RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details

of

B.Tech (Mathematics and Computing) Degree Programme

Program Code: 412

Batch: 2022-26

Department of Computer Science and Engineering
Faculty of Engineering and Technology
M S Ramaiah University of Applied Sciences

Registrar
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore-560054

University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society
2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society
3. To promote health, human well-being and provide holistic healthcare
4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences
5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business
6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in
7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes

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Programme Specifications: B. Tech. (Mathematics and Computing)

Faculty	Engineering and Technology
Department	Computer Science and Engineering
Programme Code	412
Programme Name	B. Tech. (Mathematics and Computing)
Dean of the Faculty	Prof. Dilip Kumar Mahanty
Head of the Department	Dr. T. P. Pushphavathi

1. **Title of the Award:** B. Tech. (Mathematics and Computing)
2. **Mode of Study:** Full-Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Engineering and Technology, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications:** November 2021
7. **Date of Programme Approval by the Academic Council of MSRUAS:** 15th November 2021
8. **Next Review Date:** May 2025
9. **Programme Approving Regulating Body and Date of Approval:** All India Council for Technical Education, New Delhi, 2nd July 2021
10. **Programme Accredited Body and Date of Accreditation:** Not Applicable
11. **Grade Awarded by the Accreditation Body:** Not Applicable
12. **Programme Accreditation Validity:** Not Applicable
13. **Programme Benchmark:** Not Applicable
14. **Rationale for the Programme**

Data clearly indicates the need for professionals and scientists in industry and R&D establishments in the areas of theoretical computer science to apply appropriate mathematical tools to design innovative algorithms for various problems, to solve scientific, financial and management problems using appropriate mathematical models as the basis for computer algorithms and also in driving innovations in computational models and computer architecture based on practical experience in solving complex problems.

In order to be ready for solving various problems in science, technology and business in the 21st century, students need a programme such as B. Tech. in Mathematics and Computing to not only study and investigate into traditional models of computation such as the Turing Machine or Lambda Calculus but also to gain an edge by early initiation into Quantum Computing along with the required practical knowledge gained from experimentation and implementation.

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15. Programme Mission

The purpose of the programme is to create innovative problem solvers in multi-disciplinary settings, entrepreneurs and leaders that apply their knowledge, understanding, cognitive abilities, practical skills and transferable skills gained through systematic, flexible and rigorous learning in the chosen academic domain.

16. Gradate Attributes (GAs)

GA-1. Engineering knowledge: Ability to apply knowledge of mathematics, science, and Engineering fundamentals to solve complex problems in engineering

GA-2. Problem Analysis: Ability to analyse engineering problems, interpret data and arrive at meaningful conclusions involving mathematical inferences

GA-3. Design and Development of Solutions: Ability to design an engineering system, component, or process to meet desired needs considering public health and safety, and the cultural, societal, and environmental considerations

GA-4. Conduct Instigations of Complex Problems: Ability to understand and solve complex engineering problems by conducting experimental investigations

GA-5. Modern Tool Usage: Ability to apply appropriate tools and techniques and understand utilization of resources appropriately to complex engineering activities

GA-6. The Engineer and Society: Ability to understand the effect of engineering solutions on legal, cultural, social, and public health and safety aspects

GA-7. Environment and Sustainability: Ability to develop sustainable solutions and understand their effect on society and environment

GA-8. Ethics: Ability to apply ethical principles to engineering practices and professional responsibilities

GA-9. Individual and Teamwork: Ability to work as a member of a team, to plan and to integrate knowledge of various engineering disciplines and to lead teams in multidisciplinary settings

GA-10. Communication: Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

GA-11. Project Management and Finance: Ability to lead and manage multidisciplinary teams by applying engineering and management principles

GA-12. Life-long learning: Ability to adapt to the changes and advancements in technology and engage in independent and life-long learning

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17. Programme Outcomes (POs)

B. Tech. graduates will be able to:

PO-1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO-2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO-3. Design solutions for complex engineering problems and design system componentsor processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

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

PO-5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineeringactivities with an understanding of the limitations

PO-6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO-7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO-8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO-9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO-10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO-11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO-12. Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

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18. Programme Goal

The goal of the programme is to produce graduates having critical, analytical and problem-solving skills, and ability to think independently, and to pursue a career in mathematics and computing

19. Program Educational Objectives (PEOs)

The objectives of the B. Tech. (Mathematics and Computing) Programme are to:

PEO-1. Provide students with a strong foundation in mathematics and computing along with breadth and foundational requirement in computing, science, engineering and humanities to enable them to devise and deliver efficient and safe solutions to challenging problems in Computer Science and inter-disciplinary areas

PEO-2. Impart analytic and cognitive skills required to develop innovative solutions for R&D, to build creative, dependable and safe products for Industry based on dynamic societal requirements motivated and nurtured by sound theoretical and practical knowledge of time tested and long lasting principles of computer science, current tools and technologies

PEO-3. Develop managerial and entrepreneurial skills inculcating strong human values along with social, interpersonal and leadership skills required for professional success in evolving global professional environments

20. Programme Specific Outcomes (PSOs)

At the end of the B. Tech. (Mathematics and Computing) Programme, the graduate will be able to:

PSO-1. Apply principles and best practices in design of efficient algorithms and correct programs; build reliable, secure and robust software, making use of knowledge of computer architecture, systems software , networking, Web technologies distributed computing

PSO-2. Use knowledge gained in both breadth courses in science and engineering and depth courses in mathematics and computing , solving problems of relevance to society, industry and R&D in an innovative manner

PSO-3. Engage in life long learning by applying knowledge of fields of computer science and refining it and evangelizing applications and technologies to all interested communities

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21. Programme Structure

Semester 1 (Physics Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTB101A	Engineering Mathematics-1	3	1	0	4	100
2	PYB102A	Engineering Physics and Laboratory	3	0	2	4	100
3	CEF101A	Engineering Mechanics	3	0	0	3	100
4	ECF102A	Elements of Electronics Engineering and Laboratory	3	0	2	4	100
5	MEF103A	Engineering Drawing	2	0	2	3	100
6	LAN101A	Constitution, Human Rights and Law	2	0	0	2	50
		Total	**16**	**1**	**6**	**20**	**550**
Total number of contact hours per week			**23**				

Semester 1 (Chemistry Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTB102A	Engineering Mathematics-1	3	1	0	4	100
2	CYB104A	Engineering Chemistry and Laboratory	3	0	2	4	100
3	MEF104A	Elements of Mechanical Engineering and Work shop Practice	2	0	2	3	100
4	EEF105A	Elements of Electrical Engineering and Laboratory	3	0	2	4	100
5	CSF106A	Elements of Computer Science and Engineering and Laboratory	3	0	2	4	100
6	TSN102A	Professional Communication	0	0	2	2	50
		Total	**14**	**1**	**10**	**21**	**550**
Total number of contact hours per week			**25**				

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Semester 2 (Physics Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTB102A	Engineering Mathematics-2	3	1	0	4	100
2	PYB102A	Engineering Physics and Laboratory	3	0	2	4	100
3	CEF101A	Engineering Mechanics	3	0	0	3	100
4	ECF102A	Elements of Electronics Engineering and Laboratory	3	0	2	4	100
5	MEF103A	Engineering Drawing	2	0	2	3	100
6	LAN101A	Constitution, Human Rights and Law	2	0	0	2	50
Total			16	1	6	20	550
Total number of contact hours per week			23				

Semester 2 (Chemistry Cycle)							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTB102A	Engineering Mathematics-2	3	1	0	4	100
2	CYB104A	Engineering Chemistry and Laboratory	3	0	2	4	100
3	MEF104A	Elements of Mechanical Engineering and Work shop Practice	2	0	2	3	100
4	EEF105A	Elements of Electrical Engineering and Laboratory	3	0	2	4	100
5	CSF106A	Elements of Computer Science and Engineering and Laboratory	3	0	2	4	100
6	TSN102A	Professional Communication	0	0	2	2	50
Total			14	1	10	21	550
Total number of contact hours per week			23				

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Semester 3							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MCC201A	Complex Analysis and Vector Calculus	3	1	0	4	100
2	MCC202A	Probability and Statistics	3	0	0	3	100
3	CSC201A	Discrete Mathematics	3	1	0	4	100
4	CSD201A	Data Structures Foundation	3	0	0	3	100
5	CSD202A	Logic Design	3	1	0	4	100
6	BAU201A	Innovation and Entrepreneurship	3	0	0	3	100
7	CSL204A	Python & Data Structures Laboratory	0	0	2	1	50
		Total	**18**	**3**	**2**	**22**	**650**
Total number of contact hours per week			**23**				

Semester 4							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MCC203A	Inferential Statistics	3	1	0	4	100
2	MCC204A	Integral transforms	3	1	0	4	100
3	MCC205A	Linear Algebra	3	0	0	3	100
4	CSD206A	Design and Analysis of Algorithms	3	0	0	3	100
5	CSC209A	Formal Languages and Automata Theory	3	0	0	3	100
6	CSD207A	Programming Paradigms	3	1	0	4	100
7	BTN101A	Environmental Studies	2	0	0	2	50
8	MCL201A	Mathematics and Computing Laboratory	0	0	2	1	50
9	CSL208A	Programming Paradigms Laboratory	0	0	2	1	50
		Total	**20**	**3**	**4**	**25**	**700**
Total number of contact hours per week			**27 Hours**				

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Semester 5							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MCC301A	Optimization Techniques	3	1	0	4	100
2	MCC302A	Partial Differential Equations	3	1	0	4	100
3	MCC303A	Applications of Probability and Statistics in Finance	3	0	0	3	100
4	CSD301A	Computer Networks	3	0	0	3	100
5	CSD203A	Microprocessors and Architecture	3	0	0	3	100
6	AID201A	Principles of Artificial Intelligence	3	0	0	3	100
7	AIL202A	Artificial Intelligence Laboratory	0	0	2	1	50
8	CSL301A	Computer Networks Laboratory	0	0	2	1	50
9	CSD205A	Microprocessors Laboratory	0	0	2	1	50
		Total	**18**	**2**	**6**	**23**	**750**
		Total number of contact hours per week	**26**				

Semester 6							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	CSC305A	Graph Theory and Optimization	3	0	0	3	100
2	CSC306A	Information Security and Protection	3	1	0	4	100
3	MCC309A	Quantum Computing	3	1	0	4	100
4	AIC203A	Machine Learning – I	3	1	0	4	100
5	MCC310A	Parallel Algorithms for Scientific Computing	3	0	0	3	100
6	xxxxxxx	Professional Core Elective-1 or Online Course	3	1	0	4	100
7	CSS301A	Seminar	0	0	2	1	50
8	MCL301A	Numerical Analysis Laboratory	0	0	2	1	50
		Total	**18**	**4**	**4**	**24**	**700**
		Total number of contact hours per week	**26**				

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Semester 7							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	xxxxxxx	Professional Core Elective-2 **or** Online Course	3	1	0	4	100
2	xxxxxxx	Professional Core Elective-3 **or** Online Course	3	1	0	4	100
3	xxxxxxx	Open Elective-1 **or** Online Course **or** Innovation Course	3	0	0	3	100
4	CSP401A or CSI401A	Project Work-1 **or** Internship	0	0	12	6	200
		Total	**9**	**2**	**12**	**17**	**500**
		Total number of contact hours per week	**23**				

Semester 8							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	CSP402A	Project Work-2 **or** Internship	0	0	24	12	300
		Total	**0**	**0**	**24**	**12**	**300**
		Total number of contact hours per week	**24**				

List of Professional Core Electives for the 7th Semester			
Stream	**PCE-1**	**PCE-2**	**PCE-3**
Coding and Cryptography	MTE301A	MTE402A	MTE404A
	Information Theory and Coding	Computational Number Theory and Algebra	Number Theory and Elliptic Curve Cryptography
Mathematical Models	MTE303A	MTE405A	MTE402A
	Introduction to Real Analysis	Topology	Computational Number Theory and Algebra
Artificial Intelligence and Data Sciences	AIC304A	AIC305A	AIE403A
	Computer Vision	Pattern Recognition	Artificial Intelligence and Healthcare
Software Development	CSE301A	CSE405A	CSE407A
	Software Architecture	Principles and Practices of Software Testing	Service Oriented Architecture
Applied Mathematics	MTE302A	MCC301A	MTE403A
	Advanced Mathematics	Optimization Techniques	Advanced Numerical Methods
Data Science and Analytics	CSE411A	CSC301A	CSC431A
	Data Sciences Foundation	Data Mining	Data Analytics

Note:

Students are required to select:

- **One** Professional Core Elective Course in the 6th Semester from PCE-1 Group.
- **Two** Professional Core Elective Courses in the 7th Semester, one each from PCE-2 and PCE-3 Groups.

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22. Open Elective Courses

A number of Open Elective Courses from various Faculties of RUAS are offered as mentioned in the University's website. Students can choose the Open Electives of their choice. The students are permitted to choose online electives from the list approved by the respective HoD and Dean.

22.1 Innovation Courses in Lieu of Open Elective Courses

Students can earn 3-credits by participating in innovation activities as per the approved guidelines in lieu of Open Elective Courses. The activities could be related to any of the following:

a) Design Thinking and Innovation (RAU250A)
b) Skill Development (RAU251A)
c) Industrial Problem Solving and Hackathons (RAU252A)

23. Course Delivery: As per the Timetable

24. Assessment and Grading (Subject to endorsement of revised unified academic regulations for 2022-23-report submitted)

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations
3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. Project Work
10. Project
11. Exhibitions
12. Technical Festivals

25. Assessment and Grading

25.1. Components of Grading

There shall be **two components** of grading in the assessment of each course:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (SC1, SC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have a weightage of 60:40 (CE: 60% and SEE: 40%) indetermining the final marks obtained by a student in a Course.

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The complete details of Grading are given in the Academic Regulations.

