T2: 2.5,13.4
37	Windows system forensics series architecture study,	CO 4	T2: 2.5,13.4
38	Basics, secure JDBC, securing large applications	CO 5	T2: 2.5-2.6
39	Cyber graffit	CO 5	T2: 13.3
40	Laws and ethics, digital evidence controls	CO 5	T2:13.6-13.5
41	Evidence handling procedures	CO 5	T2: 13.3-13.4
42	Basics of Indian Evidence Act IPC a	CO 6	T2: 13.5
43	Electronic communication privacy act, legal policies.	CO 6	T2:13.6
44	Linux system forensics	CO 6	T2:13.11-12
45	Network forensics	CO 6	T2:13.11-12
46	IP tracking, e-mail recovery	CO 6	T2:13.12-14
PROBLEM SOLVING/ CASE STUDIES			
47	Problems on Web attack	CO 1	T1: 1.1-1.5
48	Problems on memory Database servers	CO 1	T1: 3.2-3.5
49	Problems on Cybercrime	CO 2	T1: 7.1-7.2
50	Problems on Public key cryptography	CO 2	T1: 7.1-7.2
51	Problems on White collar crimes	CO 3	R2:8.4,8.10
52	Problems on intellectual property	CO 3	R2:8.4 - 10
53	Problems on Web hacking basics HTTP and HTTPS URL	CO 4	T2: 2.1-2.4
54	Problems on symmetric and asymmetric encryptions	CO 5	T2: 2.5-2.6
55	Problems on Digital certificates	CO 6	T2:13.11-12
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Cybercrime	CO 1	T1: 1.1-1.5
57	Viruses and interrupts	CO 2	T1: 7.1-7.2
58	Symmetric and asymmetric encryptions	CO 3	R2:8.4-10
59	Hashing	CO 4	T2: 2.1-2.4
60	Digital forensics	CO 5	T2: 2.5-2.6
DISCUSSION ON QUESTION BANK			
61	Introduction	CO 1	T1: 1.1-1.5

62	Review of Computer Security and Cybercrime Issues	CO 2	T1: 7.1-7.2
63	Web Hacking Basics and Investigation	CO 3	R2:8.4-10
64	Digital Certificates and Digital Forensics	CO 4	T2: 2.1-2.4
65	Securing Databases, Laws and Acts	CO 5	T2: 2.5-2.6

Course Coordinator **HOD,CSE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**COMPUTER SCIENCE AND ENGINEERING**				
Course Title	**CYBER SECURITY**				
Course Code	BCSD15				
Program	M.Tech				
Semester	II				
Course Type	Core				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	J.Thirupathi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITD04	IV	Computer Networks

II COURSE OVERVIEW:

This course focuses on effectively applying analytical and critical thinking to plan and execute security measures to shield an organization's computer systems, networks, and network devices from infiltration and cyber-attacks. Cyber Security course covers topics such as an overview of cybercrimes, computer security, cryptography algorithms, internet hacking and cracking, web hacking, cybercrime investigation, digital forensics and certificates, securing databases, laws, and acts. Provide career opportunities as Cyber Security Analyst, Cyber Security Practitioner, Cyber Defense Analyst, and Information Security Engineer in leading IT and Governmental Organizations.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Cyber Security	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	**x**	MOOC
x	Open Ended Experiments	✓	Seminars	**x**	Mini Project	**x**	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

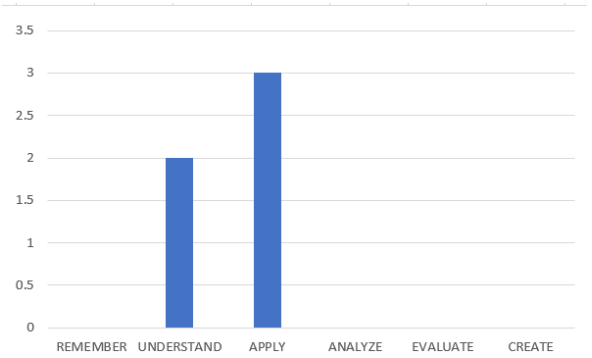
I	Preventing, monitoring, and responding to data breaches and cyber-attacks
II	The core information of assurance principles.
III	The key components of cyber security network architecture.
IV	The cyber security architecture principles

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Choose** relevant web security techniques to prevent and mitigate cyber crime	Understand
CO 2	**Make** use of cryptographic techniques to safeguard systems against unauthorized access and ensure information security**.**	Apply
CO 3	**Demonstrate** cybercrime investigation tools for detecting and recovering the loss in the web domain	Apply
CO 4	**Implement** digital security policies and procedures to effectively handle organizational security risks**.**	Understand
CO 5	**Utilize** cyber laws and regulations to support lawful electronic communication practices	Apply
CO 6	**Implement** secure JDBC and Cyber laws to ensure ethical and legal compliance in cybersecurity	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	3	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program	3	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.	3	CIE/SEE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	✓	✓	✓	✓
CO2	✓	-	✓	✓	✓	✓
CO3	✓	-	✓	✓	✓	✓
CO4	✓	-	✓	✓	✓	✓
CO5	✓	-	✓	✓	✓	✓

CO6	✓	-	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	**PO 1**	**Understand** the concepts of Web Security by applying **Scientific principles and methodology,** identify **types of cybercrime attacks** for interfacing **problems.**	**2**
	PO 3	Analyze the given **problem statement** and **formulate** the attacks in cybercrime and **use creativity** to establish **innovative solutions** for cybercrime attacks, **Interpret** the result on various applications	**2**
	PO 4	**Develop** Cyber Crime investigation tools **Problems** in preprocessors, **implement** advanced arm processor for real time applications	**5**
	PO 5	Work collaboratively in teams to design effective web s multidisciplinary environments.	**4**
	PO 6	Recognize the need for continuous learning in evolving web security techniques and cybercrime trends.	**4**
CO2	**PO 1**	Apply scientific methods to understand cybercrime investigation tools for detecting and recovering losses in the web domain.	**4**
	PO 3	Analyze digital evidence, identify crime patterns, and design investigation approaches using	**2**
	PO 4	Illustrate the concept(knowledge) of Public key cryptography to the solutions of Engineering problems	**4**
	PO 5	Collaborate on cryptographic solutions development in team-based environments, applying professional responsibility.	**5**
	PO 6	Engage in lifelong learning to keep pace with evolving encryption standards and technologies.	**3**
CO3	**PO 1**	**Understand** the concepts of cybercrime investigation tools by applying **Scientific principles and methodology, for detecting and recovering the loss in the web domain.**	**4**
	PO 3	Analyze the given **problem statement** and **formulate** the attacks in cybercrime and **use creativity** to establish **innovative solutions** for cybercrime investigation tools , **Interpret** the result on various applications	**2**

	PO 4	Illustrate the concept(knowledge) of HTTP and HTTPS URL to the solutions of Engineering problems	**4**
	PO 5	Collaborate on cryptographic solutions development in team-based environments, applying professional responsibility.	**4**
	PO 6	Recognize the importance of ongoing education in secure coding, data protection regulations, and ethical cybersecurity practices	**4**
CO4	**PO 1**	Understand the concepts of hashing by applying Scientific principles and methodology , identify types of cybercrime attacks for interfacing problems.	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge.	**2**
	PO 4	Utilize knowledge of HTTP/HTTPS and secure protocols to solve investigation-related problems in cybersecurity.	**5**
	PO 5	Participate as a responsible team member in implementing security policies across departments or organizations.	**4**
	PO 6	Stay updated with tools, laws, and techniques in cyber forensics and investigation through continuous learning	**4**
CO5	**PO 1**	**Understand** the concepts of secure JDBC by applying **Scientific principles and methodology** , identify **types of cybercrime attacks** for interfacing **problems.**	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge.	**2**
	PO 4	Apply technical knowledge in developing secure systems integrating legal standards, JDBC, and compliance protocols.	**5**
	PO 5	Coordinate across IT and legal teams to develop cybersecurity solutions that are technically sound and legally compliant.	**4**
	PO 6	Illustrate the concept(knowledge) of secure JDBC to the solutions of Engineering problems	**3**

CO 6	**PO 1**	Apply legal knowledge and security concepts to ensure lawful electronic communication practices.	**4**
	PO 3	Demonstrate mastery of secure JDBC and legal compliance aspects in cybersecurity systems beyond undergraduate-level knowledge	**2**
	PO 4	Apply technical knowledge in developing secure systems integrating legal standards, JDBC, and compliance protocols.	**4**
	PO 5	Coordinate across IT and legal teams to develop cybersecurity solutions that are technically sound and legally compliant.	**4**
	PO 6	Recognize the importance of ongoing education in secure coding, data protection regulations, and ethical cybersecurity practices	**3**

Note: For Key Attributes refer **Annexure - I**

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	2	-	2	5	4	4
CO 2	4	-	2	4	5	3
CO 3	4	-	2	4	4	4
CO 4	4	-	2	5	4	4
CO 5	4	-	2	5	4	3
CO 6	4		2	4	4	3

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	50	-	100	100	80	100
CO 2	100	-	100	80	100	75
CO 3	100	-	100	80	80	100
CO 4	100	-	100	100	80	100
CO 5	100	-	100	100	80	75
CO 6	100		100	80	80	75

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being

the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.
0 - 0 ≤ C≤ 5% – No correlation
1 -5 <C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	-	3	3	3	3
CO 2	3	-	3	3	3	3
CO 3	3	-	3	3	3	3
CO 4	3	-	3	3	3	3
CO 5	3	-	3	3	3	3
CO 6	3	-	3	3	3	3
AVERAGE	**2.5**	**-**	**3**	**3**	**3**	**3**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**INTRODUCTION**
	A web security forensic lesson, web languages, introduction to different web attacks, overview of n-tier web applications. Web servers: Apache, IIS, database servers, introduction and overview of cybercrime, nature and scope of cybercrime, types of cybercrime: social engineering, categories of cybercrime, property cybercrime.
MODULE II	**REVIEW OF COMPUTER SECURITY AND CYBERCRIME ISSUES**
	Public key cryptography, RSA, online shopping, payment gateways, unauthorized access to computers, computer intrusions, white collar crimes, viruses, malicious code, internet hacking and cracking, virus attacks, pornography, software piracy, intellectual property, mail bombs, exploitation, stalking and obscenity in the internet, digital laws and legislation, law enforcement roles and responses.
MODULE III	**WEB HACKING BASICS AND INVESTIGATION**

	Web hacking basics HTTP and HTTPS URL, web under the cover overview of java security reading the HTML source, applet security, servlets security, symmetric and asymmetric encryptions, network security basics, firewalls, and IDS. Investigation: Introduction to cybercrime investigation, investigation tools, e-discovery, digital evidence collection, evidence preservation, e-mail investigation, e-mail tracking, IP tracking, e-mail recovery, hands-on case studies; Encryption and Decryption methods, search and seizure of computers, recovering deleted evidence, password cracking. UART and other serial interfaces, PWM, RTC, WDT.
MODULE IV	**DIGITAL CERTIFICATES AND DIGITAL FORENSICS**
	Digital certificates, hashing, message digest, and digital signatures. Digital forensics: Introduction to digital forensics, forensic software and hardware, analysis and advanced tools, forensic technology and practices, forensic ballistics and photography, face, iris, and fingerprint recognition, audio video analysis, windows system forensics, Linux system forensics, network forensics.
MODULE V	**SECURING DATABASES, LAWS AND ACTS**
	Basics, secure JDBC, securing large applications, cyber graffiti; Laws and acts: Laws and ethics, digital evidence controls, evidence handling procedures, basics of Indian Evidence Act IPC and CrPC, electronic communication privacy act, legal policies.