25.2. Continuous Evaluation Policies

Continuous evaluation depends on the type of the course as discussed below:

25.2.1 Theory Courses

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests	Assignments	
CO-1			
CO-2			
CO-3			
CO-4			
CO-5			
CO-6			
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

- CE components should have a mix of term tests, quiz and assignments
- Two Tests (15 each), Two Assignments (20 marks). (One written and another to be MCQs)
- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

25.2.2 Laboratory Course

For a laboratory course, the scheme for determining the CE marks is as under:

For Laboratory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1			
CO-2			
CO-3			
CO-4			
CO-5			
CO-6			
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The subcomponents can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission

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e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

25.2.3 Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the scheme for determining the CE marks is as under:

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 60 %) Four components including one Lab component			SEE (Weightage: 25 %)	Lab (Weightage: 15 %)
	Tests (30 %)	Written Assignments+ Lab (20 %)	Assignment +Lab CE (10%)	Written exam	LSEE: SEE
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

- CE components should have a mix of term tests, quiz and assignments
- Two Tests (15 each), Two Assignments (20 marks). (One written and another to be MCQs)
- In case of courses where laboratory is combined with theory, laboratory components to be assessed in both CE and SEE
- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean

Ability Enhancement courses

For AECC Only		
Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (60% Weightage)	Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Terms Tests or Assignments	
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

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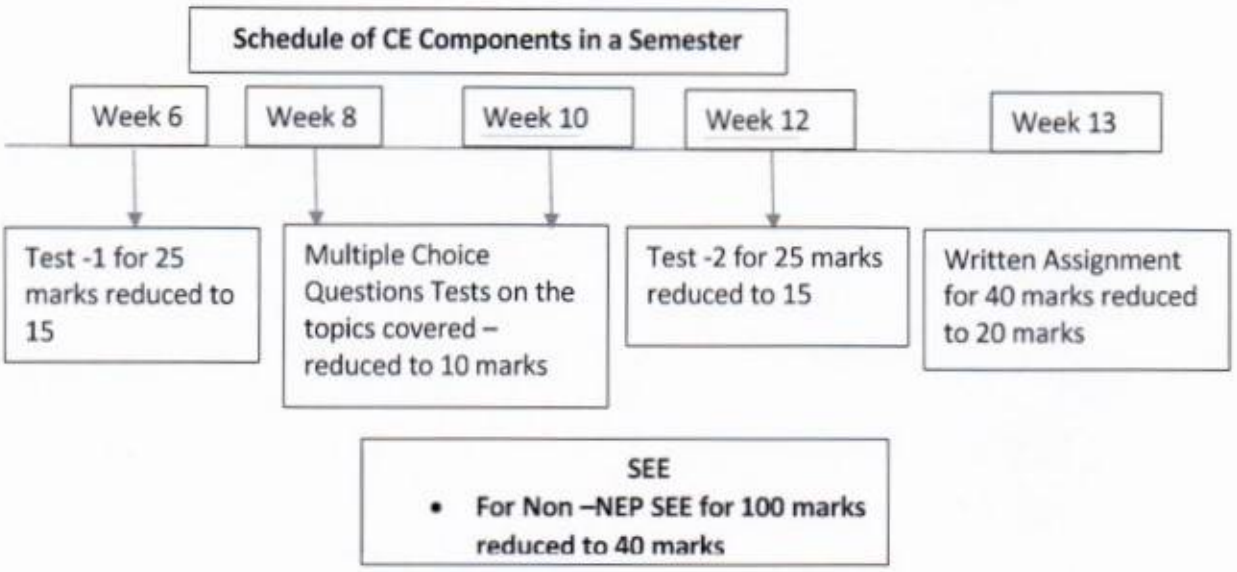
CO-6		
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.		

- Course leaders to declare the assessment components before the commencement of the session and get approval from HoD and Dean



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26. Minor Programme

The details of the following aspects of the minor programmes are presented in the **Academic Regulations** for the B. Tech. Degree Programme:

1. Programme Structure
2. Eligibility to Minor Programme
3. Registration to Minor Programme
4. Certification for Minor Programme

27. Student Support for Learning

1. Course Notes
2. Reference Books in the Library
3. Magazines and Journals
4. Internet Facility
5. Computing Facility
6. Laboratory Facility
7. Workshop Facility
8. Staff Support
9. Lounges for Discussions
10. Any other support that enhances their learning

28. Quality Control Measures

1. Review of Course Notes
2. Review of Question Papers and Assignment Questions
3. Student Feedback
4. Moderation of Assessed Work
5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports
7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

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29.Curricular Map (Course-PO-PSO Map)

Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
1	Engineering Mathematics-1	3	3	2	3						2			3	3	2
1	Engineering Chemistry and Laboratory	3	3	3	3		3	3		1	3				2	
1	Elements of Mechanical Engineering and Work shop Practice	3	3											3		
1	Elements of Electrical Engineering and Laboratory	3	3	3	2	2	2	2		1	1	1	1	3	3	1
1	Elements of Computer Science and Engineering and Laboratory	2	1	3	2	2	2		1	1		1	2	3	2	2
1	Professional Communication									3	3					2
2	Engineering Mathematics-2	3	3	2	2	2					1			3	2	1
2	Engineering Physics and Laboratory	3	3	3	3	1	1	2		1	2			2	2	
2	Engineering Mechanics	3	3	3										3		
2	Elements of Electronics Engineering and Laboratory	3	3	2										3		
2	Engineering Drawing	3	2			2					1			3	2	1
2	Constitution, Human Rights and Law						2	2							2	

3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution

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Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
3	Complex Analysis and Vector Calculus	3	3								1	1		3		1
3	Probability and Statistics	3	3		3	2	1			2			1		3	1
3	Data Structures using Python	3	3	3	1	3		1		1	3			3	3	2
3	Discrete Mathematics	2	1	2	1		3	1	1		2	2	2	2	2	1
3	Logic Design	3	2	2	3	2	1	1						3	2	1
3	Python & Data Structures Laboratory	3	3	3		2			2	2	1			3	3	1
3	Environmental Studies	1					3							1	3	
3	Additional Mathematics-1	3	3	2	3						2			3	3	2
4	Inferential Statistics	3	3	3	2	1								3	2	
4	Integral transforms	3	2	3	3	2				1			1	3	3	1
4	Linear Algebra	3	3	2	3							2		3	3	1
4	Design and Analysis of Algorithms	3	3	2	2	3	1	1			1	2	2	3	3	1
4	Formal Languages and Automata Theory	3	3	2	2	1					2		1	3	3	1
4	Programming Paradigms	3	3	3	3	3	3	2	3	1	1	1	2	3	3	2
4	Mathematics and Computing Laboratory	3	3		3									3	3	
4	Programming Paradigms Laboratory	3	3	3	3	3	3	2	3	1	1	1	2	3	3	2
4	Innovation and Entrepreneurship	1					3							1	3	

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Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
5	Optimization Techniques	3	3	3										3		
5	Partial Differential Equations	3	3	2	3							2		3	3	2
5	Quantum Computing	3	3	2	1	1	1				1		1	3	2	1
5	Principles of Artificial Intelligence	3	3	3	2	2	1			1	1			3	1	1
5	Microprocessors and Architecture	2	2	2	2	2				1	2	1	1	2	2	2
5	Computer Networks	3	3	3	2	2				1	1			3	3	1
5	Artificial Intelligence Laboratory	3	3	3	2	2	2		1	1	1			3	3	1
5	Microprocessors Laboratory	2	2	2	2	2				1	1	3		3	3	1
5	Computer Networks Laboratory	3	3	3	2	2				1	1			3	3	1
6	Application of Probability and Statistics in Finance	2	3	1	3	2								2	3	
6	Machine Learning-1	3	3	3	2	2				1	1			3	3	1
6	Parallel Algorithms for Scientific Computing	3	3	3	2	2				1	1			3	3	1
6	Graph Theory and Optimization	3	3	2	3	2	1	1			2			3	2	1
6	Information Security and Protection	1	1	3		3	3	3	3	3		3	1	3	3	1
6	Data Mining		3	3	2	3	2	2	2	2	3	2	1	3	3	2
6	Numerical Analysis Laboratory	2	3	1	3	2								2	3	

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Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
7	Information Theory and Coding	3	3	3	2	3			1	1			1	3	2	1
7	Computational Number Theory and Algebra	3	2	3	3								1	3	3	1
7	Number Theory and Elliptic Curve Cryptography	3	3	2	3							2		3	3	2
7	Introduction to Real Analysis	3	3	2	3							2		3	3	2
7	Topology	3	3											3		
7	Computer Vision	3	3	3	2	2				1	1			3	3	1
7	Pattern Recognition	2	3	2	3		1	1						3	3	1
7	Artificial Intelligence and Healthcare	3	3	3	2	2				1	1			3	3	1
7	Software Architecture	2	2	2	2	2					2	2	2	3	2	1
7	Principles and Practices of Software Testing	3	3	3		2				1	1			3	3	1
7	Service Oriented Architecture	2		2			1	1				2	2	3	2	1
7	Advanced Mathematics	3	3	3	2	2				1	1			3	3	1
7	Optimization Techniques	3	3	3			1				2			3	1	2
7	Advanced Numerical Methods	3	3	2	2	2					2			3	2	2
7	Data Sciences Foundation	3	3	3		2				1	1			3	3	1
7	Data Mining	3	3	3	2	2				1	1			3	3	1
7	Data Analytics	3	3	2	3							2		3	3	2
7	Seminar	3	1		2		1		1	2	2	3			2	2
8	Internship	1	1		3		1	2	2	2	2	3		1	2	3
8	Project Work-1 and Project Work-2	3	3	3	3	3				2	2	1	1	3	2	

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3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution

30. Co-curricular Activities

Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

31. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

32. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.

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RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Course Specifications

B. Tech. (Mathematics and Computing) Degree Programme

Programme Code: 412

Faculty of Engineering and Technology

Batch 2022-2026

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Course Specifications: Engineering Mathematics - 1

Course Title	Engineering Mathematics - 1
Course Code	MTB101A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts in real analysis and matrix algebra. Students are taught the concepts of limits, continuity, and differentiation, series expansion for the functions of one and two variables, sequence and series, convergence of series. The mathematical operations in Matrix theory, Eigen value and Eigen vector, Inversion and diagonalization of matrix and matrix solution for linear system of equations.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** State and discuss basic concepts related to single, two variable calculus and matrix algebra
- **CO-2.** Perform basic operations of matrix algebra and apply them to solve systems of linear equations
- **CO-3.** Solve simple mathematical problems associated with linear algebra, single and two variable calculus
- **CO-4.** Demonstrate competence with the basic ideas of linear systems, independence, bases and dimension, linear transformations, eigenvalues, eigenvectors and diagonalization
- **CO-5.** Solve complex real-world problems associated with linear algebra, single and two variable calculus

4. Course Contents

Unit 1 (Single Variable Calculus): Functions of single real variable, limit, continuity and differentiation. Rolle's Theorem and Lagrange's mean value theorem and their applications. Fundamental theorem of integral calculus. Improper integrals - classification and convergence, gamma and beta functions. Sequence of real numbers, Series, Tests for convergence of series: integral test, comparison test, ratio test and root test. Power series, Taylor and Maclaurin series.
Unit 2 (Two Variable Calculus): Functions of two variables, limits, continuity and partial differentiation. Total differential, errors and approximations, tangent plane approximation of a surface. Partial differentiation of composite and implicit functions, Taylor's theorem.

Unconstrained and constrained extrema.

Unit 3 (Linear Algebra): Matrix algebra, elementary row operations, row and reduced row echelon forms. Linear system of equations, existence and uniqueness of solution. Vector spaces, subspaces, linear independence, basis and dimension. Row, column and null space of a matrix. Linear transformations. Eigenvalues, eigenvectors and diagonalization.

5. **Course Map (CO-PO-PSO Map)**

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2							1			3		1
CO-2	3	3	1							1			3		1
CO-3	3	3	2	3						2			3	3	2
CO-4	3	3	2	2						2			3	2	2
CO-5	3	3	2	2						2			3	2	2
			3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution												

6. **Course Teaching and Learning Methods**

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. **Course Assessment and Reassessment**

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

1. Essential Reading

1. James Stewart, 2015, Calculus: Early Transcendentals, 8th edition, Boston, Cengage Learning
2. Steven Leon, 2014, Linear Algebra with Application, 9th edition, New Jersey,

Pearson

2. **Recommended Reading**
   1. Maurice D. Weir and Joel Hass, 2017, Thomas Calculus, 13th edition, New Jersey, Pearson
   2. Gilbert Strang, 2016, Introduction to Linear Algebra, 5th edition, Massachusetts, Cambridge Press
3. **Magazines and Journals**

4. **Websites**
   1. https://www.coursera.org/
   2. http://nptel.ac.in/

5. **Other Electronic Resources**
   1. https://ocw.mit.edu/index.htm
   2. https://www.khanacademy.org/
   3. tutorial.math.lamar.edu/

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Course Specifications: Engineering Physics and Laboratory

Course Title	Engineering Physics and Laboratory
Course Code	PYB102A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary:

The aim of this course is to impart concepts of Physics and its application to solve engineering problems. The students are taught the basic topics in modern physics which include wave particle duality, uncertainty principle, Schrodinger's wave equation, lasers and fiber optics. Electrical and mechanical properties of materials will be discussed in relation to the crystal structure. This course also intends to expose the students to the challenges and rewards related to experimental physics. Students gain hands-on experience by conducting experiments in a controlled laboratory environment. Students are trained to conduct experiments related to mechanics, optics and electric circuits. They are trained to analyze the measurements, results and infer appropriate conclusions based on fundamental concepts of physics

2. Course Size and Credits:

Number of credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total hours of interaction	75
Number of Weeks in a Semester	15
Department responsible	Physics
Total Course Marks	100
Pass requirement	As per the Academic Regulations
Attendance requirement	As per the Academic Regulations

3. Course Objectives (CO)

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

CO - 1	State, explain the concepts of mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
CO - 2	Derive standard relationships in mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser & fiber optics, and interpret them
CO - 3	Discuss the applications of mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
CO - 4	Solve problems in mechanics, electrical conductivity, quantum mechanics, crystal structure, material science, laser and fiber optics
CO - 5	Plan the experimental set-up, conduct experiments, calculate and plot the graphs to obtain the results and write a laboratory report as per the prescribed format.