TEXTBOOKS

1. Mc Clure, Stuart, Saumil Shah, Shreeraj Shah, “Web Hacking: Attacks and Defense”, AddisonWesley Professional, Illustrated Edition, 2003.
2. Garms, Jess, Daniel Somerfield, “Professional Java Security”, Word Press, Illustrated Edition, 2001.

REFERENCE BOOKS:

1. Nelson Phillips, Enfinger Steuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi,2009.
2. Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response and Computer Forensics”, Tata McGraw Hill,2009
3. Robert M Slade, “Software Forensics”, Tata McGraw Hill, New Delhi, 1st Edition,2005.

COURSE WEB PAGE:

1. http://www.mail.nih.gov/user/faq/tlsssl.htm
2. http://www.openssl.org/
3. http://www.ntsecurity.net/

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Introduction to web security forensic lesson	CO 1	T1: 1.1-1.5
3	Web languages	CO 1	T1: 3.2-3.5
4	Introduction to different web attacks,	CO 1	T1: 3.5-3.7
5	Overview of n tier web applications.	CO 1	T1: 4.1-4.2
6	Introduction to Apache, IIS	CO 1	T1: 4.2-4.3
7	Database servers,	CO 1	T1: 4.3-4.4
8	Introduction and overview of cybercrime	CO 1	T1:5.1-5.2
9	Nature and scope of cybercrime	CO 1	T1:5.2,5.5
10	Types of cybercrime	CO 1	T1: 6.1-6.2
11	Public key cryptography	CO 1	T1: 6.1-6.2
12	Unauthorized access to computers	CO 2	T1: 7.1-7.2
13	Computer intrusions	CO 2	T1: 7.1-7.2
14	White collar crimes,	CO 2	T1: 7.4-7.5
15	Internet hacking and cracking	CO 2	T1: 7.4-7.5
16	Virus attacks	CO 2	T2: 7.6-8.1
17	Software piracy	CO 2	T2: 7.6-8.1
18	Intellectual property	CO 2	T1: 8.2-8.5
19	Digital laws and legislation	CO 2	T1:9.1-9.2
20	Law enforcement roles and responses.	CO 2	T1: 9.1-9.2
21	Web hacking basics HTTP and HTTPS URL	CO 3	R2:8.4,8.10
22	Web under the cover overview of java security reading the HTML source	CO 3	R2:8.4- 10
23	Applet security	CO 3	R2:8.4
24	Servlets security	CO 3	R2: 8.14-8.16
25	Symmetric and asymmetric encryptions	CO 3	R2: 8.14-8.16
26	Network security basics,	CO 3	R2: 8.16,8.17
27	Firewalls, and IDS	CO 3	R2:8.22
28	Introduction to cybercrime investigation	CO 3	R2:8. 27

29	Digital evidence collection	CO 3	R2:8. 28
30	Encryption and Decryption methods,	CO 4	T2: 2.1-2.2
31	Digital certificates, hashing, message digest, and digital signatures	CO 4	T2:2.2-2.4
32	Introduction to digital forensics	CO 4	T2: 2.1-2.4
33	Forensic software and hardware	CO 4	T2:3.1-2.1
34	Analysis and advanced tools	CO 4	T2: 2.5
35	Forensic technology and practices,	CO 4	T2: 2.5
36	Forensic ballistics and photography	CO 4	T2: 2.5,13.4
37	Windows system forensics series architecture study,	CO 4	T2: 2.5,13.4
38	Basics, secure JDBC, securing large applications	CO 5	T2: 2.5-2.6
39	Cyber graffit	CO 5	T2: 13.3
40	Laws and ethics, digital evidence controls	CO 5	T2:13.6-13.5
41	Evidence handling procedures	CO 5	T2: 13.3-13.4
42	Basics of Indian Evidence Act IPC a	CO 6	T2: 13.5
43	Electronic communication privacy act, legal policies.	CO 6	T2:13.6
44	Linux system forensics	CO 6	T2:13.11-12
45	Network forensics	CO 6	T2:13.11-12
46	IP tracking, e-mail recovery	CO 6	T2:13.12-14
PROBLEM SOLVING/ CASE STUDIES			
47	Problems on Web attack	CO 1	T1: 1.1-1.5
48	Problems on memory Database servers	CO 1	T1: 3.2-3.5
49	Problems on Cybercrime	CO 2	T1: 7.1-7.2
50	Problems on Public key cryptography	CO 2	T1: 7.1-7.2
51	Problems on White collar crimes	CO 3	R2:8.4,8.10
52	Problems on intellectual property	CO 3	R2:8.4 - 10
53	Problems on Web hacking basics HTTP and HTTPS URL	CO 4	T2: 2.1-2.4
54	Problems on symmetric and asymmetric encryptions	CO 5	T2: 2.5-2.6
55	Problems on Digital certificates	CO 6	T2:13.11-12
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Cybercrime	CO 1	T1: 1.1-1.5
57	Viruses and interrupts	CO 2	T1: 7.1-7.2
58	Symmetric and asymmetric encryptions	CO 3	R2:8.4-10
59	Hashing	CO 4	T2: 2.1-2.4
60	Digital forensics	CO 5	T2: 2.5-2.6
DISCUSSION ON QUESTION BANK			
61	Introduction	CO 1	T1: 1.1-1.5

62	Review of Computer Security and Cybercrime Issues	CO 2	T1: 7.1-7.2
63	Web Hacking Basics and Investigation	CO 3	R2:8.4-10
64	Digital Certificates and Digital Forensics	CO 4	T2: 2.1-2.4
65	Securing Databases, Laws and Acts	CO 5	T2: 2.5-2.6

Course Coordinator **HOD,CSE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Branch	**Computer Science and Engineering**				
Course Title	**Mining and Massive Datasets**				
Course Code	BCSD20				
Program	M.Tech				
Semester	II				
Course Type	Elective - I				
Regulation	IARE- MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Dr. Ch Srinivasulu Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
M.TECH	BCSD015	I	Mathematical Foundations of Computer Science

II COURSE OVERVIEW:

This course is based on text mining of massive data sets and their applications. Topics include map reduce and the new software stack, applications of similarity search, implementation of stream data, link analysis, handling large data set's, clustering, issues in online advertising, recommendation systems and mining social network graphs

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Mining and Massive Datasets	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	**x**	Assignments	**x**	MOOC
x	Open Ended Experiments	✓	Seminars	**x**	Mini Project	**x**	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). Out of 40 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty

Table 3: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. 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.

Assignment:

To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz:
It is online proctor based online examination conducted either at the end of the CIE1 or CIE2. The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.

Alternative Assessment Tool (AAT):
In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. The AAT may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.

VI COURSE OBJECTIVES:

The students will try to learn:

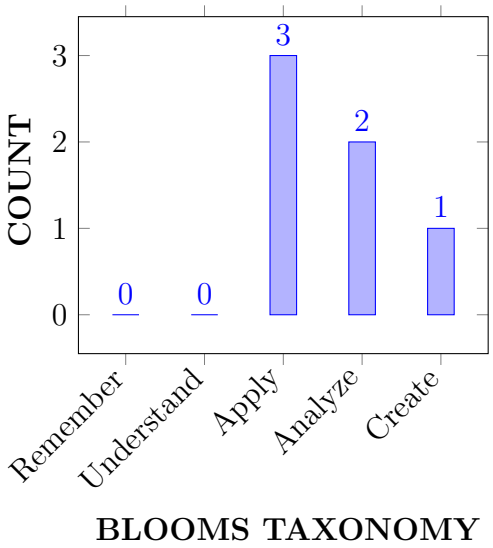
I	This course will cover practical algorithms for solving key problems in mining of massive datasets
II	This course focuses on parallel algorithmic techniques that are used for large datasets.
III	This course will cover stream processing algorithms for data streams that arrive constantly, page ranking algorithms for web search, and online advertisement systems that are studied in detail

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** MapReduce programming model for processing and analyzing massive datasets.	Apply
CO 2	**Design** algorithms for similarity search on streaming data to support large-scale data mining tasks	Create
CO 3	**Implement** frequent itemset mining techniques for discovering patterns in massive streaming data environments	Apply
CO 4	**Apply** clustering and parallel processing approaches to interpret results from streaming applications.	Analyze
CO 5	**Analyze** recommendation system content for online advertising using matching algorithms in web-based environments.	Analyze
CO 6	**Implement** algorithms for mining social network graphs to extract meaningful patterns and insights.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**I**ndependently carry out research / investigation and development work to solve practical problems.
PO 2	**W**rite and present a substantial technical report / document.
PO 3	**D**emonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development
PO 4	**A**pply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.
PO 5	**F**unction effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.
PO 6	**E**ngage in life-long learning for continuing education in doctoral level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**I**ndependently carry out research / investigation and development work to solve practical problems	3	SEE / CIE / QUIZ / AAT
PO 3	**D**emonstrate a degree of mastery in computer science and engineering emerging areas such as data science, cyber security and application development	3	SEE / CIE / QUIZ / AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 4	**A**pply advanced level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas	2	SEE / CIE / QUIZ / AAT
PO 5	**F**unction effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.	2	SEE / CIE / QUIZ / AAT

X MAPPING OF EACH CO WITH PO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓			✓	✓-	
CO 2	✓			✓	✓	
CO 3	✓			✓	✓	
CO 4	✓			✓	✓	
CO 5	✓			✓	✓	
CO 6	✓			✓	✓	

XI JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	4
	PO 3	**Design** modular solutions to **process** big data using distributed programming models.	2
	PO 4	**Identify** and **analyze** architecture of Data mining Apply advanced-level knowledge, techniques, skills ,and modern tools in the field of computer science and engineering and its allied areas. **interpret** applications of datamining	5
	PO 5	**Effective presentation and Speaking Style** on Applications of Data miningand Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multi disciplinary environments.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 6	**Understanding** the societal implications of big data applications enables students to **recognize** how data-driven decisions affect areas like public health (e.g., disease tracking, vaccination planning) and retail **analytics** (e.g., consumer behavior, targeted marketing). It fosters responsible **use of** data and ethical awareness in **technology-driven** environments.	5
CO 2	PO 1	**Understand** Independently carry out research investigation and development work to solve practical problems.**engineering science and mathematical models.**	4
	PO 3	**Develops** efficient data mining algorithms capable of working with **continuous** data streams.	2
	PO 4	**Identify and analyze** advancedlevel knowledge, techniques, skills ,and modern tools in the field of computer science and engineering and its allied areasApply advanced-level knowledge, techniques, skills ,and modern tools in the field of computer science and engineering and its allied areas	5
	PO 5	**Present effectively and Clarity** what is massive datasets and how to prepare them	4
	PO 6	Considers ethical and social issues related to real-time recommendation and personalization.	3
CO 3	PO 1	**Independently carry out research/investigation and development** collection of data for preparing of datasets.	2
	PO 3	Builds real-time itemset mining models (e.g., FP-growth, Apriori) to discover patterns.	2
	PO 4	**Define and analyze** preprocessing of data sets **model translation** the network layer and **implement** it using **principles of mathematics, science and engineering**.	5
	PO 5	**Communicate** effectively and **orally** present on the different types of data sets effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multi disciplinary environments.	4
	PO 6	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	4
CO 4	PO 1	**Independently carry out research / investigation and development work** for network management is explained	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	2
	PO 4	**Identify and analyze** various power management aspects for **model translation** using **principles of mathmatics,science and engineering** to **define** data sets**analyze** conceptual architecture	5
	PO 5	**Communicate** effectively and **orally** present on preparation of data sets	4
	PO 6	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	4
CO 5	PO 1	Using **Independently carry out research / investigation** calculate resynchronization interval and propagation delay of a sensor node	2
	PO 3	Designs parallel processing frameworks for online clustering (e.g., k-means on Spark).	2
	PO4	**Identify and analyze**ranging techniques to **define** various types of localization **solve complex** Clocks and the Synchronization Problems	5
	PO5	**Communicate** effectively and **orally** present on the Time Synchronization Protocols of wireless sensor networks	3
	PO 6	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	3
CO 6	PO 1	**Independently carry out research / investigation** the principles of mathematics, science and engineering to solve the security problems ofdata sets preparation	3
	PO 3	Designs algorithms for large-scale recommender systems in advertising platforms.	2
	PO 4	**Identify and analyze** the aggregation functions by **basic principles of mathematics, science and engineering** to **define** Attacks on Data Aggregation and **Apply** advanced-level knowledge, techniques, skills ,and modern tools in the field of computer science and engineering and its allied areas.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 5	**Communicate** effectively and **orally** Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multi disciplinary environments	2
	PO 6	**Independently carry out research / investigation and development work** towards the principles of data mining**knowledge** for understanding components of data mining-data mining stastical limits on data mining Independently carry out research/investigation and development work to solve practical problems.	2

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4	-	2	5	4	4
CO 2	4	-	2	5	4	3
CO 3	2	-	2	5	4	4
CO 4	2	-	2	5	4	5
CO 5	2	-	2	5	4	5
CO 6	2	-	2	5	3	3

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – PO:

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
	4	2	4	5	5	4
CO 1	100	-	100	100	80	100
CO 2	100	-	100	100	80	75
CO 3	50	-	100	100	80	100
CO 4	50	-	100	100	80	100
CO 5	50	-	100	100	80	100
CO 6	50	-	100	100	60	75

XIV COURSE ARTICULATION MATRIX (PO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	-	3	3	3	3
CO 2	3	-	3	3	3	3
CO 3	2	-	3	3	3	3
CO 4	2	-	3	3	3	3
CO 5	2	-	3	3	3	3
CO 6	2	-	3	3	2	3
TOTAL	**18**	**-**	**-**	**11**	**10**	**-**
AVERAGE	**3**	**-**	**-**	**1.8**	**1.6**	**-**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI SYLLABUS:

UNIT I	**DATA MINING**
	Introduction-Definition of Data Mining-Statistical Limits on Data Mining. Map Reduce and the New Software Stack-Distributed File Systems, Map Reduce, Algorithms Using Map Reduce.
UNIT II	**SIMILARITY SEARCH**
	Finding Similar Items-Applications of Near-Neighbor Search, Shingling of Documents, Similarity Preserving Summaries of Sets, Distance Measures. Streaming Data: Mining Data Streams-The Stream Data Model, Sampling Data in a Stream, Filtering Streams.
UNIT III	**LINK ANALYSIS**
	Page Rank, Efficient Computation of Page Rank, Link Spam. Frequent Item sets- Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream. Clustering-The CURE Algorithm, Clustering in Non- Euclidean Spaces, Clustering for Streams and Parallelism.
UNIT IV	**ADVERTISING ON THE WEB**

	Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Adwords Problem, Adwords Implementation. Recommendation Systems-A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction, The NetFlix Challenge .
UNIT V	**MINING SOCIAL-NETWORK GRAPHS**
	Mining Social-Network Graphs - Social Networks as Graphs, Clustering of Social- Network Graphs, Partitioning of Graphs, Simrank, Counting Triangles.

TEXTBOOKS

1. Jure Leskovec, Anand Rajaraman, Jeff Ullman, Mining of Massive Datasets, 3 rd Edition.

REFERENCE BOOKS:

1. Jiawei Han and Micheline Kamber , Data Mining – Concepts and Techniques 3rd Edition Elsevier
2. Margaret H Dunham, Data Mining Introductory and Advanced topics, PEA.

WEB REFERENCES:

1. http://i.stanford.edu/ ullman/mining/mining.html
2. http://wwww.iare.ac.in

E-TEXT BOOKS:

1. http://www.bookzz.org/
2. http://www.jntubook.com
3. http://www.4shared.com/web/preview/pdf/BhrrT3m0

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Discussion on mapping COs with POs. (OBE)		
	https://lms.iare.ac.in/index?route=course/detailsandcourseid=473		
CONTENT DELIVERY (THEORY)			
1	Definition of Data Mining	CO1	T1:1.1
2	Statistical Limits on Data Mining	CO1	T1:1.2
3	Map Reduce and the New Software Stack	CO1	T1:1.3
4	Distributed File Systems;	CO1	T1:1.4
5	Map Reduce	CO1	T1:1.5
6	Algorithms Using Map Reduce	CO1	T1:1.6
7	Finding Similar Items:	CO2	T1:2.1

8	Applications of Near-Neighbor Search	CO2	T1:2.2
9	Shingling of Documents	CO2	T1:2.3
10	Similarity Preserving Summaries of Sets	CO2	T1:2.4
11	Distance Measures	CO2	T1:2.5
12	Mining Data Streams	CO3	T1:2.6
13	The Stream Data Model C	CO3	T1:2.7
14	Sampling Data in a Stream	CO2	T1:2.8
15	Filtering Streams	CO3	T1:2.9
16	Page Rank	CO3	T1:5.3,
17	Efficient Computation of Page Rank	CO3	T1:3.1
18	Link Spam	CO3	, T1:3.2
19	Handling Larger Datasets in Main Memory	CO3	T1:3.3
20	Limited-Pass Algorithms	CO3	T1:3.4
21	GSM and IS-95 architecture	CO3	T1:3.4.1
22	Counting Frequent Items in a Stream	CO3	T1:3.5
23	The CURE Algorithm	CO3	T1:3.6
24	Clustering in Non-Euclidean Spaces	CO4	T1:3.7
25	Clustering in Non-Euclidean Spaces	CO4	T1:3.8
26	Clustering for Streams and Parallelism.	CO4	T1:3.9
27	Mobility and networking	CO4	T1:3.10
28	On-Line Algorithms802.22	CO4	T1:4.1
29	The Matching Problem	CO5	T1:4.2
30	The Adwords Problem	CO4	T1:4.3
31	Adwords Implementation	CO4	T1:4.4
32	A Model for Recommendation Systems	CO4	T1:4.5
33	Content-Based Recommendations	CO4	T1:4.6
34	Collaborative Filtering	CO4	T1:4.7
35	Dimensionality Reduction	CO4	T1:4.8
36	The NetFlix Challenge.d	CO5	T1:4.9
37	Social Networks as Graphs	CO5	T1:4.10
38	Clustering of Social-Network Graphs	CO5	T1:4.11
39	Partitioning of Graphs	CO5	T1:4.12
40	Sim rank	CO6	T1:5.2
41	Counting Triangles	CO6	T1:5.3
DISCUSSION OF QUESTION BANK			
1	Unit – I: DATA MINING	CO1	T1:1.1-1.12
2	Unit– II: Finding Similar Items-Applications of Near-Neighbor Search	CO2	T1:2.1-2.13
3	Unit – III:Page Rank, Efficient Computation of Page Rank, Link Spam	CO3, CO4	T1:3.1-3.15,

4	Unit – IV: Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Adwords Problem	CO5	T1:4.1-4.15
5	Unit – V: Mining Social-Network Graphs - Social Networks as Graphs	CO6	T1:5.1-5.14

Signature of Course Coordinator **HOD,CSE**
Dr. Ch Srinivasulu Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLET

Department	**Computer Science and Engineering**				
Course Title	**ENGLISH FOR RESEARCH PAPER WRITING**				
Course Code	BHSD02				
Program	M.Tech				
Semester	II				
Course Type	Audit				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	-	-
Course Coordinator	Mr. Ch. Vijayendar Reddy, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

In this course, students will be equipped with the necessary tools to effectively communicate their research findings in a scholarly manner. They will develop the ability to write clear, concise, and well-structured research papers that adhere to academic standards. These skills will not only benefit them in their academic pursuits but also in their future professional careers as researchers, scholars, and professionals in various fields

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
English For Research Paper Writing	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	**x**	MOOC
x	Open Ended Experiments	✓	Seminars	**x**	Mini Project	**x**	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

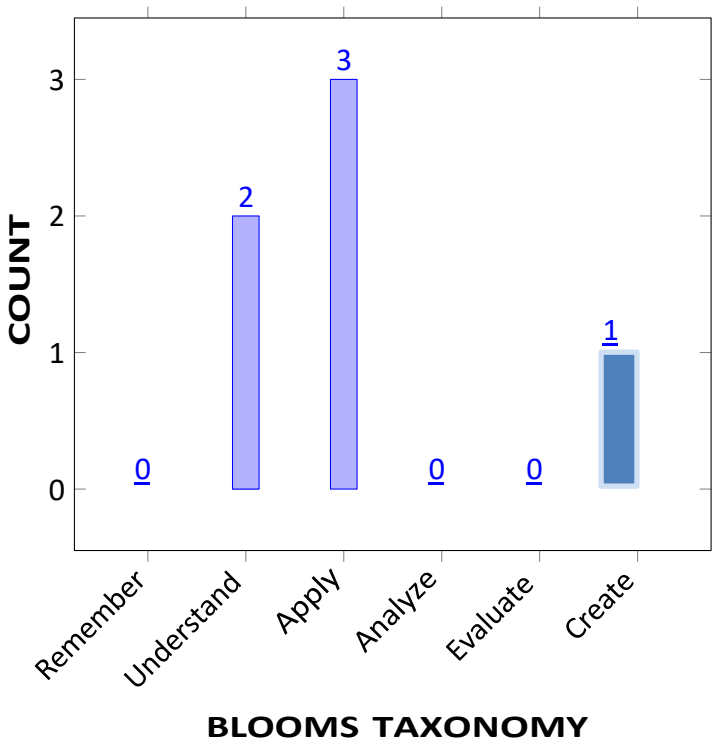
I	How to improve the writing skills and level of readability
II	The methodology that what to write in each section
III	The skills needed when writing a Title Ensure the good quality of paper at very first-time submission