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4. Course Contents

Unit 1 – (Elasticity): Review of Elasticity — Expression for Y, h and K in terms of linear and lateral strains (Deformation of a cube)—Poisson's ratio—Twisting couple on a cylinder—Expression for couple per unit twist—Torsion Pendulum -- determination of rigidity modulus of a wire using torsion pendulum—Bending of beams— Geometrical moment of inertia of circular and rectangular cross sections—Single cantilever—Expression for Young's modulus of a cantilever beam

Unit 2 – (Rigid body dynamics): Review of Rigid body dynamics — Expressions for moments of inertia of a circular disc and rectangular plate about different axes—MI of Flywheel

Unit 3 – (Quantum theory of radiation): Blackbody spectrum—Wien's law—Raleigh-Jeans law—Stefan-Boltzmann law—Planck's quantum theory—Reduction of Planck's formula to Raleigh Jeans and Wien's formulae—Compton effect—Wave particle dualism—de Broglie hypothesis and matter waves—Phase velocity and group velocity of matter waves

Unit 4 – (Quantum Mechanics): Heisenberg's uncertainty principle—Applications of Heisenberg's uncertainty principle—wave function and its properties - Setting up of Schrodinger's one-dimensional time independent wave equation—Application of Schrodinger's equation to a particle in an infinite potential well to determine eigen values and eigen functions

Unit 5 – (Lasers): Interaction of radiation with matter - Absorption, spontaneous emission and stimulated emission - Characteristics of laser light - Expression for the energy density of electromagnetic radiation – Requisite conditions for production of a laser beam—Helium-Neon laser—Semiconductor laser—Applications of lasers—Lidar—laser isotope separation—laser fusion

Unit 6 – (Optical Fibers): Principle-- Angle of acceptance—Expression for Numerical aperture-- condition for propagation—Intermodal dispersion-- material dispersion—Refractive index profiles of step index and graded index fibers(GRIN)—Modal propagation in step index and GRIN fibers –Attenuation—Different types of loss mechanisms--Fiber optic communication system

Unit 7 – (Crystal structure): Space lattice—Bravais lattice—Lattice parameters—unit cell and primitive cell—Crystal systems - Miller indices - Indexing directions and planes in a crystal - Atomic packing fraction and coordination number for simple, body centered and face centered cubic Crystals - Expression for inter planar Spacing - Structures of NaCl and diamond crystals—Bragg's law—Identification of cubic crystals using Bragg's law

Unit 8 – (Electrical conductivity of metals): Review of Classical free electron theory - Failure of classical free electron - Quantum free electron theory—Density of States (Qualitative) – Fermi energy – Fermi factor - Effect of temperature on Fermi-Dirac Distribution functio

Unit 9 – (Lab Experiments)

1 Determination of the relationship between the torque and angular acceleration of a flywheel
2 Determination of the (i) the moment of inertia of the given disc and (ii) the rigidity modulus of the material of a wire by torsional oscillations
3 Analysis of Powder X-ray diffraction pattern.
4 Determination of Young's modulus of material of a beam by uniform bending method.
5 Determination of radius of curvature of a plano-convex lens by setting up Newton's rings.
6 Determination of the wavelength of prominent spectral lines of Hg source using diffraction

grating with minimum deviation method.
7 Determination of thickness of paper by air wedge experiment.
8 Determination of efficiency of Solar cell.
9 Determination of Planck's constant using LED.
10 Study of I-V characteristics of Zener diode
11 Determination of the frequency response of series and parallel resonance circuit and to find the resonant frequency and quality factor.
12 Determination the width of the forbidden energy gap in a semiconductor diode.
13 Determination of dielectric constant of a material by charging and discharging a capacitor.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3		2		1								3	1	0
CO-2	2	1	3	3		1	1						3	2	0
CO-3	3	2											3	0	0
CO-4	3	2	2	1									3	1	0
CO-5	3	2		3			2		1	2			3	3	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer		
Numeracy		13
1. Solving Numerical Problems	13	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory		
3. Engineering Workshop / Course Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		00
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Mid Terms, Written Examination		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programmes. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3 or LSC4), COs are assessed as illustrated in the following Table.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	CE (Weightage: 50 %)			SEE (Weightage: 35 %)	Lab (Weightage: 15 %)
	Tests	Assignments	Lab CE	Written exam	LSEE: SEE
	50 marks	25 Marks	25 Marks	70 Marks	30 Marks
CO-1	X			X	
CO-2	X	X		X	
CO-3	X	X		X	
CO-4	X	X		X	
CO-5			X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8 Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No.	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Class room lectures, and demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment
5.	Problem Solving Skills	Class room, assignment
6.	Practical Skills	Class room, assignment
7.	Group Work	Classroom
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Course

13.	Information Management	Assignment, examination
14.	Personal Management	Assignment, examination
15.	Leadership Skills	Effective management of learning, time management, achieving the learning

9. Course Resources

a. Essential Reading

1. Class Notes
2. Rajendran, V. (2011) Engineering Physics, TMH
3. Srinivasan M. R. (2011) Physics for Engineers, 3rd Ed, New Age International
4. Gyan Prakash, (2012) Experimental Physics,
5. Michael Sayer, Abhai Mansingh, (1999) Measurement, Instrumentation and Experiment Design in Physics and Engineering, PHI

b. Recommended Reading

1. Halliday, I.D., Resnick, R and Walker, J (2010) Fundamentals of Physics, 9th Ed, Wiley
2. Richtmeyer, F. K., Kennard, E.H. and Cooper, J.N (2007) Modern Physics, 6th Ed, TMH
3. Beisser, A. (2009) Concepts of Modern Physics, 6th Ed, TMH
4. Kittel, C. (2010) Introduction to Solid State Physics, 8th Ed, Wiley
5. S.O. Pillai (2011), A Textbook of Solid State Physics, 6th Ed, New Age International
6. Srinivasan M.R. (2011) Applied Solid State Physics, 1st Ed, New Age International
7. Giri, P.K., (2005) Physics Laboratory Manual for Engineering Undergraduates, Department of Physics, Indian Institute of Technology Guwahati

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/
2. Other Electronic Resources

e. Electronic resources on the subject area are available on MSRUAS library

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Course Specifications: Engineering Mechanics

Course Title	Engineering Mechanics
Course Code	CEF101A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This subject deals with laws of engineering mechanics for static and dynamics equilibrium of rigid bodies. They will be trained on application of engineering mechanics to solve practical problems pertaining to static and dynamic equilibrium of rigid bodies. In addition, effects of friction, energy methods for analyzing static and dynamic analysis of rigid bodies will be dealt.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Civil Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. State and describe the laws of Statics, Friction and Dynamics and their contexts of application.
CO-2. Interpret standard mathematical relationships and apply for solving simple static and dynamic problems in engineering mechanics
CO-3. Calculate moment of inertia, determine centroid, centre of gravity for the structural members
CO-4. Apply the laws of statics and dynamics for the equilibrium analysis of rigid bodies with and without friction
CO-5. Apply energy methods in analyzing of static and dynamic aspects of engineering structures made of rigid bodies

4. Course Contents

Unit 1 (Engineering Mechanics): Branches of mechanics and its importance: Engineering Design , Mechanics in engineering, Introduction to SI units , Basic idealisations - Particle, Continuum, Rigid body and Point force with examples, principles of mechanics with examples- laws of parallelogram, law of transmissibility, gravitation, Classification of force and force systems; Principle of physical independence of forces, Principle of superposition of forces; constraints on rigid bodies and corresponding reactions. Moment of a force, couple, moment of a couple, characteristics of couple,

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Equivalent force - couple system; Resolution of forces, composition of forces; Numerical problems on moment of forces and couples, equivalent force and couples.

Unit 2 (Analysis of Coplanar Concurrent and Non-Concurrent System of Forces): Varignon's theorem, resultant of Concurrent and non-concurrent force systems. Equilibrium of Structural Systems: Types of forces acting on a body, Free Body diagram Analysis, Lami's Theorem, Equilibrium of connected bodies, types of supports in beams, determination of support reactions, Applications to engineering problems. Classification of Structures –Axial force members, trusses, frames, beams and cables, Numerical Examples.

Unit 3 (Centroid of planes and Moment of inertia of area): Differences between centre of gravity and Centroid, use of axis of symmetry, Centroid of simple built-up sections by integration, Moment of Inertia of planes, radius of gyration, Theorems of moment of inertia, moments of inertia of standard sections by integration, Numerical Examples.

Unit 4 (Friction in Engineering Systems): Laws of friction, angle of friction, angle of repose, cone of friction, Analysis of blocks resting on horizontal and inclined planes, rolling friction, rope friction, Application to wedge and ladder problems, problems involving non concurrent force systems.

Unit 5 (Energy methods in engineering mechanics): Application of principle of virtual work and Castigliano's theorem. Energy relations in rigid bodies- conservation of energy principle, examples on kinetic energy, potential energy and total energy, power as applied to rigid bodies.

Unit 6 (Introduction to dynamics): General principles and types of motions and D'Alembets principle with examples, Newton's laws of motion. Linear motions and projectiles -Motion with uniform velocity and acceleration, motion with varying acceleration, motion of bodies projected horizontally, projection on inclined planes, Numerical examples.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3	3	3											3		
CO-4	3	2	1										2		
CO-5		2	3										3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	

3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X	X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignment
2.	Understanding	Classroom lectures, Assignment, Self-study
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Classroom lectures, Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	--
8.	Self-Learning	Assignment, Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Satheesh Gopi (2010), Basic Civil Engineering, Dorling Kindersley (India) Pvt Ltd
3. R K Rajput (2011), A Text Book of Applied Mechanics, 3rd Edn, Laxmi Publications
4. Richard H. McCuen, Edna Z. Ezzell (2011), "Fundamentals of Civil Engineering: An Introduction to the ASCE Body of Knowledge", CRC press

b. Recommended Reading

1. S. S. Bhavikatti, K. G. Rajashekarappa (2004), Engineering Mechanics, New Age International
2. C. Lakshamanarao, J. Lakshinarashiman, Raju Sethuraman, Srinivasan M. Sivakumar (1993), Engineering Mechanics: Statics and Dynamics, PHI, New Delhi

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. https://nptel.ac.in/

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Course Specifications: Elements of Electronics Engineering and Laboratory

Course Title	Elements of Electronics Engineering and Laboratory
Course Code	ECF102A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to create a strong foundation of Digital Electronics. The students are taught the basic components of digital systems and the process of their implementation. The students are also taught Boolean algebra, logic gates, basics of memories, and implementation of combinational and sequential digital circuits using logic gates. This course also emphasizes on different types of memories and logic designing platforms and their merits and demerits. Students are trained to employ the principles of digital electronics to implement digital design for the given problem. Basic electronics laboratory deals with practical applications of electronic circuits and their theoretical concepts.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:2
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Electronics and Communication Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain working principles of PN junction diode, Zener diode, transistors, amplifier configurations, Op-Amps, power supply, logic gates and electronic displays
CO-2. Derive mathematical relationships for electronic devices and circuits
CO-3. Solve simple numerical and design problems related to analog / digital circuits as well as devices
CO-4. Design and analyse operation of standard analog / digital circuits for a given application
CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values
CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

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4. Course Contents

Unit 1 (Basic concepts in Electronics): Semiconductor: p-type, n-type; p-n junction diode, its characteristics, half wave, full wave and bridge type rectifiers, basic filter circuits, Diode as voltage multiplier, clipper and clamper circuit, Zener diode characteristics, Zener diode as a voltage regulator.
Unit 2 (Transistor- BJT): Transistor configurations: CB, CE and CC; Transistor parameters: alpha, beta and gamma, working of transistor as a switch, Amplifier; Transistor biasing – Base, Collector-to-base and Voltage Divider Bias.
Unit 3 (Amplifiers): Differential amplifiers and their transfer characteristics, IC Op-Amps, their ideal and practical characteristics, Op-Amp in different modes as inverting amplifier, non-inverting amplifier, summing amplifier, scale changer, differentiator and integrator.
Unit 4 (Power Supplies): Introduction and working of Switched Mode Power Supply (SMPS), Voltage Regulator, Introduction to Inverters and UPS.
Unit 5 (Digital Electronics): Binary, Octal and Hexadecimal number systems and conversions, Boolean Algebra, Truth table of logic gates- AND, OR, NOT, NAND, NOR; Universal gates; Generation of Integrated Circuits- SSI, MSI, LSI and VLSI.

Unit 6 (Laboratory): List of Experiments

1	Forward and Reverse bias V-I Characteristics of a P-N Junction diode
2	Forward and Reverse bias V-I Characteristics of Zener diode
3	Half wave and Full wave Rectifier circuits: a) Output of half/full wave rectifier with and without capacitor filter.
4	Bridge Rectifier circuits: a) Output of bridge rectifier with and without capacitor filter
5	Clipping circuits (Shunt clippers) Clipping circuits (Series clippers)
6	Clamping circuits
7	Characteristics of Op-amp inverting and non- inverting amplifiers
8	Logic Gates circuits: Verification of the truth tables of AND, OR, NOT, NAND, NOR, and EX-OR gates.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3		3	2										3		
CO-4		3	2										3		
CO-5		3											3		
CO-6		3		2									3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours

Face to Face Lectures		33
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3 and LSC4), COs are assessed as illustrated in the following Table.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	**CE (Weightage: 50 %)**			**SEE (Weightage: 35 %)**	**Lab (Weightage: 15 %)**
	Tests	**Assignments**	**Lab CE**	**Written exam**	**LSEE: SEE**
	50 marks	**25 Marks**	**25 Marks**	**70 Marks**	**30 Marks**
CO-1	X			X	
CO-2	X	X		X	
CO-3	X	X		X	
CO-4	X	X		X	
CO-5	X	X		X	
CO-6			X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Class room lectures, Assignments, Laboratory instruction
2.	Understanding	Class room lectures, Assignments, Laboratory instructions and experiments
3.	Critical Skills	Class room lectures, Assignments
4.	Analytical Skills	Class room lectures, Assignments
5.	Problem Solving Skills	Class room lectures, Assignments
6.	Practical Skills	Laboratory Work
7.	Group Work	Laboratory Work
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination, Laboratory work
10.	Verbal Communication Skills	Laboratory work
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, examination, Laboratory
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Millman and Halkias, 2001, Integrated Electronics, Tata McGraw-Hill Education
3. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 7th Ed. Prentice Hall
4. Dale R. Patrick, 1989, Electricity and Electronics Laboratory, The Goodheart-willcox Company Inc, Illinois

b. Recommended Reading

1. Albert Malvino, 2006, Electronic Principles, Tata McGraw - Hill Education
2. Donald L. Shilling & Charles Belowl, 1968, Electronic Circuits, New York: McGraw-Hill
3. Tocci R J and Widmer N S, 2001, Digital Systems – Principles and Applications, 8th Ed., Pearson Education India, New Delhi
4. Cooper and Helfrick, 1996, Modern Electronic Instrumentation and Measuring Techniques, 4th print Prentice Hall of India, New Delhi

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5. H S Kalsi, 2007, Electronic Instrumentation, TMH, 2nd Edition
6. R A Gaikwad, 2001, Op-Amps and Linear Integrated Circuits, PHI, 4th edition
7. Millman and Grabel, 1999, Microelectronics, 2nd Ed. Tata McGraw-Hill
8. Louis R. Nardizzi, 1973, Basic circuits and electronics experiments, Van Nostrand
9. George B. Rutkowski, 1984, Basic electricity for electronics, Bobbs-Merrill Educational Pub.
10. Russell L. Meade, 2003, Foundations of Electronics: Circuits and Devices, Delmar learning, a division of Thomson learning, Inc.

c. **Magazines and Journals**

1. Electronics For You
2. IEEE Transaction on Circuits and System I and II

d. **Websites**

1. http://www.electronics-lab.com
2. http://www.labmanager.com
3. http://electronicsforu.com
4. http://www.lifescienceleader.com

e. **Other Electronic Resources**

1. https://ocw.mit.edu/index.htm MultiSim software
2. Analog trainer kit
3. Digital trainer kit
4. Discrete electronic components

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Course Specifications: Engineering Drawing

Course Title	Engineering Drawing
Course Code	MEF103A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course deals with graphical representation of geometrical entities in various views for visualization and communication. The students will be taught orthographic and isometric projection of points, lines, planes and solids. The students will be taught sections and development of solids. The students will be equipped to visualize and apply principles of orthographic projection to given application. The students will also be trained to use CAD tool to carry out these geometric projections.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the conventions used in projections of geometric entities and interpret the same

CO-2. Draw orthographic projections for the geometric entities in specified positions

CO-3. Develop lateral surfaces of un-sectioned and sectioned regular solids

CO-4. Develop orthographic projections for given applications

CO-5. Draw isometric projections for the solids and their combinations

CO-6. Demonstrate competency in using CAD tool for drawing projections of geometric entities

4. Course Contents

Unit 1 (Introduction to Engineering Drawing and CAD Tool): Drawing Instruments and their uses, BIS conventions and specifications, Dimensioning and Significance of Lettering, Graphical User Interface (GUI), Co-ordinate system and reference planes. Definitions of Horizontal Plane (HP), Vertical Plane (VP), Right Profile Plane (RPP) & Left Profile Plane (LPP). Creation of 2D/3D environment. Selection of drawing size and scale. Creation of geometric entities and text.