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the technique of determining a research problem for a crucial part of the research study.	Understand
CO 2	**Examine** the way of methods for avoiding plagiarism in research	Understand
CO 3	**Apply** the feasibility and practicality of research methodology for a proposed project	Apply
CO 4	**Make** use of the legal procedure and document for claiming patent of invention	Apply
CO 5	**Identify** different types of intellectual properties, the right of ownership, scope of protection to create and extract value from IP.	Apply
CO 6	**Develop** a well-structured research paper using appropriate language, style, and format suitable for academic and professional publishing standards	Create

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply advanced-level knowledge, techniques, skills, and modern tools in the field of computer science and engineering and its allied areas.
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2	CIE/SEE/AAT
PO 5	Function effectively as a member or leader in diverse teams to carry out development work, and produce solutions that meet the specified needs with frontier technologies in multidisciplinary environments.	1	CIE/SEE/AAT
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.	2	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	-	-	✓	✓
CO2	✓	-	-	-	✓	✓
CO3	✓	-	-	-	✓	✓
CO4	✓	-	-	-	✓	✓
CO5	✓	-	-	-	✓	✓
CO6	✓	-	-	-	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	PO 1	Students learn to define research questions relevant to real-world problems	2
	PO 5	Encourages collaboration and teamwork in framing research issues.	2
	PO 6	Promotes continuous learning for future research challenges.	2
CO2	PO 1	Helps students uphold research ethics and academic integrity.	1
	PO 5	Encourages teamwork with responsible contribution and originality.	2
	PO 6	Reinforces ethical conduct as a lifelong academic value.	1
CO3	PO 1	Applies research methods to real-life problem solving.	2
	PO 5	Supports collaboration in project-based research environments.	1
	PO 6	Encourages continued development in research practices.	1
CO4	PO 1	Encourages understanding of the patent process to sec innovations.	2
	PO 5	Trains students to contribute effectively to interdisciplinary innovation teams.	2
	PO 6	Promotes awareness of intellectual property in lifelong learning.	1
CO5	PO 1	Helps students apply knowledge to protect their work.	2
	PO 5	Encourages application of IP knowledge in collaborative innovation.	1
	PO 6	Promotes engagement with current legal and IP practices relevance.	1

CO 6	**PO 1**	Enables students to structure and articulate research outcomes clearly.	**2**
	PO 5	Fosters effective contribution to documentation and presentations in teams.	**2**
	PO 6	Promotes continuous development in writing for academi growth.	**1**

Note: For Key Attributes refer **Annexure - I**

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	-	-	-	2	2
CO 2	1	-	-	-	2	1
CO 3	2	-	-	-	1	1
CO 4	2	-	-	-	2	1
CO 5	2	-	-	-	1	1
CO 6	2	-	-	-	2	1

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	50	0	0	0	40	50
CO 2	25	0	0	0	40	25
CO 3	50	0	0	0	20	25
CO 4	50	0	0	0	40	25
CO 5	50	0	0	0	20	25
CO 6	50	0	0	0	40	25

XIV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation

1 -5 <C≤ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	0	0	0	1	2
CO 2	1	0	0	0	1	1

CO 3	2	0	0	0	1	1
CO 4	2	0	0	0	1	1
CO 5	2	0	0	0	1	1
CO 6	2	0	0	0	1	1
TOTAL	**9**	**0**	**0**	**0**	**6**	**7**
AVERAGE	**2**	**0**	**0**	**0**	**1**	**1.5**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**Planning and Preparation**
	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
MODULE II	**Abstract**
	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
MODULE III	**Discussion and Conclusions**
	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.
MODULE IV	**Discussion and Conclusions**
	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.
MODULE V	**Quality and Time Maintenance**
	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

TEXTBOOKS

1. Goldbort R, “Writing for Science”, Yale University Press. 2011.
2. Adrian Wallwork, “English for Writing Research Papers”, Springer New York Dordrecht Heidelberg London, 2011.

REFERENCE BOOKS:

1. Highman N, “Handbook of Writing for the Mathematical Sciences”, SIAM Highman’s Book.

COURSE WEB PAGE:

1. 1. http://s http://saba.kntu.ac.ir/eecd/ecourses/Seminar90/2011Papers.pdf

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO’s	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=354
	CONTENT DELIVERY (THEORY)		
2	Planning and Preparation	CO 1	T1: 1.1-1.5
3	Word Order	CO 1	T1: 3.2-3.5
4	breaking up long sentences	CO 1	T1: 3.5-3.7
5	Structuring Paragraphs and Sentences	CO 1	T1: 4.1-4.2
6	Being Concise and Removing Redundancy	CO 1	T1: 4.2-4.3
7	Avoiding Ambiguity and Vagueness	CO 1	T1: 4.3-4.4
8	Clarifying Who Did What	CO 1	T1:5.1-5.2
9	Highlighting Your Findings	CO 1	T1:5.2,5.5
10	Hedging and Criticizing	CO 1	T1: 6.1-6.2
11	Paraphrasing and Plagiarism	CO 1	T1: 6.1-6.2
12	Sections of a Paper	CO 2	T1: 7.1-7.2

13	Abstracts Introduction	CO 2	T1: 7.1-7.2
14	Review of the Literature,	CO 2	T1: 7.4-7.5
15	Methods, Results	CO 2	T1: 7.4-7.5
16	Discussion	CO 2	T2: 7.6-8.1
17	Conclusions	CO 2	T2: 7.6-8.1
18	The Final Checks	CO 2	T1: 8.2-8.5
19	Key skills are needed when writing a Title	CO 2	T1:9.1-9.2
20	key skills are needed when writing an Abstract	CO 2	T1: 9.1-9.2
21	key skills are needed when writing an Introduction	CO 3	R2:8.4,8.10
22	skills needed when writing a Review of the Literature	CO 3	R2:8.4- 10
23	Skills are needed when writing the Methods	CO 3	R2:8.4
24	skills needed when writing the Results	CO 3	R2: 8.14-8.16
25	skills are needed when writing the Discussion	CO 3	R2: 8.14-8.16
26	skills are needed when writing the Conclusions.	CO 3	R2: 8.16,8.17
27	Useful phrases	CO 3	R2:8.22
28	how to ensure paper is as good as it could possibly be the first- time submission.	CO 3	R2:8. 27
29	Overall Equipment Effectiveness (OEE)	CO 3	R2:8. 28
30	Downtime Reduction.	CO 4	T2: 2.1-2.2
31	Asset Management	CO 4	T2:2.2-2.4
32	Energy Efficiency	CO 4	T2: 2.1-2.4
33	Equipment Reliability	CO 4	T2:3.1-2.1
34	Product Quality	CO 4	T2: 2.5
35	Waste Reduction	CO 4	T2: 2.5

Course Coordinator **HOD,CSE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING				
Course Title	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTIMENT SKILSS				
Course Code	BHSD09				
Program	M.Tech				
Semester	III				
Course Type	Elective				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. RM Noorullah, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECD04	III	Computer System Architecture
M.Tech	BCSD13	II	Advanced algorithms

II COURSE OVERVIEW:

Quantum computing is an evolving and complex field that merges concepts from quantum mechanics, computer science, and mathematics. Provide insights into specific quantum algorithms, their advantages over classical algorithms, and their applications in various domains such as cryptography, optimization, and machine learning.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Quantum Computing	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

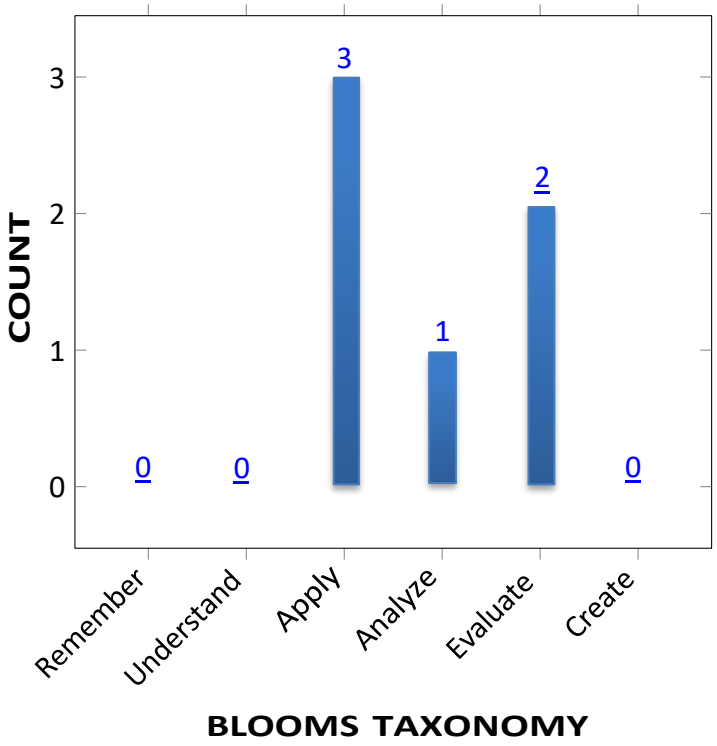
I	The different quantum computing mechanics
II	The indepth of quantum computation theory.
III	Quantum algorithms, and their advantages over classical algorithms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Summarize steps to develop personality with a stable mind, pleasing manners, and determination.	Apply
CO 2	Identify day-to-day work and duties for developing peace and prosperity as depicted in the Geeta.	Apply
CO 3	Formulate the daily lifestyle by depicting the verses from the Bhagavat Geetha	Apply
CO 4	Outline the verses of Shrimad Bhagavad Geetha for holistic development.	Analyze
CO 5	Demonstrates personality development by verses of t h e Bhagavat Geetha	Evaluate
CO 6	Cultivate a positive mind set and the ability to handle stress , failures in real time.	Evaluate

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	2	CIE/SEE/AAT
PO 2	Write and present a substantial technical report / document	0	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program	0	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.	0	CIE/SEE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	1.5	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	-	-	-	✓	✓
CO2	✓	-	-	-	✓	✓
CO3	✓	-	-	-	✓	✓
CO4	✓	-	-	-	✓	✓
CO5	✓	-	-	-	✓	✓
CO6	✓	-	-	-	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	**PO 1**	Apply principles of quantum physics and linear algebra to understand quantum computing fundamentals.	**2**
	PO 5	Use quantum simulators and programming environments such as IBM Q Experience for implementing quantum code.	**2**
	PO 6	Understand the societal and ethical implications of quantum technology applications in cybersecurity, etc.	**2**
CO2	**PO 1**	apply their understanding of quantum theory to implement quantum logic gates and circuit behavior.	**1**
	PO 5	use modern quantum computing tools (like Qiskit or IBM Q) to create and test quantum logic circuits.	**2**
	PO 6	understand how quantum computing solutions can impact encryption, data security, and social systems.	**1**
CO3	**PO 1**	apply fundamental knowledge of quantum mechanics and algorithms to analyze algorithmic efficiency.	**2**
	PO 5	simulate and test quantum algorithms using modern platforms like Qiskit, IBM Q, or other quantum IDEs.	**1**
	PO 6	identify societal benefits and risks of implementing powerful quantum algorithms in domains like cryptography.	**1**
CO4	**PO 1**	apply theoretical concepts of computation and quantum mechanics to understand advanced quantum models.	**2**

	PO 5	model and simulate quantum systems using tools that support theoretical model implementation.	**2**
	PO 6	assess the broader implications of scalable quantum computing models on future technological and social systems.	**1**
CO5	**PO 1**	apply their knowledge of quantum gates and circuits to real-world frameworks and environments.	**2**
	PO 5	effectively use tools like Qiskit, IBM Q Experience, and simulators to program and simulate quantum operations.	**1**
	PO 6	understand the societal and industrial relevance of quantum programming platforms in advancing technology.	**1**
CO 6	**PO 1**	Research and critically evaluate quantum vs classical methods.	**2**
	PO 5	Collaborate in teams to evaluate computational approaches.	**2**
	PO 6	Engage in lifelong learning regarding optimization advancements.	**1**

Note: For Key Attributes refer **Annexure – I**

TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAP- PING:

.