Modification and editing of geometric entities. Dimensioning, line conventions and material conventions

Unit 2 (Orthographic Projections- Points and Lines): Definitions - Planes of projection, reference line and conventions employed. Projections of points in all the four quadrants, Projections of straightlines (located in First quadrant, first angle projection), True and apparent lengths, True andapparent inclinations to reference planes (simple problems).

Unit 3 (Orthographic Projections - Planes (First Angle Projection): Definitions–projections of plane surfaces–triangle, square, rectangle, pentagon, hexagon and circle. Planes in different positions by change of position method only.

Unit 4 (Orthographic Projections – Solids (First Angle Projection): Definitions – Projections of solids–cube, prisms, cylinder, pyramids, cones and tetrahedron in different positions.

Unit 5 (Orthographic Projections – Section of Solids and Development of Surfaces (First Angle Projection): Section planes, Sections, Section views, Apparent shapes and True shapes of sections of right regular prisms, pyramids, cylinders and cones resting in simple positions.

Unit 6 (Isometric Projections using Isometric Scale) : Section planes, Sections, Section views, Apparent shapes and True shapes of sections of right regular prisms, pyramids, cylinders and cones resting in simple positions. Application of Projection of points and lines to given situation.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3	2								1			3		1
CO-3	3	2								1			3		1
CO-4	3	2								1			3		1
CO-5	3	2								1			3		1
CO-6					2									2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop /	00	

Kitchen		
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X	X	X
CO-2	X	X	X
CO-3			X
CO-4	X	X	X
CO-5			X
CO-6	X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course

1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignment
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment, Examination
14.	Personal Management	Course Work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. K. R. Gopalakrishna, 2005, Engineering Graphics, 32nd Edition, Shubhash Publishers

b. Recommended Reading

1. W. J. Luzadder, 2006, Fundamentals of Engineering Drawing, 11th Edition, Prentice Hall India
2. N. D. Bhatt and V. M. Panchal, 2006, Engineering Drawing, 49th Edition, Charotar Publishing House
3. CAD Tool Users Manuals

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in

e. Other Electronic Resources

1. Electronic resources on the course area are available on MSRUAS library

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Course Specifications: Constitution, Human Rights and Law

Course Title	Constitution, Human Rights and Law
Course Code	LAN101A
Course Type	Ability Enhancement Compulsory Course
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course aims at enabling students understand the key principles of Indian Constitution, Human Rights and Law. The course facilitates the understanding of the framework of Indian constitution and the judicial and the legal systems that guides Indian citizens. It aims at building awareness about the application of Human Right principles and Law. It allows students to work towards the formulating realistic solutions for protection of human rights.

2. Course Size and Credits

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	School of Law
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the key principles of the Indian Constitution
CO-2. Explain Indian legal system and judicial structure that govern the citizens
CO-3. Discuss UN Declaration of Human Rights
CO-4. Discuss the scope and application of Human Rights Principles and Law
CO-5. Suggest strategies for protection of human rights and resolving legal issues in compliance with applicable laws

4. Course Contents

Unit 1 (Constitution of India): The framework of Constitution of India, Constituent Assembly, The Constitution and the government, The constitution and the judiciary, The constitution and the legislature.

Unit 2 (Introduction to Law): Indian Legal System and Judicial Structure, Liability under the Law, Issues relating to Good Corporate Governance, Company Law.

Unit 3 (Concept of Human Rights and Duties): Inherent, inalienable, universal, indivisible, values, dignity, liberty, equality, justice, unity in diversity, classification of rights, classification of duties, correlation of rights and duties, need for balance between rights and duties, freedom and responsibility.

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Unit 4 (International Human Rights Standards and UN): Universal declaration of human rights 1948, international covenant on civil and political rights 1966, international covenant on economic, social and cultural rights 1966, UN system and human rights, convention on elimination of all forms of racial discrimination 1965, convention on elimination of all forms of discrimination against women 1979, convention on the rights of the child 1989, UN declaration and duties and responsibilities of individuals 1997, UN agencies to monitory compliance such as UN high commission for human rights.

Unit 5 (Contract Law and Disputes): Formation of Contract: offer and acceptance, Terms of Contract: avoidance, representation, illegality, Breach of Contract and Remedies, Industrial Disputes Act, Negligence, Trespass and Breach of Statutory Duty, Litigation, Arbitration, Judicial Remedies.

Unit 6 (Intellectual Property Law): Copyright, Protection and Infringement of Copyright, Trade Marks, Protection of Trade Marks and Passing-off, Patents, Ownership and Protection of Patents, Product Liability, Government Schemes for IPR Protection.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3	3									2			3		2
CO-4	3	2											3		
CO-5										3					3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**50 Marks**
Maximum Marks ▸	**25**	**25**	
CO-1	X	X	X
CO-2			X
CO-3		X	X
CO-4	X		
CO-5	X	X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Face to face lectures
2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	
4.	Analytical Skills	Face to face lectures, activities, group discussions, assignments
5.	Problem Solving Skills	
6.	Practical Skills	Face to face lectures, activities, group discussions, course work

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7.	Group Work	Course work, practice, assignment, group discussion
8.	Self-Learning	Course work, practice, assignment, group discussion
9.	Written Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
10.	Verbal Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
11.	Presentation Skills	
12.	Behavioral Skills	Course work, practice, assignment, group discussion, presentation practice, role plays
13.	Information Management	Assignment
14.	Personal Management	Face to face lectures
15.	Leadership Skills	Face to face lectures, group discussions

9. Course Resources

a. Essential Reading

1. Course notes
2. Tulsian, PC. (2008) Business Law, Tata McGraw Hill, New Delhi
3. Donnelly, J. (1998) International Human Rights, 2nd edn, Westview Press

b. Recommended Reading

1. Gulshan , S. S and Kapoor, G. K. (2005) Business Law including Corporate Laws, New Age International (P) Ltd. Publishers, New Delhi
2. Perry, M. (1998) The Idea of Human Rights, Oxford University Press
3. K Swamyraj (2017), Law of Contract (General Principles), God's Grace Publication, New Delhi
4. D D Basu (1983), Constitutional Law of India, Lexis Nexis Butterworths Publication, Nagpur
5. Introduction to Intellectual Property Theory and Practice (1997), World Intellectual Property Organisation, Geneva
6. Smith, R. (2007) Textbook on international human rights 3rd edn, Oxford University Press

c. Magazines and Journals

d. Websites

1. http://industrialrelations.naukrihub.com/industrial-relation-policy.htm
2. http://labour.nic.in/
3. http://whitepapers.businessweek.com/tlist/Legal-Environment.html
4. http://nptel.ac.in/

e. Other Electronic Resources

1. Electronic resources on the course area are available on MSRUAS library

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Course Specifications: Engineering Mathematics - 2

Course Title	Engineering Mathematics - 2
Course Code	MTB102A
Course Type	Core Theory
Department	Applicable for all programmes
Faculty	Engineering and Technology

1. Course Summary

This course deals with analytical solutions of ordinary differential equations and Laplace transform. Students are taught the concepts of fundamentals of ordinary differential equations and Laplace transform. The solution procedures for certain standard forms of ordinary differential equations are illustrated. The role, relevance of ordinary differential equations in modelling some of the real world problems are emphasized and this course also covers the underlying principles and applications of transform techniques in various engineering disciplines.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the fundamentals of ordinary differential equations and Laplace transform
CO-2. Solve standard forms of ordinary differential equations
CO-3. Solve simple problems in ordinary differential equations and Laplace transform
CO-4. Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations using Laplace transform
CO-5. Apply Laplace transform in solving complex real world engineering problems

4. Course Contents

Unit 1 (First Order Differential Equation): First order differential equations - Introduction, basic concepts and geometrical meaning. Separable, linear and exact differential equations. Integrating factors and transformations. Applications of first order ordinary differential equations: orthogonal trajectories, growth/decay problems and mixture problems

Unit 2 (Higher Order Differential Equation): Introduction, initial and boundary value problems. Linear homogenous/nonhomogeneous differential equations with constant coefficients, method of undetermined coefficients and variation of parameters. Cauchy-Euler equations. Application of second order linear differential equations with constant coefficients, mass-spring-dashpot system, electric circuits. System of linear differential equations of first order, solutions by matrix method.

Unit 3 (Laplace Transform): Definition, properties and theorems, transform of derivatives, integrals, periodic functions, unit step function, Dirac's delta function and time shifting property. Inverse Laplace transform, convolution theorem, solution of initial value problems

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2							1			3		1
CO-2	2	3	2							1			3		1
CO-3	3	3	1							1			3		1
CO-4	3	3	2	2	2					1			3	2	1
CO-5	3	3	2	2	2					1			3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

5. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson Dennis Zill, 2012,
6. A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole
7. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons

b. Recommended Reading

1. George Simmons, 2017, Differential Equations with Applications and Historical Notes, 2nd edition, New Jersey, McGraw Hill
2. Dennis Zill and Warren Wright, 2011, Advanced Engineering Mathematics, 4th edition, Jones and Bartlet
3. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, tenth edition, John Wiley & Sons Inc.

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/
2. https://ocw.mit.edu/index.htm

e. Other Electronic Resources

1. https://www.khanacademy.org/
2. tutorial.math.lamar.edu/

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Course Specifications: Engineering Chemistry and Laboratory

Course Title	Engineering Chemistry and Laboratory
Course Code	CYB104A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This subject aims at enhancing the basic understanding of chemistry with reference to engineering systems and to train students to perform quantitative analysis related to Engineering Chemistry.

This subject deals with topics on electrochemistry, energy stage devices, fuels, chemical kinetics, corrosion science, metal finishing, polymers and nanomaterials.

Students are trained to determine physical and chemical properties of a given sample experimentally. They are trained to analyze the results and infer appropriate conclusions based on concepts of Engineering Chemistry.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the basic concepts of electrochemistry, conversion of chemical energy into electrical energy, theory of corrosion and principles of metal finishing

CO-2. Differentiate renewable - nonrenewable fuels, primary - secondary electrodes & primary - secondary batteries, batteries - fuel cells, electroplating – electroless plating, thermosetting – thermoplastic polymers and dry corrosion - wet corrosion

CO-3. Discuss the reaction chemistry and stoichiometry of combustion of fuels, remedial measures to control oxides of nitrogen, sulphur and carbon, polymerization – methods, mechanism, preparation, properties and applications of some polymers, concepts of nano science and nanotechnology

CO-4. Identify the types of corrosion and methods to prevent corrosion, suitable polymers and nanocomposite materials for engineering applications

CO-5. Derive kinetic rate equations for various chemical systems and equation for electromotive force

CO-6. Analyze the suitability of polymers & composites for various applications and solve problems related to storage devices, chemical kinetics, electro chemistry, corrosion and metal finishing

CO-7. Plan the experimental set up, conduct experiments, calculate and plot the graphs to obtain results, and write a laboratory report as per the prescribed format

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4. Course Contents

Unit 1 Electrochemistry: Electrochemical cell, Electrode Potential and EMF. Construction of Galvanic cell, Types of Electrodes. Numerical on Electrode Potential of cell using Nernst equation. Construction and working of reference electrodes: calomel and silver-silver chloride electrode. Construction, working and application of Ion-selective electrode: Glass electrode. Determination of pH using glass electrode

Unit 2 Storage and Conversion devices – Batteries: Storage devices – Batteries: Primary batteries, Secondary batteries, reserve batteries and super capacitors. Construction, working and application of dry cell, lead acid, Nickel-Cadmiun, Nickel-Metal hydride, Zinc –Air, Lithium-ion batteries, Lithium polymer batteries.
Conversion devices: Fuel cells, Construction, working and application of: Hydrogen-Oxygen, Methanol-Oxygen cells.

Unit 3 Corrosion and its Control: Types of corrosion. Electrochemical theory of corrosion. Factors affecting, Corrosion control: Metal coating, cathodic protection, organic coating, corrosion-inhibitors.

Unit 4 Metal Finishing: Technological importance of metal finishing, Polarization and factors influencing polarization, Principle of electroplating, factors affecting electrodeposition, Electroplating of Chromium and Gold. Electro-less Plating of Copper and Nickel.

Unit 5 Chemical Kinetics: Order of Reactions, Derivation of second, third, consecutive reactions, rate equations, Steady State Concept, numerical problems with suitable examples of different kinds of reactions.

Unit 6 Combustion Chemistry: Introduction to Fuels, types and classification, Sources of Fuels, Characteristics of a good fuel, Proximate and ultimate analysis, Petroleum cracking, Mechanism of Knocking and its effect, Anti-knocking agents, Octane and Cetane numbers, Functioning of Catalytic converter, Introduction to Biofuels, Flue gases and control measures.

Unit 7 Polymers and polymerization: Introduction & Classification of polymers, Addition, condensation and co- ordination polymerizations, mechanism of free radical addition polymerization with ethylene as example, Techniques of polymerization (Bulk, Solution, suspension, emulsion), Tg, factors affecting Tg, effect of structure on properties of polymers, fundamentals of biodegradable polymers, preparation, properties and technical applications of thermoplastics (PVC, PVA, Teflon), thermosets (PF, UF), elastomers (natural rubber, SBR) & adhesives (epoxy and acrylics) Introduction to polymeric composites.