COURSE OUTCOMES	**PROGRAM OUTCOMES**					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4	2	2	4	5	4
CO 2	4	2	2	5	5	4
CO 3	4	2	2	5	5	4
CO 4	4	2	2	5	5	4
CO 5	4	2	2	5	5	4
CO 6	4	2	2	5	5	4

XII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	**PROGRAM OUTCOMES**					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4

CO 1	50	0	0	0	40	50
CO 2	25	0	0	0	40	25
CO 3	50	0	0	0	20	25
CO 4	50	0	0	0	40	25
CO 5	50	0	0	0	20	25
CO 6	50	0	0	0	40	25

XIII COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation

1 -5 <C≤ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	0	0	0	1	2
CO 2	1	0	0	0	1	1
CO 3	2	0	0	0	1	1
CO 4	2	0	0	0	1	1
CO 5	2	0	0	0	1	1
CO 6	2	0	0	0	1	1
TOTAL	**11**	**0**	**0**	**0**	**6**	**7**
AVERAGE	1.83	0.0	0.0	0.0	1.0	1.17

XIV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVI SYLLABUS:

MODULE I	**INTRODUCTION OF QUANTUM COMPUTING AND OVERVIEW**
	History of quantum computation and quantum information, Quantum bits, Multiple qubits, Quantum computation, Single qubit gates, Multiple qubit gates, Measurements in bases other than the computational basis, Quantum circuits, Qubit copying circuit, Example: Bell states, Example: quantum teleportation. Quantum algorithms: Classical computations on a quantum computer, Quantum parallelism, Deutsch's algorithm, The Deutsch–Jozsa algorithm, and Quantum algorithms summarized.
MODULE II	**INTRODUCTION TO COMPUTER SCIENCE**

	Models for computation, Turing machines, Circuits, The analysis of computational problems, How to quantify computational resources, Computational complexity, Decision problems and the complexity classes P and NP, A plethora of complexity classes, Energy and computation, and Perspectives on computer science.
MODULE III	**QUANTUM SEARCH ALGORITHMS**
	The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP-complete problems, Quantum search of an unstructured database, Optimality of the search algorithm, Black box algorithm limits.
MODULE IV	**QUANTUM ERROR-CORRECTION**
	The three-qubit bit flip code, the Three-qubit phase flip code, The Shor code, the Theory of quantum error correction Discretization of the errors, Independent error models, Degenerate codes, The quantum Hamming bound.
MODULE V	**QUANTUM CRYPTOGRAPHY**
	Private key cryptography, Privacy amplification and information reconciliation, Quantum key distribution, Privacy, and coherent information, and security of quantum key distribution.

TEXTBOOKS

1. Nielsen and Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2010.

REFERENCE BOOKS:

1. Scott Aaronson, “Quantum Computing since Democritus”, Cambridge, 2013.
2. Riley Tipton Perry, “Quantum Computing from the Ground Up”, World Scientific Publishing Ltd 2012.
3. V.K Sahni, Quantum Computing (with CD), TATA McGraw-Hill, 2007.

COURSE WEB PAGE:

1. https://fivebooks.com/best-books/quantum-computing-chris-bernhardt/
2. https://philpapers.org/browse/quantum-computation
3. https://link.springer.com/referenceworkentry/10.1007/978-1-4020-8265-8_1230

E-Text Books:

1.https://www.fi.muni.cz/usr/gruska/qbook1.pdf
2.https://library.oapen.org/handle/20.500.12657/48236
3.https://freecomputerbooks.com/Quantum-Computing-for-the-Quantum-Curious.html

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://www.aicte-india.org/sites/default/files/OBE-Manual.pdf
CONTENT DELIVERY (THEORY)			
2	Course Introduction & Motivation	CO1	T1:1-1.2
3	Classical vs Quantum Computing	CO1	T1:1.3-1.6
4	Complex Numbers, Linear Algebra Basics	CO1	T1:2-2.3
5	Vector Spaces, Inner & Outer Product	CO1	T1:2.4-2.7
6	Dirac Notation	CO1	T1:3-3.3
7	Tensor Product & Multi-Qubit States	CO1	T1:3.4-3.7
8	Postulates of Quantum Mechanics (Part 1)	CO1	T1:4-4.2
9	Postulates of Quantum Mechanics (Part 2)	CO1	T1:4.3-4.6
10	Bloch Sphere & Qubit Representation	CO1	T1:5-5.2
11	Superposition and Measurement	CO2	T1:5.3-5.6
12	Quantum Entanglement	CO2	T1:6-6.2
13	Identity, Pauli Gates	CO2	T1:6.3-6.6
14	Hadamard, Phase, S, T Gates	CO2	T1:7-7.2
15	Controlled Gates: CNOT, Toffoli, Fredkin	CO2	T1:7.3-7.6
16	Matrix Representation of Gates	CO3	T1:8-8.2
17	Unitary Operators	CO3	T1:8.3-8.6
18	Quantum Circuit Diagrams	CO3	T1:9-9.2
19	Quantum Circuit Example – Bell State	CO3	T1:9.3-9.6
20	Quantum Teleportation: Concept	CO2, CO3	T1:10-10.2
21	Quantum Teleportation: Circuit	CO3	T1:10.3-10.6
22	No Cloning Theorem	CO1	T1:11-11.2
23	Quantum Measurement Theory	CO2	T1:11.3-11.6
24	Deutsch Algorithm: Theory	CO4	T1:12-12.3
25	Deutsch Algorithm: Circuit	CO4	T1:12.4-12.7
26	Deutsch-Jozsa Algorithm: Concept	CO4	T1:13-13.3
27	Deutsch-Jozsa Algorithm: Simulation	CO4	T1:13.4-13.7
28	Grover's Algorithm: Introduction	CO4	T1:14-14.3

29	Grover's Algorithm: Iterations	CO4	T1:14.4-14.7
30	Quantum Fourier Transform (QFT)	CO4	T1:15-15.3
31	Phase Estimation Algorithm	CO4	T1:15.4-15.7
32	Shor's Algorithm: Background	CO4	T1:16-16.3
33	Shor's Algorithm: Circuit & Logic	CO4	T1:16.4-16.7
34	Quantum Error Correction – Concepts	CO3, CO5	T1:17-17.3
35	Bit Flip & Phase Flip Codes	CO3, CO5	T1:17.4-17.7
36	Quantum Cryptography: BB84 Protocol	CO5	T1:18-18.3
37	Quantum Key Distribution – Security	CO5	T1:18.4-18.7
38	Quantum Programming Frameworks: Qiskit	CO5	T1:19-19.3
39	Qiskit Hands-on: Bell Circuit	CO5	T1:19.4-19.7
40	Quantum Hardware: IBM Q, IonQ, etc.	CO5	T1:20-20.3
41	Quantum Noise & Decoherence	CO5	T1:20.4-20.7
42	Quantum Supremacy: Google Case Study	CO5	T1:21-21.3
43	Current Limitations & Challenges	CO5	T1:21.4-21.7
44	Future Scope & Research Directions	CO5	T1:22-22.3
45	Course Recap & CO Mapping Review	CO1–CO5	T1:22.3-22.6
46	Grover's Algorithm: Iterations	CO4	T1:23-23.3
PROBLEM SOLVING/ CASE STUDIES			
47	Qubit State Design & Measurement	CO1, CO2	T1:2.4-2.7
48	Quantum Gate Sequences	CO2, CO3	T1:4-4.2
49	Quantum Circuit Simulation (Qiskit/Cirq)	CO3, CO5	T1:5.3-5.6
50	Deutsch-Jozsa Case Study	CO3, CO4	T1:9.3-9.6
51	Grover's Algorithm Application	CO4	T1:11.3-11.6
52	Shor's Algorithm Walkthrough	CO4	T1:13-13.3
53	Quantum Error Correction Code Implementation	CO3, CO5	T1:15.4-15.7
54	Quantum Cryptography Case Study	CO5	T1:16-16.3
55	Industry Case Review: IBM Q / Google Sycamore	CO5	T1:12-12.3
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Qubit and Superposition	CO1	T1:1-1.2
57	Entanglement and Tensor Product	CO1	T1:3-4
58	Dirac Notation and State Vectors	CO1, CO3	T1:5-6
59	Quantum Gates Terminology	CO2	T1:9-10
60	Measurement and Circuit Terminology	CO2, CO3	T1:13-15

DISCUSSION ON QUESTION BANK			
61	Quantum Fundamentals & Qubits	CO1	T1:1-3
62	Quantum Gates & Circuits	CO2, CO3	T1:5-7
63	Quantum Algorithms	CO4	T1:9-11
64	Quantum Error Correction & Cryptography	CO3, CO5	T1:13-15
65	Tools, Applications & Review	CO5	T1:1-15

Course Coordinator **HOD,CSE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE ENGINEERING

COURSE DESCRIPTION

Course Title	**ADVANCED ALGORITHMS LABORATORY**				
Course Code	BCSD23				
Program	M.Tech				
Semester	II				
Course Type	Laboratory				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	4	2
Course Coordinator	Mr. J Thirupathi , Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC06	V	Computer Networks

II COURSE OVERVIEW:

This laboratory course offers practical exposure to designing, implementing, and evaluating advanced algorithms across domains such as graph theory, dynamic programming, computational geometry, and NP-complete problems. Through hands-on programming assignments and experimentation, students develop strong analytical and problem-solving skills. The course emphasizes performance analysis, algorithm optimization, and the application of efficient computational techniques to solve real-world problems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Advanced algorithms Laboratory	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). **Semester End Examination (SEE):** The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

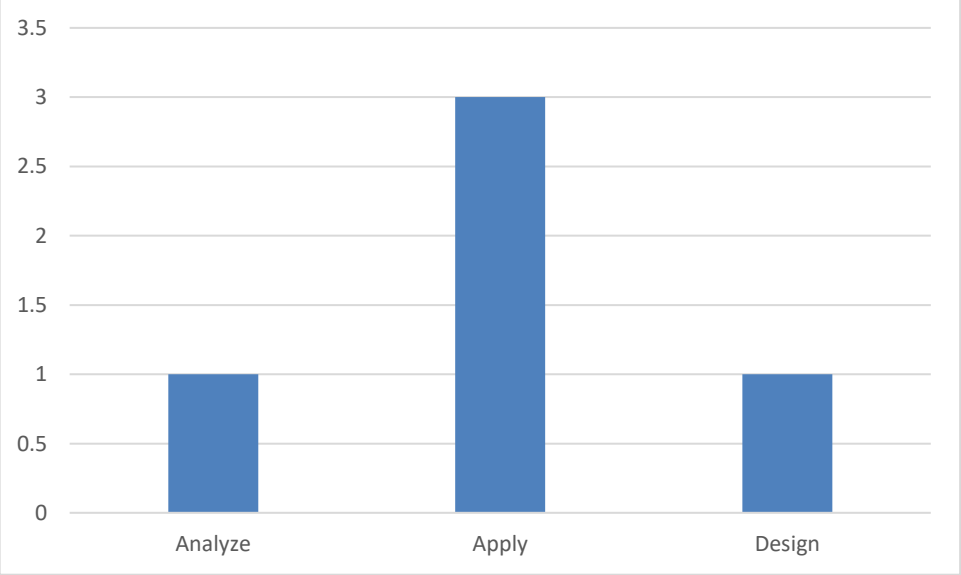
I	Learn to implement cryptographic algorithms to ensure data confidentiality and security.
II	Identify, analyze, and remediate computer security breaches using algorithmic approaches.
III	Understand the importance and application of digital signature algorithms in secure communication.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Implement complex optimization problems using greedy analyze their performance.	Implement
CO 2	Utilize hash-based and tree-based data structures to address diverse problem-solving scenarios	Analyze
CO 3	Design algorithms using the divide and conquer approach and analyze their efficiency in problem-solving.	Apply
CO 4	Develop solutions using dynamic programming and analyze their efficiency in solving optimization problems.	Apply
CO 5	Evaluate the application of flow concepts in Min-Max algorithms for performance analysis	Design
CO 6	Interpret recurrence relations through substitution and recurrence-tree techniques to assess algorithm	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Apply knowledge of mathematics, algorithms, and computer science to implement advanced algorithmic solutions.
PO 2	Identify and analyze complex computational problems to develop optimized and secure algorithms
PO 3	Design scalable and efficient algorithms for real-world applications, including cryptographic techniques
PO 4	Conduct experiments and evaluate algorithm performance using analytical and research-based methods
PO 5	Use modern programming tools and technologies for algorithm development and testing.
PO 6	Understand and address ethical, legal, and societal issues related to algorithm design and data security.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	Apply knowledge of mathematics, algorithms, and computer science to implement advanced algorithmic solutions.	2.5	Laboratory practices, student viva
PO2	Identify and analyze complex computational problems to develop optimized and secure algorithms	3	Laboratory Practices, student viva
PO 3	Design scalable and efficient algorithms for real-world applications, including cryptographic techniques	3	Laboratory Practices, student viva
PO 4	Conduct experiments and evaluate algorithm performance using analytical and research-based methods	2.5	Laboratory Practices, Mini-Project
PO 5	Use modern programming tools and technologies for algorithm development and testing.	1	Laboratory Practices, Mini-Project
PO 6	Understand and address ethical, legal, and societal issues related to algorithm design and data security.	1.5	Laboratory Practices, Mini-Project

3 = High; 2.5 = Medium; 1 = Low

X MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO4	PO 5	PO 6
CO 1	**4**	**2**	**4**	**3**	**2**	**1**
CO 2	**4**	**2**	**4**	**2**	**2**	**2**
CO 3	**4**	**2**	**4**	**3**	**2**	**3**
CO 4	**3**	**2**	**3**	**3**	**2**	**2**
CO 5	**4**	**2**	**4**	**4**	**2**	**2**
CO 6	**2**	**2**	**2**	**4**	**2**	**2**

XI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIII SYLLABUS:

WEEK I	Design and implement an algorithm to solve the maximum-subarray problem with improved time complexity
WEEK II	Develop an efficient implementation of Strassen's algorithm for matrix multiplication. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK III	Develop an efficient implementation of the Substitution Method for Solving Recurrences. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK IV	Develop an efficient implementation of the recurrence-tree method for Solving Recurrences. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK V	Design and implement Red-Black Trees that optimize dynamic operations such as insertions and deletions. Investigate scenarios where the standard Red-Black Tree operations might be suboptimal and propose enhancements to minimize the time complexity of these dynamic operations
WEEK VI	Design and implement binary search Trees that optimize dynamic operations such as insertions and deletions. Investigate scenarios where the standard binary search Tree operations might be suboptimal and propose enhancements to minimize the time complexity of these dynamic operations..
WEEK VII	Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table(HT) of m memory locations with L as the set of memory addresses (2-

	digit) of locations in HT. Let the keys in K and addresses in L are Integers. Design and develop a Program in C that uses the Hash function H: K * L as H(K)=K mod m (remainder method) and implement a hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.
WEEK VIII	Develop an efficient implementation of the matrix chain multiplication using dynamic programming. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK IX	Develop an efficient implementation of the Huffman codes using a greedy strategy. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK X	Implement the Bellman-Ford Algorithm for solving the single-source shortest path algorithm. Write codes to input the graph as a linked list. Here node of the graph should also contain a field to store cost. Check the output for negative cost edges/negative cycles
WEEK XI	Implement of Ford-Fulkerson algorithm for solving the maximum flow problem in a network. Write code to input the network as a directed graph as a linked list. Compute the minimum capacity of the cut in the network. Compare the maximum flow with the capacity of the minimum cut.
WEEK XII	Implement of Edmond- Karp maximum-flow algorithm for solving the maximum flow problem in a network.
WEEK XIII	Develop an efficient implementation of the Floyd-Warshall algorithm using dynamic programming. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity
WEEK XIV	Develop an efficient implementation of the greedy selection criteria for the Knapsack Problem. Investigate techniques to optimize the algorithm's performance in terms of both time and space complexity

REFERENCE BOOKS:

1. Ellis Horowitz, Satraj Sahni and Rajasekharan “Fundamentals of Computer Algorithms”, Universities Press, 2008.
2. Aho, Hopcroft, Ullman "The Design and Analysis of Computer Algorithms", Pearson Education, 2 nd edition, 2018.
3. Kleinberg and Tardos "Algorithm Design", Pearson Education, 2 nd edition, 2016.

WEB REFERENCES:

1. https://www.scribd.com/document/445971276/Advanced-Algorithms-Lab-Manual
2. https://people.iitism.ac.in/~download/lab%20manuals/mathandcomp/Advanced%20Data%20Structures%20And%20Algorithms.pdf

COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Implement symmetric cipher algorithms (AES and RC4)	CO1	T1: 6–6.5
2	Random number generation (subset of digits/alphabet & subset-sum)	CO1	T2: 2.4–2.6
3	RSA algorithm: encryption, decryption, and key generation	CO2	T1: 9–9.3
4	Hash algorithms: SHA-1 and MD5	CO3	T1: 11–11.4
5	Trusted secure web transaction implementation	CO4	T2: 17.1–17.3
6	Digital Signature Standard (DSS) implementation	CO4	T1: 13.1–13.3
7	Diffie-Hellman key exchange algorithm	CO2	T1: 10.4–10.5
8	ElGamal cryptosystem implementation	CO2	T1: 10.3
9	Goldwasser-Micali probabilistic public key system	CO2	T2: 10.6
10	Rabin cryptosystem implementation	CO2	T2: 10.5
11	Kerberos cryptosystem implementation	CO4	T2: 15.2
12	Firewall configuration and verification (ICMP, TCP SYN, IPs)	CO5	T2: 16.4–16.5
13	Network packet analysis using Wireshark	CO5	T2: 18.1–18.2
14	Detecting probe attacks in network flows	CO5	T2: 19.1–19.3

XIV EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Advanced Graph-Based Encryption Algorithms
1	Implement classical encryption techniques such as Caesar, Vigenère, and Playfair ciphers.
2	Perform symmetric key encryption and decryption using AES and RC4.
3	Develop public key cryptosystems including RSA, ElGamal, and Diffie-Hellman key exchange.
4	Implement digital signature schemes using the Digital Signature Standard (DSS).
5	Apply cryptographic hashing techniques using SHA-1 and MD5 algorithms.

Signature of Course Coordinator **HOD,CSE**
Mr. J Thirupathi Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE ENGINEERING

COURSE DESCRIPTION

Course Title	**CYBER SECURITY LABORATORY**				
Course Code	BCSD24				
Program	M.Tech				
Semester	II				
Course Type	Laboratory				
Regulation	MT-23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	4	2
Course Coordinator	Mr. J Thirupathi , Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AITC06	V	Computer Networks

II COURSE OVERVIEW:

This course typically aims to equip students with the knowledge and skills necessary to protect information and information systems from various threats. This course covers public key crypto systems, Kerberos, and firewall mechanisms. The students can gain expertise in information security and contribute to the protection of valuable organizational assets

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Cyber Security Laboratory	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). **Semester End Examination (SEE):** The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

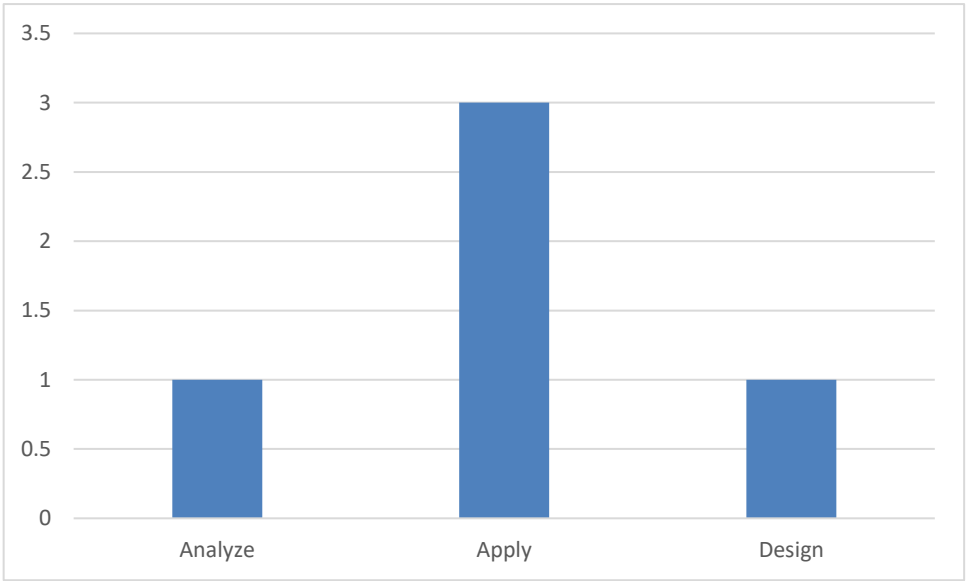
I	How to implement the cryptographic algorithms.
II	How to identify, analyze, and remediate computer security breaches.
III	The importance of digital signature algorithms