Unit 8 Introduction to nanoscience and nanotechnology: Basic concepts of Nanoscience and Nanotechnology – Graphene – Carbon nanotubes – Material processing by top down and down top synthesis; chemical vapor deposition and physical vapor deposition– Potential uses of nanomaterials in electronics, robotics, computers, sensors, vehicles and transportation – Medical applications of nanomaterials.

Unit 9 – (Lab Experiments)	
1	Determination of Viscosity Coefficient of a given liquid using Ostwald's Viscometer
2	Conductometric estimation of an acid using standard NaOH solution

3	Determination of pKa of the given weak acid using Glass electrode-Ag/AgCl electrode assembly
4	Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution
5	Colorimetric estimation of Copper
6	Determination of total hardness of a given water sample
7	Determination of percentage of Cu from the given brass sample
8	Determination of percentage of Fe in the rust solution by external indicator Method
9	Determination of first order reaction constant for acid hydrolysis of ethyl acetate
10	Electroplating of copper*
11	Determination of composition of brass alloy using UV-Vis spectroscope*
12	Measurement of voltage in a hydrogen-oxygen fuel cell*
13	Preparation of printed circuit board*
14	Construction and operation of lead acid battery cell*
15	Determination of empirical formula of a fuel using exhaust gas analyzer*

* Demo experiments

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2						3								3	
CO-3							3							3	
CO-4			3										3		
CO-5							1							1	
CO-6		3		2						3			3	2	3
CO-7	3	2		3			2		1	3			3	3	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programmes. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3, LSC4 or LSC5), COs are assessed as illustrated in the following Table.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	**CE (Weightage: 50 %)**			**SEE (Weightage: 35 %)**	**Lab (Weightage: 15 %)**
	Tests	**Assignments**	**Lab CE**	**Written exam**	**LSEE: SEE**
	50 marks	**25 Marks**	**25 Marks**	**70 Marks**	**30 Marks**
CO-1	X			X	
CO-2	X			X	
CO-3	X			X	
CO-4	X	X		X	
CO-5	X			X	
CO-6		X		X	
CO-7			X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment

4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Gadag, R.V. and Nityananda Shetty A., (2010), Engineering Chemistry, Second Edition, New Delhi, I.K. International Publishing House
3. O.G. Palanna, (2011), Engineering Chemistry, New Delhi, Tata McGraw Hill Education Pvt Ltd.
4. Gurudeep Raj, (2014), Advanced Physical Chemistry, Meerut-Uttar Pradesh, Krishnan Prakashana
5. Pradeep. T, (2012) "A Text Book of Nanoscience and Nanotechnology", New Delhi, Tata McGraw Hill Company Ltd.

b. Recommended Reading

1. Pletcher, D. and Walsh, F.C., (1993), Industrial Electrochemistry, Second edition, UK, Blackie Academic and Professional
2. Kuriacose, J.C. & Rajaram, J., (1998), Chemistry in Engineering & Technology (Vol I & II), Third reprint, New Delhi, Tata McGrahill Company
3. C. N. R. Rao, Achim Muller and A.K. Cheetham, (2004), The Chemistry of Nanomaterials, Vol I & II, Weinheim, Wiley VCH.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. http://nptel.ac.in/
2. Electronic resources on the subject area are available on MSRUAS library

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Course Specifications: Elements of Mechanical Engineering and Workshop Practice

Course Title	Elements of Mechanical Engineering and Workshop Practice
Course Code	MEF104A
Course Type	Core Theory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing the students to understand the concepts and underlying principles of mechanical engineering. The students are taught various types of energy sources, power generation, energy conversion methods and types of power plants. Students are taught the working of IC engines, refrigeration and air-conditioning and power transmission elements. Students are also exposed to basic operations and applications of machine tools.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:0:1
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Demonstrate the understanding on Classification of energy sources, energy conversion systems, mechanical power transmission systems, machine tools and processes

CO-2. Describe various energy conversion systems, mechanical power transmission systems and machine tools

CO-3. Explain the working principle of refrigeration systems, biomass conversion technologies and machining operations

CO-4. Solve numerical problems on IC engines and mechanical power transmission systems

CO-5. Apply principles of energy conversion systems, power transmission systems, machining processes and mechanical joints to practical applications

4. Course Contents

Unit 1 (Energy Sources and its Conversion Devices): Energy sources and their classification, Fuels and their properties. Bio-mass energy, OTEC, Solar energy, Wind energy, Geo-thermal energy, Tidal energy, Nuclear Energy. Demonstration of Gas Turbine

Unit 2 (Boilers and Accessories): Steam boilers – classification, Lancashire boiler, Babcock and Wilcox boiler, working and function of boiler mountings and accessories. Demonstration of Steam Turbine

Unit 3 (Hydraulic Pumps and IC engines): Classification, Principles and operations of Reciprocating and rotary types of pumps and compressors.
Internal Combustion Engines: Classification of IC Engines, engines components, 2 and 4–Stroke Petrol and diesel engines, P-V diagrams for Otto and Diesel cycles, IC engine performance-numerical on IC engines, electric and Hybrid vehicles. Demonstration of Pumps, Blower Compressors and Multi-cylinder Engine.

Unit 4 (Refrigeration and Air Conditioning): Properties of refrigerants, Performance of Refrigeration System - Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, Unit of Refrigeration, Energy Efficiency Ratio (EER). Principle and working of vapour compression refrigeration, vapour absorption refrigeration, comparison of vapour compression and vapour absorption refrigeration. Principles and applications of air conditioners, Room air conditioner, automotive air conditioning system

Unit 5 (Mechanical Power Transmission): Belt Drives - Classification and applications, Length of belt, Velocity ratio, Creep and slip, Idler pulley, stepped pulley and fast and loose pulley, beltand pulley construction. Demonstration of Open and Cross Belt drive. Applications of chain drive and rope drives. Gear Drives: Definitions, Terminology, types and uses, Gear Drives and Gear Trains – Simple problems on gear drives. Demonstration of Simple and Compound Gear Trains. Importance of machining and machine tools

Unit 6 (Machine Tools and Mechanical Joints): Lathe - Principle of working of a Centre Lathe, Parts of a lathe, Lathe Operations. Drilling Machine – Principle of working and classification of drilling machines, types of drilling machines, drilling operations. Demonstration of working of Lathe and drilling machines along with different operations performed. Mechanical Joints: Temporary and permanent fasteners- Threaded fasteners, Riveted joints, welded joints, Knuckle joint, cotter and pin joints, couplings. Demonstration of Fitting operations, Sheet Metal operations, Arc Welding, Fasteners and Couplings.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3												3		
CO-3	3												3		
CO-4		3											3		
CO-5		3											3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	

3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		20
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	30	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X	X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. V. K. Manglik, 2013, Elements of Mechanical Engineering, PHI Learning
3. K. R. Gopalakrishna, 2008, Elements of Mechanical Engineering, Subhash Publishers

b. Recommended Reading

1. G.D. Gokak, J.K. Kittur, 2014, Elements of Mechanical Engineering, Wiley publications
2. G. S. Sawhney, 2003, Fundamental of Mechanical Engineering, Prentice Hall of India Publication
3. S. Trymbaka Murthy, 2006, A Text Book of Elements of Mechanical Engineering, 3rd Revised Edition, I .K. International Publishing House Pvt. Ltd.
4. K. P. Roy and S. K. Hajra Chaudhary, 2005, Elements of Mechanical Engineering, Media Promoters and Publishers Pvt. Ltd.

c. Magazines and Journals

1. ASME Mechanical Engineering Magazine
2. Machine Tools

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/
3. www.asme.org

e. Other Electronic Resources

1. Electronic resources on the course area are available on RUAS library

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Course Specifications: Elements of Electrical Engineering and Laboratory

Course Title	Elements of Electrical Engineering and Laboratory
Course Code	EEF105A
Course Type	Core Theory and Laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. **Course Summary**

This course deals with basic principles and concepts of electric and magnetic circuits. Students are taught construction, principle of operation, working, characteristics of DC machines, transformers and AC rotating machines. They are introduced to fractional-kW motors, special purpose machines and facilitated to understand measuring instruments, domestic wiring and earthing techniques. Basic electrical laboratory deals with practical applications of circuits and their theoretical concepts.

2. **Course Size and Credits:**

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Electrical Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. **Course Outcomes (COs)**

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

CO-1. State and explain various laws of electric circuits, magnetic circuits and their significance, phasor diagrams for electrical elements
CO-2. Explain construction, principle of operation, working and characteristics of DC machines, transformers, AC rotating machines and their applications
CO-3. Derive equations for electrical circuits, magnetic circuits and performance of various AC and DC machines
CO-4. Solve problems on electric circuits, magnetic circuits, DC machines, transformers and AC rotating machines
CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values
CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

4. **Course Contents**

Unit 1 (Circuit Analysis Technique-I): DC Fundamentals: Circuit elements, voltage and current division, Ohm's law and Kirchhoff's laws, mesh analysis, nodal analysis, source transformations, application of star delta transformation, Thevenin's theorem, maximum power transfer theorem, superposition theorem.

Unit 2 (Circuit Analysis Technique-II): A.C. Fundamentals: Sinusoidal voltage and currents, period, frequency, instantaneous, peak, average, r.m.s. values, peak factor and form factor, phase difference, lagging, leading and in phase quantities. Simple R, L and C circuits.

Unit 3 (Magnetic Circuits): Magnetic effect of electrical current, cross and dot convention, right hand thumb rule and cork screw rule, Fleming's right hand rule, Fleming's left hand rule, Faraday's law of electromagnetic induction, statically and dynamically induced EMF's, concepts of m.m.f, flux, flux density, reluctance, permeability and field strength, basic analogy between electric and magnetic circuits.

Unit 4 (DC Machines): Constructional details, working principle and methods of excitation of DC machine as a generator and a motor. EMF equation of generator, relation between inducedEMF and terminal voltage with brush contact drop, back EMF, torque equation of a DC motor.

Unit 5 (Transformers and AC Rotating Machines): Single Phase Transformers: Necessity of transformer, Constructional Details (core and shell types), Principle of operation, Ideal Transformer and Practical Transformer. EMF equation, Losses, Transformer Test, Circuit Model of Transformer, Determination of Parameters of Circuit Model of Transformer, Impedance shifting, Efficiency and Regulation Calculations
Three phase induction machine: Constructional details, principle of operation, slip and rotor frequency.

Unit 6 (Domestic Wiring): Domestic wiring, concealed conduit wiring, two-way and three-way control

Unit 7 (Laboratory): List of Experiments

No.	Course Content for Laboratory
1	Verification of KVL and KCL for DC circuits
2	Verification of superposition theorem
3	Verification of Thevnin's theorem
4	Verification of maximum power transfer theorem
5	Verification of mesh analysis
6	Verification of node analysis
7	Determination of relationship between phase and line voltages; Phase and line currents in a three phase system
8	Determination of efficiency of a single phase transformer
9	Analysis of load characteristics of DC shunt motor
10	Wiring of two-way and three-way switching of lamp

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2				2	2			1		1	3	2	1
CO-2	3	2				2	2					1	3	2	1
CO-3	3	2	2									1	3		1
CO-4	3	3	2		2				1	1		1	3	2	1
CO-5	3	3	3	2	2	2			1	1	1	1	3	2	1
CO-6	3	3	3	2	2				1	1	1		3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	30	
Practical Work		30
1. Course Laboratory	20	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3 and LSC4), COs are assessed as illustrated in the following Table.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	**CE (Weightage: 50 %)**			**SEE (Weightage: 35 %)**	**Lab (Weightage: 15 %)**
	Tests	**Assignments**	**Lab CE**	**Written exam**	**LSEE: SEE**
	50 marks	**25 Marks**	**25 Marks**	**70 Marks**	**30 Marks**
CO-1	X			X	
CO-2	X			X	
CO-3	X			X	
CO-4	X	X		X	
CO-5	X	X		X	
CO-6		X	X		X

The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Edward Hughes, 2011, Electrical and Electronics Technology, 10th edition, Dorling Kindersley India Pvt. Ltd.
3. Del Toro V. 2008, Electrical Engineering Fundamentals, PHI

b. Recommended Reading

1. Mittle V. and Arvind Mittle, 2007, Basic Electrical and Electronics Engineering, Tata McGraw Hill, New Delhi
2. Delton Horn T. 1993, Basic Electricity and Electronics, McGraw-Hill Limited, Europe

c. Magazines and Journals

1. IEEE Circuits and Designs magazine

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

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Course Specifications: Elements of Computer Science and Engineering

Course Title	Elements of Computer Science and Engineering and Laboratory
Course Code	CSF106A
Course Type	Core Theory and laboratory
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide an understanding of the elements of computer science and engineering and development of computer programs using algorithmic and programming constructs, for students across streams. Elements and methods of computer science and engineering and their applications to engineering computational problems are discussed using illustrative examples. Students are taught the methodology of solving computational problems algorithmically, programming concepts and constructs, basic algorithms and data structures. They are also exposed tothe practice of software development, modern computing systems and their scope for engineering applications.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the elements and methodology of Computer Science and Engineering
CO-2. Explain the basic principles and techniques of algorithms and programming
CO-3. Select appropriate approach to solve a computational problem
CO-4. Design an algorithmic solution and draw a flow chart of the solution
CO-5. Develop computer programs for moderately complex problems
CO-6. Test and validate developed computer programs

4. Course Contents

Unit 1 (Introduction): Computers and other computing devices, interface between Computer Science and Engineering (CSE) and other disciplines, idea of computing, nature and purpose of CSE, software and computer programs, practice of CSE. Relationship between data, information and knowledge.

Unit 2 (Problem Solving using Computers): Algorithmic problem solving. Flowcharts: symbols and meaning. Drawing flowcharts for simple problems. Fundamental algorithms, efficiency. Example of algorithms in practice: Illustration of algorithms for numerical computation, simulation and data processing in engineering domains. Lab Exercises on Problem Solving Using Computers.

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Unit 3 (Building Blocks of Computer Programs): Programming languages and process of compiling and program execution. Data representation and storage. Python programming language, IDEs and Workbooks. Data types, variables and keywords. Program structure. Simple data manipulation and logical statements, lists, tuples, sets and dictionaries, conditional and looping control statements, functions, nested expressions, recursion. Plotting and other utility libraries. Lab Exercises on Building Blocks of Computers.

Unit 4 (Elements of Computer Programming): Elements of good programming style, decomposing problems, moving from algorithm to code, random number generation, testing and validation of programs. Lab Exercises on Problem Solving Using random number generation.

Unit 5 (Basic Algorithms and Data Structures): Iterative and recursive algorithms, algorithms for search, sorting algorithms, idea of a data structure, basic data structures and algorithms, and their use. Lab Exercises on Problem Solving Using Iterative and recursive algorithms.

Unit 6 (Algorithm Design): Recursion, Brute force, Divide and conquer, Greedy approaches. Introduction to Backtracking and Dynamic programming.