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Implement cryptography techniques and attack detection for providing security solutions.	Implement
CO 2	Analyze the impact of public key cryptosystems for secure exchange of information and web transactions	Analyze
CO 3	Experiment with a signature scheme using the Digital signature standard.	Apply
CO 4	Make Use of hashing and authentication for implementing data integrity and develop Kerberos.	Apply
CO 5	Design a firewall for restricting user activities over the network.	Design
CO 6	Apply random number generation techniques for cryptosystems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research/investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report/document.
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	Independently carry out research/investigation and development work to solve practical problems.	3	Laboratory practices, student viva
PO2	Write and present a substantial technical report/document	2	Laboratory Practices, student viva
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3	Laboratory Practices, student viva
PO 4	Identify, formulate and solve real-time problems with advanced-level knowledge, techniques, skills, and modern tools in computer science thrust areas.	3	Laboratory Practices, Mini-Project
PO 5	Function effectively in multidisciplinary environments with the knowledge of frontier technologies by working cooperatively, creatively, and responsively as a member or leader in diverse teams.	3	Laboratory Practices, Mini-Project
PO 6	Engage in life-long learning for continuing education in doctoral-level studies and professional development.	3	Laboratory Practices, Mini-Project

3 = High; 2 = Medium; 1 = Low

X MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO4	PO 5	PO 6
CO 1	**2**	**2**	**2**	**5**	**4**	**4**
CO 2	**4**	**2**	**2**	**4**	**5**	**3**
CO 3	**4**	**2**	**2**	**4**	**4**	**4**
CO 4	**4**	**2**	**2**	**5**	**4**	**4**
CO 5	**4**	**2**	**2**	**5**	**4**	**3**
CO 6	**4**	**2**	**2**	**4**	**4**	**3**

XI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIII SYLLABUS:

WEEK I	**CIPHER ALGORITHM**
	Implement the encryption and decryption of symmetric cipher algorithm (AES and RC4)
WEEK II	**RANDOM NUMBER GENERATION**
	a) Design and implement a Random number generation algorithm using a subset of digits and alphabets. b) Design and implement a Random number generation algorithm using a Subset-sum of numbers
WEEK III	**RSA ALGORITHM**
	a) Implement RSA algorithm for encryption and decryption in C b) In an RSA System, the public key of a given user is e=31, n=3599. Write a program to find the private key of the User.
WEEK IV	**HASH ALGORITHMS**
	Calculate the message digest of a text using the SHA-1 and MD-5 algorithm
WEEK V	**WEB TRANSACTIONS**
	Implement a trusted secure web transaction
WEEK VI	**DIGITAL SIGNATURE ALGORITHM**
	Implement the SIGNATURE SCHEME – Digital Signature Standard.

WEEK VII	**DIFFIE-HELLMAN ALGORITHM**
	Implement the Diffie-Hellman Key Exchange algorithm
WEEK VIII	**CRYPTOSYSTEM**
	Implement of EIGAMAL cryptosystem.
WEEK IX	**PUBLIC KEY SYSTEM**
	Implement of Goldwasser-Micali probabilistic public key system
WEEK X	**CRYPTOSYSTEM**
	Implement of Rabin Cryptosystem
WEEK XI	**KERBEROS**
	Implementation of Kerberos cryptosystem
WEEK XII	**FIREWALL IMPLEMENTATION**
	Configure a firewall to block the following for 5 minutes and verify the correctness of this system using the configured parameters: (a) Two neighborhood IP addresses on your LAN (b) All ICMP requests (c) All TCP SYN Packets.
WEEK XIII	**WIRESHARK**
	Install and analyze the network packets using Wireshark.
WEEK XIV	**PROBE ATTACKS**
	Write an algorithm to detect probe attacks in network flows.

REFERENCE BOOKS:

1. William Stallings "Network Security Essentials (Applications and Standards)" Pearson Education 6 th edition, 2017.
2. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", Cengage Learning, 2011.

WEB REFERENCES:

1. https://www.iiitm.ac.in/index.php/en/information-security-la
2. https://omscs.gatech.edu/cs-6265-information-security-lab
3. https://isec.unige.ch/

COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Implement the encryption and decryption of symmetric cipher algorithm (AES and RC4)	CO 1	T1:1.1,1.2
2	a) Design and implement a Random number generation	CO 6	T1:1.1,1.3

	algorithm using a subset of digits and alphabets. b) Design and implement a Random number generation algorithm using a Subset-sum of numbers		
3	a) Implement RSA algorithm for encryption and decryption in C b) In an RSA System, the public key of a given user is e=31, n=3599. Write a program to find the private key of the User.	CO 2	T1:9,1.4
4	Calculate the message digest of a text using the SHA-1 and MD-5 algorithm	CO 4	T1:10.1,1.3
5	Implement a trusted secure web transaction	CO 2	T1:11.1,1.5
6	Implement the SIGNATURE SCHEME – Digital Signature Standard.	CO 3	T1:10.1,1.3
7	Implement the Diffie-Hellman Key Exchange algorithm	CO 2	R1:11.2-11.4
8	Implement of EIGAMAL cryptosystem.	CO 2	R2:9.1,1.6
9	Implement of Goldwasser-Micali probabilistic public key system	CO 2	R3:10.2-11.4
10	Implement of Rabin Cryptosystem	CO 2	R2:9.2-11.4
11	Implementation of Kerberos cryptosystem	CO 4	T1:12,1.9
12	Configure a firewall to block the following for 5 minutes and verify the correctness of this system using the configured parameters: (a) Two neighborhood IP addresses on your LAN (b) All ICMP requests (c) All TCP SYN Packets.	CO 5	T1:1.1,1.5
13	Install and analyze the network packets using Wireshark.	CO 1	R2:8.2-11.4
14	Write an algorithm to detect probe attacks in network flows.	CO 1	R3:13.2-11.4

XIV EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Cryptography & Encryption
1	Implement Caesar, Vigenère, and Playfair Ciphers
2	AES and RC4 encryption & decryption
3	RSA, El Gamal, and Diffie-Hellman key exchange
4	Digital Signatures using DSS
5	Implement Hashing with SHA-1 and MD5

Signature of Course Coordinator **HOD,CSE**
Mr. J Thirupathi Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	COMPUTER SCIENCE AND ENGINEERING				
Course Title	QUANTUM COMPUTING				
Course Code	BCSD29				
Program	M.Tech				
Semester	III				
Course Type	Elective				
Regulation	MT23				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. RM Noorullah, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECD04	III	Computer System Architecture
M.Tech	BCSD13	II	Advanced algorithms

II COURSE OVERVIEW:

Quantum computing is an evolving and complex field that merges concepts from quantum mechanics, computer science, and mathematics. Provide insights into specific quantum algorithms, their advantages over classical algorithms, and their applications in various domains such as cryptography, optimization, and machine learning.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Quantum Computing	60 Marks	40 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

Theory Course: Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

Semester End Examination (SEE): The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module carries equal weightage 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). Two CIE Tests are Compulsory and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course. The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is manda- tory and the responsibility lies with the concerned course faculty.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIE-1	CIE-2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Assignment / Quiz	5 Marks	5 Marks		10 Marks
Alternative Assessment Tool (AAT)	5 marks	5 marks		10 marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 COURSE OBJECTIVES:

The students will try to learn:

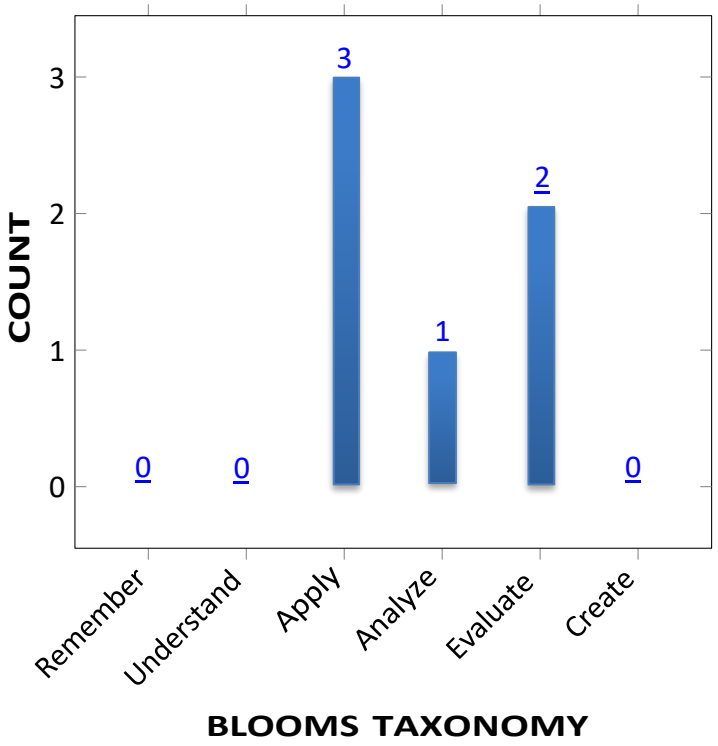
I	The different quantum computing mechanics
II	The indepth of quantum computation theory.
III	Quantum algorithms, and their advantages over classical algorithms.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Demonstrate fundamental quantum computing algorithms and apply them to solve real-world computational problems	Apply
CO 2	Utilize classification methods to address deterministic and non-deterministic problems in the context of quantum computing.	Apply
CO 3	Apply quantum search algorithms to improve the efficiency of solving NP-complete problems using quantum information	Apply
CO 4	Examine the mechanisms of three-qubit phase flip and Shor codes to understand their role in Quantum error detection and correction	Analyze
CO 5	Select suitable cryptographic techniques to secure quantum information against potential threats	Evaluate
CO 6	Evaluate quantum computing techniques in comparison to classical computing for solving real-world optimization problems	Evaluate

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	Independently carry out research / investigation and development work to solve practical problems.
PO 2	Write and present a substantial technical report / document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems.	3	CIE/SEE/AAT
PO 2	Write and present a substantial technical report / document	3	CIE/SEE/AAT
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program	3	CIE/SEE/AAT
PO 4	Apply the skills and knowledge needed to serve as a professional engineer skilful at designing embedded systems for effective use in communications, IoT, medical electronics and signal processing applications.	3	CIE/SEE/AAT
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	CIE/SEE/AAT
PO 6	Recognize the need to engage in lifelong learning through continuing education and research.	3	CIE/SEE/AAT

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Out-comes	PO'S	Justification for mapping (Students will be able to)	No. of Key com-petencies matched.
CO1	PO 1	Apply principles of quantum physics and linear algebra to understand quantum computing fundamentals.	4
	PO 2	Analyze quantum phenomena like superposition and entanglement in computing contexts.	2
	PO 3	Interpret quantum logic gates and circuits to design simple quantum algorithms.	2
	PO 4	Investigate theoretical quantum models and simulate qubits and gates using tools like Qiskit.	4
	PO 5	Use quantum simulators and programming environments such as IBM Q Experience for implementing quantum code.	5
	PO 6	Understand the societal and ethical implications of quantum technology applications in cybersecurity, etc.	4
CO2	PO 1	apply their understanding of quantum theory to implement quantum logic gates and circuit behavior.	4
	PO 2	analyze the functionality of quantum gates and identify their role in solving quantum computational problems.	2
	PO 3	design and build quantum circuits using standard gate operations to perform basic quantum algorithms.	2
	PO 4	simulate and validate the performance of quantum circuits using test cases and analysis tools.	5
	PO 5	use modern quantum computing tools (like Qiskit or IBM Q) to create and test quantum logic circuits.	5

	PO 6	understand how quantum computing solutions can impact encryption, data security, and social systems.	**4**
CO3	**PO 1**	apply fundamental knowledge of quantum mechanics and algorithms to analyze algorithmic efficiency.	**4**
	PO 2	break down quantum algorithms to understand their behavior, performance, and applicability to real problems.	**2**
	PO 3	develop optimized solutions using well-known quantum algorithms for specific search and decision problems.	**2**
	PO 4	evaluate and compare classical vs. quantum algorithms in terms of speed, complexity, and feasibility.	**5**
	PO 5	simulate and test quantum algorithms using modern platforms like Qiskit, IBM Q, or other quantum IDEs.	**5**
	PO 6	identify societal benefits and risks of implementing powerful quantum algorithms in domains like cryptography.	**4**
CO4	**PO 1**	apply theoretical concepts of computation and quantum mechanics to understand advanced quantum models.	**4**
	PO 2	critically analyze differences and trade-offs between classical and quantum computational models.	**2**
	PO 3	conceptualize and evaluate quantum circuits based on model requirements for specific quantum operations.	**2**
	PO 4	investigate the computational limits and behavior of quantum models under various problem scenarios.	**5**
	PO 5	model and simulate quantum systems using tools that support theoretical model implementation.	**5**
	PO 6	assess the broader implications of scalable quantum computing models on future technological and social systems.	**4**

CO5	**PO 1**	apply their knowledge of quantum gates and circuits to real-world frameworks and environments.	**4**
	PO 2	analyze practical quantum programs for correctness, efficiency, and output behavior using simulations.	**2**
	PO 3	design and implement simple quantum circuits using actual cloud-based quantum computing platforms.	**2**
	PO 4	test and debug quantum programs, investigating results and comparing outputs with expected theoretical models.	**5**
	PO 5	effectively use tools like Qiskit, IBM Q Experience, and simulators to program and simulate quantum operations.	**5**
	PO 6	understand the societal and industrial relevance of quantum programming platforms in advancing technology.	**4**
CO 6	**PO 1**	Research and critically evaluate quantum vs classical methods.	**4**
	PO 2	Report analysis of classical and quantum computing trade-offs.	**2**
	PO 3	Display mastery through comparative study of optimization techniques.	**2**
	PO 4	Apply findings in practical optimization system designs.	**5**
	PO 5	Collaborate in teams to evaluate computational approaches.	**5**
	PO 6	Engage in lifelong learning regarding optimization advancements.	**4**

Note: For Key Attributes refer **Annexure – I**

TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAP- PING:

.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	4	2	2	4	5	4
CO 2	4	2	2	5	5	4
CO 3	4	2	2	5	5	4
CO 4	4	2	2	5	5	4
CO 5	4	2	2	5	5	4
CO 6	4	2	2	5	5	4

XII PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	4	2	2	5	5	4
CO 1	100	100	100	80	100	100
CO 2	100	100	100	100	100	100
CO 3	100	100	100	100	100	100
CO 4	100	100	100	100	100	100
CO 5	100	100	100	100	100	100
CO 6	100	100	100	100	100	100

XIII COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0 ≤ C≤ 5% – No correlation

1 -5 <C≤ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3
CO 5	3	3	3	3	3	3
CO 6	3	3	3	3	3	3
TOTAL	**18**	**18**	**18**	**18**	**18**	**18**
AVERAGE	3	3	3	3	3	3

XIV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	✓	Seminars	✓	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVI SYLLABUS:

MODULE I	**INTRODUCTION OF QUANTUM COMPUTING AND OVERVIEW**
	History of quantum computation and quantum information, Quantum bits, Multiple qubits, Quantum computation, Single qubit gates, Multiple qubit gates, Measurements in bases other than the computational basis, Quantum circuits, Qubit copying circuit, Example: Bell states, Example: quantum teleportation. Quantum algorithms: Classical computations on a quantum computer, Quantum parallelism, Deutsch's algorithm, The Deutsch–Jozsa algorithm, and Quantum algorithms summarized.
MODULE II	**INTRODUCTION TO COMPUTER SCIENCE**

	Models for computation, Turing machines, Circuits, The analysis of computational problems, How to quantify computational resources, Computational complexity, Decision problems and the complexity classes P and NP, A plethora of complexity classes, Energy and computation, and Perspectives on computer science.
MODULE III	**QUANTUM SEARCH ALGORITHMS**
	The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP-complete problems, Quantum search of an unstructured database, Optimality of the search algorithm, Black box algorithm limits.
MODULE IV	**QUANTUM ERROR-CORRECTION**
	The three-qubit bit flip code, the Three-qubit phase flip code, The Shor code, the Theory of quantum error correction Discretization of the errors, Independent error models, Degenerate codes, The quantum Hamming bound.
MODULE V	**QUANTUM CRYPTOGRAPHY**
	Private key cryptography, Privacy amplification and information reconciliation, Quantum key distribution, Privacy, and coherent information, and security of quantum key distribution.

TEXTBOOKS

1. Nielsen and Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2010.

REFERENCE BOOKS:

1. Scott Aaronson, “Quantum Computing since Democritus”, Cambridge, 2013.
2. Riley Tipton Perry, “Quantum Computing from the Ground Up”, World Scientific Publishing Ltd 2012.
3. V.K Sahni, Quantum Computing (with CD), TATA McGraw-Hill, 2007.

COURSE WEB PAGE:

1. https://fivebooks.com/best-books/quantum-computing-chris-bernhardt/
2. https://philpapers.org/browse/quantum-computation
3. https://link.springer.com/referenceworkentry/10.1007/978-1-4020-8265-8_1230

E-Text Books:

1.https://www.fi.muni.cz/usr/gruska/qbook1.pdf
2.https://library.oapen.org/handle/20.500.12657/48236
3.https://freecomputerbooks.com/Quantum-Computing-for-the-Quantum-Curious.html

XVII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://www.aicte-india.org/sites/default/files/OBE-Manual.pdf
	CONTENT DELIVERY (THEORY)		
2	Course Introduction & Motivation	CO1	T1:1-1.2
3	Classical vs Quantum Computing	CO1	T1:1.3-1.6
4	Complex Numbers, Linear Algebra Basics	CO1	T1:2-2.3
5	Vector Spaces, Inner & Outer Product	CO1	T1:2.4-2.7
6	Dirac Notation	CO1	T1:3-3.3
7	Tensor Product & Multi-Qubit States	CO1	T1:3.4-3.7
8	Postulates of Quantum Mechanics (Part 1)	CO1	T1:4-4.2
9	Postulates of Quantum Mechanics (Part 2)	CO1	T1:4.3-4.6
10	Bloch Sphere & Qubit Representation	CO1	T1:5-5.2
11	Superposition and Measurement	CO2	T1:5.3-5.6
12	Quantum Entanglement	CO2	T1:6-6.2
13	Identity, Pauli Gates	CO2	T1:6.3-6.6
14	Hadamard, Phase, S, T Gates	CO2	T1:7-7.2
15	Controlled Gates: CNOT, Toffoli, Fredkin	CO2	T1:7.3-7.6
16	Matrix Representation of Gates	CO3	T1:8-8.2
17	Unitary Operators	CO3	T1:8.3-8.6
18	Quantum Circuit Diagrams	CO3	T1:9-9.2
19	Quantum Circuit Example – Bell State	CO3	T1:9.3-9.6
20	Quantum Teleportation: Concept	CO2, CO3	T1:10-10.2
21	Quantum Teleportation: Circuit	CO3	T1:10.3-10.6
22	No Cloning Theorem	CO1	T1:11-11.2
23	Quantum Measurement Theory	CO2	T1:11.3-11.6
24	Deutsch Algorithm: Theory	CO4	T1:12-12.3
25	Deutsch Algorithm: Circuit	CO4	T1:12.4-12.7
26	Deutsch-Jozsa Algorithm: Concept	CO4	T1:13-13.3
27	Deutsch-Jozsa Algorithm: Simulation	CO4	T1:13.4-13.7
28	Grover's Algorithm: Introduction	CO4	T1:14-14.3

29	Grover's Algorithm: Iterations	CO4	T1:14.4-14.7
30	Quantum Fourier Transform (QFT)	CO4	T1:15-15.3
31	Phase Estimation Algorithm	CO4	T1:15.4-15.7
32	Shor's Algorithm: Background	CO4	T1:16-16.3
33	Shor's Algorithm: Circuit & Logic	CO4	T1:16.4-16.7
34	Quantum Error Correction – Concepts	CO3, CO5	T1:17-17.3
35	Bit Flip & Phase Flip Codes	CO3, CO5	T1:17.4-17.7
36	Quantum Cryptography: BB84 Protocol	CO5	T1:18-18.3
37	Quantum Key Distribution – Security	CO5	T1:18.4-18.7
38	Quantum Programming Frameworks: Qiskit	CO5	T1:19-19.3
39	Qiskit Hands-on: Bell Circuit	CO5	T1:19.4-19.7
40	Quantum Hardware: IBM Q, IonQ, etc.	CO5	T1:20-20.3
41	Quantum Noise & Decoherence	CO5	T1:20.4-20.7
42	Quantum Supremacy: Google Case Study	CO5	T1:21-21.3
43	Current Limitations & Challenges	CO5	T1:21.4-21.7
44	Future Scope & Research Directions	CO5	T1:22-22.3
45	Course Recap & CO Mapping Review	CO1–CO5	T1:22.3-22.6
46	Grover's Algorithm: Iterations	CO4	T1:23-23.3
PROBLEM SOLVING/ CASE STUDIES			
47	Qubit State Design & Measurement	CO1, CO2	T1:2.4-2.7
48	Quantum Gate Sequences	CO2, CO3	T1:4-4.2
49	Quantum Circuit Simulation (Qiskit/Cirq)	CO3, CO5	T1:5.3-5.6
50	Deutsch-Jozsa Case Study	CO3, CO4	T1:9.3-9.6
51	Grover's Algorithm Application	CO4	T1:11.3-11.6
52	Shor's Algorithm Walkthrough	CO4	T1:13-13.3
53	Quantum Error Correction Code Implementation	CO3, CO5	T1:15.4-15.7
54	Quantum Cryptography Case Study	CO5	T1:16-16.3
55	Industry Case Review: IBM Q / Google Sycamore	CO5	T1:12-12.3
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Qubit and Superposition	CO1	T1:1-1.2
57	Entanglement and Tensor Product	CO1	T1:3-4
58	Dirac Notation and State Vectors	CO1, CO3	T1:5-6
59	Quantum Gates Terminology	CO2	T1:9-10
60	Measurement and Circuit Terminology	CO2, CO3	T1:13-15

DISCUSSION ON QUESTION BANK			
61	Quantum Fundamentals & Qubits	CO1	T1:1-3
62	Quantum Gates & Circuits	CO2, CO3	T1:5-7
63	Quantum Algorithms	CO4	T1:9-11
64	Quantum Error Correction & Cryptography	CO3, CO5	T1:13-15
65	Tools, Applications & Review	CO5	T1:1-15

Course Coordinator **HOD,CSE**