Unit 7 (Modern Computing Systems): Software development process, operating systems, network of computers, distributed computing, high performance computing, Internet and Web technology, cloud computing.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1	3	2	2	2		1			1	2	3	2	2
CO-2	2	1	3	2	2	2		1			1	2	3	2	2
CO-3	2	1	3	2	2	2		1			1	2	3	2	2
CO-4	2	1	3	2	2	2		1			1	2	3	2	2
CO-5	2	1	3	2	2	2		1			1	2	3	2	2
CO-6	2	1	3	2	2	2		1			1	2	3	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	

3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**85**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

For Combined Courses (Theory + Laboratory)					
Focus of COs on each Component or Subcomponent of Evaluation					
Course Outcome	**CE (Weightage: 50 %)**			**SEE (Weightage: 35 %)**	**Lab (Weightage: 15 %)**
	Tests	**Assignments**	**Lab CE**	**Written exam**	**LSEE: SEE**
	50 marks	**25 Marks**	**25 Marks**	**70 Marks**	**30 Marks**
CO-1	X			X	
CO-2	X			X	
CO-3	X			X	
CO-4	X	X		X	
CO-5	X	X		X	
CO-6		X	X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving Cos

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Dromey, R. G., 1982, How to Solve It by Computer, New Delhi: Pearson Education.

b. Recommended Reading

1. Downey, A. B., 2016, Think Python: How to Think Like a Computer Scientist, O'Rielly.
2. Polya, G., 1990, How to Solve It: A New Aspect of Mathematical Method, 2nd edn. New Delhi: Penguin Books.
3. Aho, A. V., Hopcropt, J. E., and Ulman, J. D., 1974, The Design and Analysis of Computer Algorithms, New Delhi: Pearson Education.

c. Magazines and Journals

1. Quanta Magazine Computer Science Section, http://www.quantamagazine.org/ computerscience
2. Dr. Dobb's Journal, http://drdobbs.com/
3. Lifehacker, https://lifehacker.com/

d. Websites

1. Association of Computing Machinery (ACM), http://www.acm.org/
2. IEEE Computer Society, http://www.computer.org/

e. Other Electronic Resources

1. Electronic resources on the course area available on MSRUAS library
2. Think Python online: http://openbookproject.net/thinkcs/python/english2e/

Course Specifications: Professional Communication

Course Title	Professional Communication
Course Code	TSN102A
Course Type	Ability Enhancement Compulsory Course
Department	Applicable to all Programmes
Faculty	Engineering and Technology

1. Course Summary

This course aims at equipping students with the skills required for effective communication in professional context. The students will be guided through professional practices of written and oral communication. Students will be sensitized to the importance of professional etiquette. Students will be taught to apply oral and written communication skills in a given situation.

2. Course Size and Credits

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Directorate of Transferable Skills and Leadership Development
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Apply the concepts of grammar for communication
CO-2. Compose precise paragraphs
CO-3. Demonstrate professional etiquette
CO-4. Demonstrate appropriate verbal and non-verbal communication in the given context
CO-5. Develop professional written document

4. Course Contents

Unit 1 (Grammar for Effective Communication): Sentence formation, sentence types, different parts of speech, adjectives and articles, verbs and preposition, present and past tense, future tense,use of participles in different tenses, usage of tenses, rules of subject verb agreement, Direct and indirect sentences, usage of direct and indirect sentences

Unit 2 (Communication – Verbal: Written): Paragraph Writing: Structure of a paragraph – topic sentence, supporting sentence, conclusion sentence, functions of paragraph, paragraph patterns, paragraph writing principles – coherence, unity, order, length; Précis Writing: Paraphrasing techniques, Usage of appropriate words;

Report Writing: Purpose of report writing, report format, use of language while report writing

Unit 3 (Communication-Nonverbal): Meaning, Nature and importance, Kinesics, Proxemics, Time, Paralanguage, Touching Behavior, Body Language, effects of nonverbal communication on verbal communication

Unit 4 (Professional Etiquette): Etiquette and its importance, types of etiquette - email etiquette, telephone etiquette, conversation; Body language in conversation, tones in conversation, conversation manners, stages of conversation – introduction, feed forward, close, order of introduction, conversation barriers

Unit 5 (Presentation): The importance of presentation skills, various stages of presentation planning – development of structure and style, interpersonal sensitivity, presentation accessories and equipment, time management during presentation, stages of presentation – introduction, body and conclusion, presentation etiquette

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1										2					2
CO-2										3					3
CO-3									3						3
CO-4									3	3					3
CO-5										3					3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		0
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		04
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	04	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		06
1. Case Study Presentation	02	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	02	
6. Discussing Possible Innovations	00	
Mid Terms, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B.Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.
Focus of CO's on each Component or Subcomponent of Evaluation:

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		**Component 2: SEE (40% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**50 Marks**
Maximum Marks ▸	**25**	**25**	
CO-1	X	X	X
CO-2			X
CO-3		X	X
CO-4	X		
CO-5	X	X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Face to face lectures
2.	Understanding	Face to face lectures, group discussions
3.	Critical Skills	--
4.	Analytical Skills	Face to face lectures, activities, , group discussions, assignment
5.	Problem Solving Skills	--
6.	Practical Skills	Face to face lectures, activities, , group discussions, course work

7.	Group Work	Course work, practice, assignment, group discussion
8.	Self-Learning	Course work, practice, assignment, group discussion
9.	Written Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
10.	Verbal Communication Skills	Face to face lectures, Course work, practice, assignment, group discussion
11.	Presentation Skills	--
12.	Behavioral Skills	Course work, practice, assignment, group discussion, presentation practice, role plays
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Course Resources**

a. **Essential Reading**

1. Class Notes
2. Raman M and Sharma S (2004) Technical Communication: Principles and Practice. New Delhi: Oxford University Press
3. Hory Sankar Mukherjee, (2013), Business Communication, Oxford University Press
4. Kroehnert, Gary (2004), Basic Presentation Skills, Tata McGraw Hill

b. **Recommended Reading**

1. Sathya Swaroop Debashish and Bhagaban Das, (2014), Business Communication, PHI, New Delhi
2. Young, Dona J (2006) Foundations of Business Communications:
3. An Integrated Approach, Tata McGraw Hill
4. Kaul, Asha (2007) Effective Business Communication, Prentice Hall India
5. Bienvenu, Sherron (2008) The Presentation Skills Workshop, Prentice Hall
6. KavitaTyagi and Padma Misra (2011) Professional Communication, PHI Learning Private Limited, New Delhi

c. **Magazines and Journals**

d. **Websites**

1. www.myenglishpages.com
2. www.britishcouncil.com
3. www.englishmagazine.com
4. www.justenglishmagazine.com

e. **Other Electronic Resources**

1. Electronic resources on the course area are available on RUAS library

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Course Specifications: Complex Analysis and Vector Calculus

Course Title	Complex Analysis and Vector Calculus
Course Code	MCC201A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to introduce the concepts of integral calculus and Complex analysis. Students are taught the concepts of line integral, double integral, vector integration, continuous functions in complex plane, analytic functions, complex integration, power series, residues, and conformal mapping.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Explain basic concepts in multiple integrals, vector integration and complex plane
- **CO-2.** State and prove important theorems related to multiple integrals, vector integration, analytic functions, and complex integration in C
- **CO-3.** Solve simple problems related to multiple integrals, vector integration, analytic functions, power series and complex integration
- **CO-4.** Model real world problems using multiple integrals, vector integration and properties of analytic functions
- **CO-5.** Solve complex problems related to multiple integrals, vector integration, analytic functions, power series and complex integration

4. Course Contents

Unit 1 (Complex analysis): Complex numbers and elementary properties; Complex functions - limits, continuity and differentiation, Cauchy-Riemann equations, analytic and harmonic functions, elementary analytic functions, anti-derivatives and line (contour) integrals, Cauchy-Goursat theorem, Cauchy's integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra and maximum modulus principle; Power series: Taylor series, zeros of analytic functions, singularities and Laurent series, Rouche's theorem and argument principle, residues, Cauchy's Residue theorem and applications, Mobius transformations and applications.

Unit 2 (Integral calculus): Line and double integrals, change of order of integration, change of variables, polar coordinates. Applications of double integrals. Triple integrals, change of variables, cylindrical and spherical coordinates. Line integral, green's theorem, surface integral, Stokes' theorem, volume integral and divergence theorem.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2											3		
CO-2	3	2											3		
CO-3	3	3							1	1			3		1
CO-4	3	3							1	1			3		1
CO-5	3	3							1	1			3		1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Zill D. and Shanahan P. (2013), *Complex Analysis*, 3rd edition, Jones, and Bartlett
3. Zill D. and Wright, W. S. (2012), *Advanced Engineering Mathematics*, 5th edition, Jones, and Bartlett

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b. Recommended Reading

1. Brown J. and Churchill, R. V. (2017), *Complex Variables and Applications*, 8th edition, McGraw Hill Education
2. Spivak, M. (2006), *Calculus*, 3rd edition, Cambridge University Press
3. Marsden, J. E. and Tromba, A. (1996) *Vector Calculus*, 2nd edition, Freeman, and Company.

Magazines and Journals

c. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

d. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://www.khanacademy.org/
3. tutorial.math.lamar.edu/

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Course Specifications: Probability and Statistics

Course Title	Probability and Statistics
Course Code	MCC202A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aims to teach elements of Probability Theory, Stochastic Processes and Statistics useful in modelling and analysis of Computer Science and Engineering systems, especially data science, machine learning, simulation, computer networks and operating systems. Probability spaces, random variables, conditioning, distributions, expectations, and Probability Laws are taught. Stochastic Processes are introduced. Statistics, Statistical estimation, and Hypothesis Testing are covered.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the basic concepts and techniques of Probability and Statistics.
CO-2. Explain the principles and applications of basic probability models and statistical techniques
CO-3. Develop probabilistic and statistical models for a given application
CO-4. Solve and analyse probabilistic and statistical models
CO-5. Apply probability models and statistical techniques to solve a complex problem

4. Course Contents

Unit 1 (Probability Specs): Introduction: Randomness and probability models. Outcomes, events, probabilities, and probability space. Axioms of probability. Discrete probability spaces: Sample space, atomic and compound events, probability, exclusive events, conditional probability, and independence. Partitions and Total Probability. Bayes' rule. Product sample spaces and probabilities. Continuous probability spaces: Simple generalizations of discrete probability notions.

Unit 2 (Random Variables): Definition. Examples of discrete- and continuous-valued random variables on discrete and continuous probability spaces. Probability Density Function (PDF), Cumulative Density Function (CDF) of a random variable. Distribution Function induced by a random variable. Commonly used discrete and continuous distributions and random variables: Bernoulli, Binomial, Geometric, Uniform, (Negative) Exponential, Poisson and Gaussian/Normal. Functions of random variables. Simulation of random variables.

Unit 3 (Algorithmic Design Techniques): Brute-Force. Greedy algorithms: Elements of greedy strategy,

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Examples: Huffman Codes, 0/1 Knapsack, and Prim and Kruskal's MST Algorithms. Divide and Conquer: Merge Sort, Strassen's algorithm, Branch-and-Bound, Backtracking, Dynamic Programming: Concept and methodology, Examples: Matrix chain multiplication, optimal binary search trees, Floyd-Warshall algorithm, n-Queen's problem

Unit 4 (Joint distribution): Joint distribution of two and more random variables. Conditional probability distribution. Independent and IID random variables. Distribution of the sum of random variables: convolution. Distributions of the maximum and the minimum of IID random variables.

Unit 5 (Expectation): Expected value, Change-of-variable formula, Jensen's Inequality. Variance. Independent random variables. Covariance and Correlation Coefficient. Mean and variance of sums of random variables. Limit Theorems: Law of Large Numbers. Central Limit Theorem.

Unit 6 (Statistics): Elements of a statistical models: statistical experiments, random samples, and outcomes. Univariate sample statistics and empirical estimation: sample mean, variance, standard deviation, empirical distribution functions. Histogram. Descriptive statistical summary of a distribution: mean, median and variance. Quantiles and quartiles, Box-and-whisker plot. Bivariate data sets and scatter plots.

Unit 7 (Stochastic Processes): Idea of a stochastic process. Bernoulli and Poisson Processes. Geometric distribution of first passage times. Discrete Time Markov Chains: Probability Transition Matrix, steady-state probability vector and its computation.

Unit 8 (Statistical Methods): Unbiased estimators: Sample statistic, estimator, and bias. Unbiased estimators of the expectation and variance. Mean Squared Error. Linear regression. Least squares method. Confidence Intervals. Estimating the sample size. Hypothesis Testing: Null- and alternative-hypotheses, test statistic and p-values. Type I and Type II errors. Significance level, critical region, and critical values. Neyman-Pearson approach. t-Test. Comparing two samples.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3												3	1
CO-2	3	3												3	1
CO-3	3	3		3	2	1			2			1		3	1
CO-4				3	2	1			2			1			
CO-5				3	2	1			2			1			
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		

1. Solving Numerical Problems	15	15
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

4. Class notes
5. Dekking, F. M., Kraaikamp, C., Lopuhaa, H. P., and Meester, L. E. (2005) A Modern Introduction to Probability and Statistics, Springer

b. Recommended Reading

1. Rice, J. A. (2007) Mathematical Statistics and Data Analysis, 3rd edn., Thomson Books/Cole.
2. Ross, S. M. (2014) Introduction to Probability and Statistics for Engineers, 5th edn., Academic Press.
3. Trivedi, K. S. (2016) Probability and Statistics with Reliability, Queuing and Computer Science Applications, 2nd edn., Wiley.
4. Unpingco, J. (2016) Python for Probability, Statistics and Machine Learning, Springer

c. Magazines and Journals

1. ACM Transactions on Algorithms

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. The Stony Brook Algorithm Repository http://www.cs.sunysb.edu/~algorith/

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Course Specifications: Discrete Mathematics

Course Title	Discrete Mathematics
Course Code	CSC201A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to teach the principles, concepts and applications of logic and discrete mathematical structures. Basic discrete structures of sets, relations and functions are taught. Propositional and Predicate Logic, inference rules, logical proof of mathematical statements are covered. Proof techniques, mathematical induction and recursion are discussed. Abstract algebraic structures of partitions, partially ordered sets (posets), lattices, algebras, groups, rings and fields are taught. Students are exposed to analyze logical and algebraic structures arising in computing contexts.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the concepts and theories of sets, logic, integer arithmetic and algebraic structures Classify and describe types of digital circuits

CO-2. Explain the principles and applications of set theory, logic, integer arithmetic and abstract algebra

CO-3. Apply set theory, logic, integer arithmetic and abstract algebra to solve a given problem

CO-4. Develop models of computing systems using logical and algebraic structures for given application

CO-5. Analyze the properties and behavior of algorithms, programs and computing systems using logical and algebraic constructs

4. Course Contents

Unit 1 (Basic Discrete Structures): Review of basic set theory, relations and functions. Useful sets and functions. Cartesian product and exponentiation of sets. Inverses, composition and powers of relations and functions. Characteristic Functions, and bitmap representation of subsets. Matrices, Boolean matrices and their operations. Set cardinality. Infinite sets countable and uncountable.

Unit 2 (Logic): Logic and its role in Mathematics and Computer Science. Propositional Logic: Propositions. Logical Connectives. Well Formed Formulas. Inference Rules. Truth Tables. Deductive Proofs. Validity, Soundness and Completeness. Predicate Logic: History and need for Predicate Logic. Variables.

Quantifiers. Predicates. Inference Rules. Deductive Proofs. Soundness, Completeness and Undecidability.

Unit 3 (Counting): Basic counting principles: Product, Sum and Inclusion-Exclusion rules. Permutations and Combinations: Definitions. Binomial Theorem. Binomial coefficients and Identities. Generalized permutations and combinations. Generating permutations and combinations. Solution of linear recurrence relations. Generating functions and solution of recurrence relations. Generalized Inclusion-Exclusion Principle and its applications to counting. Pigeonhole Principle and its applications. Introduction to Ramsey Theory and its applications.

Unit 4 (Integer Arithmetic and Applications): Divisibility. Fundamental theorem of algebra. Modular Arithmetic. Modular Number Systems. GCD and LCM. Progressions. Prime numbers. Congruencies. Fermat's Little Theorem. Solution of congruencies. Chinese Remainder Theorem. Fast Modular Exponentiation. Applications to Hashing, Pseudo-random number generation and encryption.

Unit 5 (Proof Techniques): Proof Techniques: Idea of a mathematical proof. Direct and Indirect proofs. Proof by contradiction and contraposition. Counter examples. Mathematical Induction: Successor function. Peano's Axioms. Induction Principle. Weak and Strong (First and Second Principles of) Mathematical Induction. Structural Induction. Recursion: Recursively defined functions and sets. Recursive Algorithms. Program Verification: Program correctness. Hoare Logic. Proof calculus of programming constructs. Loop Invariants.

Unit 6 (Abstract Algebra and Applications): Relational Algebra and applications: Matrix and digraph representation of relations. Binary and n-ary relations. Powers and algebra of relations. Relational Data Modelling. Reflexivity, symmetry, anti-symmetry and transitivity. Closure of relations: Transitive closure, paths and computation of transitive closure. Equivalence Relations: Equivalence Classes and Partitions. Ordering: Ordered sets. Partial and well ordering. Posets and Hesse diagrams. Lattices. Linearization (topological sorting) of Posets.

Unit 7 (Abstract algebra and applications): The conceptual approach of Abstract Algebra. Definitions of Monoids, Groups, Rings and Fields. Group Theory: Semigroups, sub-groups and permutation groups. Lagrange's Theorem. Normal groups. Applications to Coding theory: Concept of a code, block codes and group codes. Hamming codes. Lattices, Rings and Applications: Distributive and modular lattices. Rings. Integer domains and commutative rings. Fields. Ideals and Quotient Rings. Divisibility and Division Algorithm. Unique Factorization Theorem. Polynomial rings over fields. Complex roots of unity and applications. Finite fields and applications.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1	2	1		3	1	1		2		2	2	2	1
CO-2	2	1	2					1			1		1	1	
CO-3	2	1	2	1		3	1				2		1	2	
CO-4	2	1	2	1		3	1	1			2		1	2	
CO-5	2	1	2	1		3	1				2		1	1	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Rosen, K. A., 7th edition, 2017, Discrete Mathematics and its Applications, Tata McGraw-Hill.

b. Recommended Reading

1. Biggs, N. L., 2003, Discrete Mathematics, 2nd edn., Oxford University Press.
2. Huth, M., and Ryan, M., 2004, Logic in Computer Science: Modelling and Reasoning about Systems, 2nd edn., Cambridge University Press.
3. Birkhoff, G., and Bartee, T. C., 1987, Modern Applied Algebra, CBS Publications.
4. Cormen, T. H., Leiserson, C. E., Rivest, R. L., and Stein, C., 2010, Introduction to Algorithms, 3rd edn., PHI.
5. Lipschutz, S., and Lipson, M. L., Revised Third edition, 2017, Discrete Mathematics, McGraw-Hill.

c. Magazines and Journals

1. SIAM Journal on Discrete Mathematics
2. Discrete Mathematics journal, Elsevier
3. Mathematics in Computer Science journal, Springer
4. Applicable Algebra in Engineering, Communication and Computing journal, Springer.
5. Mathematical Structures in Computer Science, Cambridge University Press 6. SIAM News

d. Websites

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1. ACM SIGSIAM (Symbolic and Algebraic Manipulation) http://www.sigsam.org/
2. ACM SIGACT (Algorithms and Computation Theory) http://www.sigact.org/

e. Other Electronic Resources

1. https://jupyter.org/
2. https://oeis.org/

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Course Specifications: Data Structures Foundation

Course Title	Data Structures Foundation
Course Code	CSD201A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing the students to understand and apply the principles of data structures and algorithms, implement standard data structures and develop algorithms for efficient computer programs. A broad range of abstract data types as well as algorithms for data storage, access and manipulation used in program development are taught. Data representation in computer memory, features of linear and non-linear data structures, algorithms for searching and sorting, analysis of computational time and space usage are covered. Students are trained to develop applications using appropriate data structures and algorithms. Students implement and test computer programs in Python language.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe Linear and Non- Linear data structures such as Stacks, Queues, Linked Lists and Trees
CO-2. Explain the approaches used to implement the data structures
CO-3. Discuss the working of standard data access and manipulation algorithms
CO-4. Implement Stacks, Queues, Linked Lists and Trees
CO-5. Recommend a suitable data structure and algorithm for modeling a given scenario
CO-6. Develop computer programs using data structures to solve moderately complex problems

4. Course Contents

Unit 1 (Stacks, Queues, and Deques): Stacks, Queues, and Double-Ended Queues

Unit 2 (Linked Lists): Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists, Positional List ADT

Unit 3 (Trees): General Trees, Binary Trees, Implementing Trees, Tree Traversal Algorithms

Unit 4 (Priority Queues): The Priority Queue Abstract Data Type, Implementing a Priority Queue, Heaps, Sorting with a Priority Queue

Unit 5 (Maps, Hash Tables, and Skip Lists): Maps and Dictionaries, Hash Tables, Sorted Maps, Sets, Multisets, and Multimaps

Unit 6 (Search Trees): Binary Search Trees, Balanced Search Trees, and AVL Trees

Unit 7 (Sorting and Selection): Why Study Sorting Algorithms, Merge-Sort, Quick-Sort, and Selection

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		1			1						3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		3				1	3			3		
CO-5	3	3	3		3				1	3			3	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		15
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

3. Class Notes
4. Goodrich, M.T., Tamassia, R. and Goldwasser, M.H., 2013. Data structures and

algorithms in Python. John Wiley & Sons Ltd.

b. Recommended Reading

1. Necaise, R.D., 2011. Data structures and algorithms using Python. Wiley.

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

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Course Specifications: Logic Design

Course Title	Logic Design
Course Code	CSD202A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to prepare students to design basic logic circuits and components used in a computer. Students are taught the principles and techniques of sequential and combinational logic circuits. Simulation of digital logic elements and their optimization for design and implementation of digital logic circuits and their applications are covered. Students are trained to build, simulate and test digital circuits.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the elements of switching and digital design
CO-2. Explain the principles and techniques of sequential and combinational logic circuits
CO-3. Apply principles of sequential and combinational logic to design digital circuits
CO-4. Analyze and optimize digital logic circuits
CO-5. Design the digital components of a computer using digital logic circuits
CO-6. Test and validate digital logic circuits

4. Course Contents

Unit 1 (Introduction): Need for Logic, Reasoning and Propositional logic in the real world, Real world its Analogous nature, Analog system merits and demerits, Sampling theorem, examples and problems, Analog to digital conversion, Problems. Number system binary, octal and hexadecimal, and conversion, Codes- BCD, Gray Code, Excess-3 Code, ASCII, EBCDIC, Conversion between various Codes

Unit 2 (Logic and Boolean Laws): Data, Information and knowledge representation using bits. Real world system representation using bits, checking the status and controlling bits. Application based on Boolean algebra and Logic gates: Axiomatic definition of Boolean algebra, Basic theorem and properties of Boolean algebra, Boolean functions, Canonical and standard forms, Digital logic gates, Integrated circuits Gate-Level Minimization: The Map method, Karnaugh Maps, Product-of-Sum simplification, Don't care condition, NAND and NOR Implementation, Exclusive-OR-function

Unit 3 (Combinational Logic): Combinational circuits, Analysis and design procedures, Binary Adder-Subtractor, Decimal Adder, Ripple carry adder and carry look ahead adder, BCD adder, Binary Multiplier, Magnitude comparator, Decoders and encoders, Multiplexers

Unit 4 (Synchronous Sequential Logic): Sequential circuits design, Latches, Flip flops, Analysis of clocked sequential circuits, State reduction and state assignment, Design procedure. Counters and Registers: Registers, Shift Registers, Ripple Counters, Synchronous Counters, Other Counters

Unit 5 (Memory and Programmable Logic): Introduction, Random Access Memory, Memory decoding design, Error detection and correction Hamming code, Read-Only Memory, Programmable Logic Array.

Unit 6 (Tutorial): Exercises and Practical's of the topics in the above Units.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1		2				1							3		1
CO-2		2				1							3		1
CO-3		2	2	3	2	1	1						3		1
CO-4	3		2	3	2		1						3	2	1
CO-5	3		2	3	2		1							2	1
CO-6	3		2	3	2		1							2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		15
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	

5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments
5.	Problem Solving Skills	Classroom lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	–

11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

5. Class Notes
6. Mano, M.M. and Ciletti, M.D., 2007, Digital Design, 4th Ed., Prentice-Hall.

b. Recommended Reading

1. Jain, R.P., 2010, Modern Digital Electronics, 3rd Ed., Tata McGraw-Hill.
2. Floyd, T.L., 2007, Digital Fundamentals, 8th Ed., Pearson Education.
3. Ananda Kumar, A., 2009, Switching Theory and Logic Design, Prentice Hall of India.

c. Magazines and Journals

1. IEEE transaction on Electronic Computers
2. IEEE Design & Test of Computers

d. Websites

1. https://www.ieee.org/
2. http://sigact.org/

e. Other Electronic Resources

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Course Specifications: Innovation and Entrepreneurship

Course Title	Innovation and Entrepreneurship
Course Code	BAU201A
Course Type	Core Theory Course
Department	Management Studies
Faculty	Management and Commerce

1. Course Summary

This course on Innovation and Entrepreneurship is introduced across all the undergraduate programs with an aim to impart comprehensive knowledge of an entrepreneurial ecosystem. Further, the course enables to develop entrepreneurial skills by building entrepreneurial intentions among students. The students also gain knowledge on competencies to provide with necessary inputs for creation of new ventures and scaling up existing startups. The students are also introduced to design thinking process to nurture entrepreneurial way of thinking.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Respective Department of the Faculty
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the concepts and process of Innovation as well as entrepreneurship
CO-2. Construct and apply the idea generation techniques
CO-3. Discuss the opportunities for launching of new venture and various entry strategies**CO-4.** Examine innovative ideas for the creation and management of entrepreneurship **CO-5.** Formulate and present a viable business plan to the investors' appraisal

4. Course Contents

Unit 1: Introduction to Entrepreneurship
Introduction to entrepreneurship, Evolution of the concept, Entrepreneurial process, Types of Entrepreneurship - Social entrepreneurship, rural entrepreneurship. Characteristics of an Entrepreneur, Incorporation of a Company, Managing a Family Business, Corporate Intrapreneurship

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Unit 2: Innovation and Creativity:
Types of Innovations. Identify Various Sources of Ideas for New Ventures, Methods Available for Generating New Venture Ideas - Creativity, Design Thinking and the Techniques for Creative Problem Solving. Aspects of the Product Planning and Development Process.

Unit 3
New Venture:
Creating Opportunities, Resources, Role of New Ventures and Small Businesses in the Economy, Types of Entry Strategies, Launch a New Venture and the Generic Strategies

Unit 4
Strategies to Sustain and Grow:
Strategies for Expansion, Joint Ventures, Acquisitions, Merges, Franchising, Growth Strategy, Exit Strategy.

Unit 5 Business Plan
Business plan, scope and value of the business plan, step-by-step explanation of the business plan, marketing plan, Organizational plan, financial plan (source of capital), entrepreneurship models

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	2	2	2									2			3
CO-2	3	2	2	2	3								3	2	
CO-3	3	3	2	2								2		2	
CO-4	3	2	2	2	2	3			3	3			2		3
CO-5	2	3		2							3		2	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Posters	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		03
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	03	
4. Clinical Laboratory	00	

5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	05	
2. Guest Lecture	01	
3. Industry / Field Visit	02	15
4. Brain Storming Sessions	02	
5. Group Discussions	04	
6. Discussing Possible Innovations	01	
Mid Terms, Laboratory Examination/Written Examination, Presentations		05
Total Duration in Hours		**45**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Program Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.
The evaluation questions are set to measure the attainment of the COs. In either component (CEor SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.

For Theory Courses Only			
Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Terms Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3		X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, shall provide the focus of COs in each component of assessment in the beginning of the semester to capture the Group Task evaluation parameters such as: field visit, presentation of business plan, case study presentation on success and failure companies. Ideating and running the business for a day inside the campus.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Class room lectures
2.	Understanding	Class room lectures

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3.	Critical Skills	Assignment
4.	Analytical Skills	Class room, assignment, examination
5.	Problem Solving Skills	Assignment, Field visit and presentation
6.	Practical Skills	Assignment
7.	Group Work	Case study Presentation
8.	Self-Learning	Assignment
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Case study and group discussions
11.	Presentation Skills	Case study and group discussions
12.	Behavioral Skills	Group discussions
13.	Information Management	Assignment
14.	Personal Management	Assignment and Group Discussion
15.	Leadership Skills	Group discussions and Case study

9. Course Resources

a. Essential Reading

1. Course notes
2. Hisrich, R., Peters, M. and Shepherd, D., 2020. *Entrepreneurship*. 11th ed.Noida: McGraw Hill.

b. Recommended Reading

1. Charantimath, P., 2018. *Entrepreneurship development and small businessenterprises*. 3rd ed. Belgaum, India: Pearson Education.
2. Roy, R., 2020. *Entrepreneurship*. 3rd ed. Noida: Oxford University Press.

c. Magazines and Journals

1. Business World: ABP Group
2. Journal of Small Business Management, Blackwell Publishing
3. Business Strategy: PwC Strategy & Inc.

d. Websites

1. India, S., 2022. *Homepage*. [online] Start-up India. Available at: <https://www.startupindia.gov.in/> [Accessed 10 July 2022].
2. Allsharktank, Products., 2022. *Homepage*. [online] All Shark Tank Products. Available at: <https://www.allsharktankproducts.com/> [Accessed 10 July 2022].
3. India, M., 2022. *Make In India*. [online] Makeinindia.com. Available at: <https://www.makeinindia.com/> [Accessed 10 July 2022].

e. Other Electronic Resources

NA

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Course Specifications: Python and Data Structures Laboratory

Course Title	Python and Data Structures Laboratory
Course Code	CSL204A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to train the students to design and develop computer programs of moderate complexity using data structures and algorithms in the engineering context. Students are trained to develop and document algorithms and computer programs for specified problems using a graded set of exercises and problems. Students implement and test computer programs using Python programming language. This course is also aimed at training the students to design, implement, analyze and integrate data structures and algorithms for the development of efficient computer programs. Algorithms are analyzed for their computational time and space complexities. Empirical performance of the implementations is measured and compared with the theoretical complexity measures. Students are required to generate a technical report documenting the laboratory effort.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Identify fundamental data structures and algorithms to solve a given problem
CO-2. Illustratethe working of different data structures
CO-3. Develop algorithms and programs to solve a given problem using appropriate data structures
CO-4. Design and develop solution for efficient sorting and searching operations
CO-5. Evaluate the empirical performance of implemented data structures and algorithms
CO-6. Document work done and prepare a laboratory report

4. Course Contents

1	Stacks, Queues, Double-Ended Queues
2	Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists
3	Binary Trees
4	Tree Traversal Algorithms
5	Priority Queue
6	Heaps
7	Sorting with a Priority Queue

8	Maps and Dictionaries
9	Hash Tables
10	Binary Search Trees, AVL Trees
11	Merge-Sort
12	Quick-Sort
13	Selection

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3							1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2			2	1	1			3		
CO-5	3	3	3		2			2	1	1			3	3	1
CO-6								2							
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	04	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X		X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

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9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. Goodrich, M.T., Tamassia, R. and Goldwasser, M.H., 2013. Data structures and algorithms in Python. John Wiley & Sons Ltd.

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Course Specifications: Additional Mathematics - 1

Course Title	Additional Mathematics - 1
Course Code	MTB202A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course introduces students to the basic concepts in real analysis, MATLAB programing and matrix algebra. Students are taught the concepts of limits, continuity, differentiation, series expansion for the functions of one and two variable, indefinite and definite integrals of single real variable functions. Basic concepts of vectors with necessary properties and operations are taught. The mathematical operations in Matrix theory, Eigen value and Eigen vector, Inversion and diagonalization of matrix and matrix solution for linear system of equations and implementation of the same using MATLAB are discussed in this course.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. State and explain the important theorems and solve simple mathematical problems in one variable calculus and vector algebra
CO-2. State theorems and solve simple problems in two variable calculus
CO-3. Solve complex real world problems associated with one and two real analysis
CO-4. Illustrate fundamentals of MATLAB programming and write simple programs
CO-5. Solve complex mathematical problems associated with linear algebra and compare the results with that of solutions obtained using MATLAB

4. Course Contents

Unit 1 (Single Variable Calculus): Functions of single real variable, limit, continuity and differentiation. Mean value theorems and their applications. Taylor's Theorem, Taylor and Maclaurin series. Indefinite integrals, methods of integration - integration by parts, integration by substitution, integration by method of partial fractions. Definite integral and its properties, the fundamental theorem of Calculus, areas between curves.

Unit 2 (Two Variable Calculus): Functions of two variables, limits, continuity and partial differentiation. Total differential, errors and approximations, tangent plane approximation of a surface. Partial differentiation of composite functions, unconstrained and constrained extrema

Unit 3 (Vector Algebra): Vectors, properties, vector components, magnitude and argument, dot and cross products.

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Unit 4 (MATLAB fundamentals): Introduction to MATLAB, Basic algebraic and matrix operations, built-in and command line functions. Graphics using MATLAB, 2D and 3D plots. Scripts and functions. Relational and logical operators, conditional statements and looping structures, simple programs.

Unit 5 (Linear Algebra): Matrix algebra, elementary row operations, row and reduced row echelon forms. Linear system of equations, existence and uniqueness of solution. Vector spaces, subspaces, linear independence, basis and dimension. Row, column and null space of a matrix. Linear transformations. Eigenvalues, eigenvectors and diagonalization

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2							1			3		1
CO-2	3	3	2							1			3		1
CO-3	3	3	2	1						1			3	1	1
CO-4	3	3	2	3						2			3	3	2
CO-5	3	3	2	3						2			3	3	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. **Course Resources**
   a. **Essential Reading**
      1. Class notes
      2. James Stewart, 2015, Calculus: Early Transcendentals, 8th edition, Boston, Cengage Learning
      3. Steven Leon, 2014, Linear Algebra with Application, 9th edition, New Jersey, Pearson
      4. Rudra Pratap, 2013, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, New York, Oxford University Press
   b. **Recommended Reading**
      1. Maurice D. Weir and Joel Hass, 2017, Thomas Calculus, 13th edition, New Jersey, Pearson
      2. Gilbert Strang, 2016, Introduction to Linear Algebra, 5th edition, Massachusetts, Cambridge Press
   c. **Magazines and Journals**
   d. **Websites**
      1. https://www.coursera.org/
      2. http://nptel.ac.in/
   e. **Other Electronic Resources**
      1. https://ocw.mit.edu/index.htm
      2. https://www.khanacademy.org/
      3. tutorial.math.lamar.edu/

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Course Specifications: Inferential Statistics

Course Title	Inferential Statistics
Course Code	MCC203A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to provide an understanding of inferential Statistics. The course introduces students to the basic definitions and concepts of inferential statistics. Students are taught the confidence intervals for mean, variance and standard deviation. This course discusses the hypothesis testing for mean, variance and standard deviation of small and large samples and the applications of Chi-Square distribution, student t distribution and F-distribution.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Explain the principles of confidence interval and hypothesis testing
- **CO-2.** Describe the steps involved in computation of confidence interval and formulation of hypothesis for significance tests
- **CO-3.** Solve simple mathematical problems associated with confidence interval and hypothesis testing
- **CO-4.** Model real world problems using confidence interval and hypothesis testing
- **CO-5.** Solve complex problems associated with confidence interval and hypothesis testing

4. Course Contents

Unit 1 (Estimation): Point estimation and interval estimation. Point Estimation: Unbiased estimation, consistent estimators and simple problems. Method of moments and maximum likelihood estimation.

Unit 2 (Confidence Intervals): Confidence intervals for the mean for small and large samples. Confidence intervals for population proportions. Confidence intervals for variance.

Unit 3 (Hypothesis Testing): Null and alternate hypothesis. Simple and composite, test functions, Critical region, Errors of Type I and Type II. Level of significance and power of the test. Tests concerning proportion: Single population, two populations.

Unit 4 (Tests concerning means): Single population, two population and bivariate population. Tests concerning variance: Single population, two populations.

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Unit 5 (Chi-square Test): Chi-Square-test for goodness of fit and test for independence of attributes.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3			2	1								3	2	
CO-2	3		3	2	1								3	2	
CO-3	2	3	3	2	1								3	2	
CO-4	2	3	3	2	1								3	2	
CO-5	2	3	3	2	1								3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Jack Carl Kiefer (2018*) Introduction to Statistical Inference*. Springer International Publishing

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A .G.
3. C. Radhakrishna Rao.C.(1965) *Linear Statistical Inference and Its Applications*. John Wiley and Sons, INC.

b. Recommended Reading

1. Hogg, Tannis, Rao, (1997*). Probability and Statistical Inference*. 7h Edition. Pearson Publication.
2. Pradeep Kumar Sahu. Santi Ranjan Pal and Ajit Kumar Das. (2015) *Estimation and inferential Statistics*. Springer International Publishing A.G.

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/

e. Other Electronic Resources

1. https://www.khanacademy.org/

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Course Specifications: Integral transforms

Course Title	Integral transforms
Course Code	MCC204A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with various transform techniques in the context of engineering problems. The rudimentary principles and important theorems in transforms are taught in this course. The assumptions, principles and distinguishing features of Fourier series, Fourier transform, Laplace transform and Z-transform are emphasized. This course also covers the underlying principles and applications of transform techniques in various engineering disciplines. This course also aims at solving engineering problems associated with Fourier series, Fourier transform and Laplace transform and Z-transform methods using MATLAB.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. State and explain the important theorems in Fourier series and transforms
CO-2. Solve simple problems in Fourier series and transforms
CO-3. Apply Fourier series, transforms in solving complex real world engineering problems
CO-4. Implement the plot of piecewise, periodic and Fourier series of a function in MATLAB and illustrate transforms in MATLAB.
CO-5. Apply transforms in analyzing some real-world problems

4. Course Contents

Unit 1 (Fourier Series): Periodic functions, Dirichlet's conditions for convergence of Fourier series, Fourier series for a periodic function of period T, half range Fourier series, complex Fourier series. Practical Harmonic analysis.

Unit 2 (Laplace Transforms): Definition, properties and theorems, transform of derivatives, integrals, periodic functions, unit step function, Dirac's delta function and time shifting property. Inverse Laplace transform, convolution theorem, solution of initial value problems

Unit 3 (Fourier Transform): Definition, Fourier transform of elementary functions, properties. Inverse Fourier transform, Finite Fourier transforms, solution of initial value problems. DFT and FFT.

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Unit 4 (Z-transform): Difference equations – Basic definitions. Z-transforms – Definition, Standard Z-transforms, Linearity property, Damping rule, Shifting rule, Initial value theorem, Final value theorem, Inverse Z-transforms. Application of Z-transforms to solve difference equations.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	1									1	3		1
CO-2	2	2	3									1	3		1
CO-3	2	2	3						1			1	3		1
CO-4	2	1	1	3					1			1	2	3	1
CO-5	2	2	2		2							1	2	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes

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2. G. James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson.

b. Recommended Reading

1. D. Zill and W. Wright, 2011, Advanced Engineering Mathematics, 4th edition, Jones and Bartlet
2. E. Kreyszig, 2015, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://www.khanacademy.org/
3. tutorial.math.lamar.edu/

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Course Specifications: Linear Algebra

Course Title	Linear Algebra
Course Code	MCC205A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to introduce the applied concepts of linear algebra which is the study of vectors and linear functions. In this course the students are taught various algorithms to solve a system of linear equations by using the underlying theory of matrices. The course includes vector spaces, linear transformations, norms and inner products, eigenvalues and eigenvectors, matrix decompositions, linear functional, and adjoints.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain basic system of linear equations, vector spaces, eigenvalues, linear transformations, operators

CO-2. State and prove important theorems related to linear transformations, inner product space, eigenvalues and adjoints.

CO-3. Solve simple problems related to matrices, system of linear equations, orthogonal basis, eigenvalues and eigenvectors, matrix of linear transformations, orthonormal projections, singular value decomposition

CO-4. Model real world problems using linear algebra

CO-5. Solve complex problems related to diagonalization, linear transformations, change of basis, inner product spaces, eigenvalues and adjoints.

4. Course Contents

Unit 1 (Vector Spaces and Linear Transformations): Review of vector spaces, bases and dimensions, direct sums. linear dependence and independence, basis, dimension, row space, column space, null space, rank-nullity theorem, linear transformations, matrix representations, change of basis, Similarity matrices.

Unit 2 (Orthogonality): Norms and inner products, orthonormal bases, orthogonal projections, orthogonality, Gram – Schmidt orthogonalization process.

Unit 3 (Eigenvalues): Eigenvalues and eigenvectors, diagonalization, Cayley-Hamilton theorem,

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quadratic forms, positive definite matrices, singular value decompositions.

Unit 4 (Linear functional and adjoints): Linear functional and adjoints, self-adjoint and normal operators, Schur decomposition, spectral theorems for self-adjoint, unitary and normal operators, positive definite operators, isometry and polar.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	1							1		3	1	1
CO-2	3	3	1	2							1		3	2	1
CO-3	3	3	2	3							2		3	3	2
CO-4	3	3	2	2							2		3	2	2
CO-5	3	3	2	2							2		3	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. **Course Resources**

a. **Essential Reading**

1. Class notes
2. Leon, S., 2014, Linear Algebra with Application, 9th edition, New Jersey, Pearson
3. Halmos, P, R., 2017, Finite-Dimensional Vector Spaces, 2nd edition, Dover Publications Inc.

b. **Recommended Reading**

1. Strang, G., 2016, Introduction to Linear Algebra, 5th edition, Massachusetts, Cambridge Press
2. Hoffman, K. and Kunze, R., 2015, Linear Algebra, 2nd edition, New Delhi, PHI Learning.
3. Kumaresan, S., 2000, Linear Algebra: A Geometric Approach, New Delhi, PHI Learning

c. **Magazines and Journals**

d. **Websites**

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. **Other Electronic Resources**

1. https://ocw.mit.edu/index.htm
2. https://www.khanacademy.org/
3. tutorial.math.lamar.edu/

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Course Specifications: Design and Analysis of Algorithms

Course Title	Design and Analysis of Algorithms
Course Code	CSD206A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to teach the fundamental concepts, principles, techniques, and methodology of creating software. The topics Requirements analysis, Structured and Object-oriented analysis and design are covered. In addition, implementation of software conforming to design and requirements, validation of the implementation with respect to the requirements and software maintenance are covered in detail. Students are trained to design, develop, implement, and test software based on the given requirements.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the concepts of design of algorithms
CO-2. Explain the principles of analysis of algorithms
CO-3. Choose appropriate techniques for design and analysis of algorithms for a given problem
CO-4. Analyze the worst case and average case complexity of a given algorithm
CO-5. Design efficient algorithms for a given problem
CO-6. Compare algorithms based on appropriately chosen measures of complexity

4. Course Contents

Unit 1 (Introduction): Role of algorithms, basic algorithm analysis, asymptotic analysis and bounds–best, average and worst-case behaviors, standard notations for expressing algorithmic complexity-Big O, little o, omega and theta notation

Unit 2 (Analysis of Algorithms and recurrences): Worst case and best-case analysis of recursive and non-recursive algorithms, solving recurrence relations: recurrence relations, solutions to recurrence relations, substitution method, Master Theorem, Recursion Tree

Unit 3 (Algorithmic Design Techniques): Brute-Force. Greedy algorithms: Elements of greedy strategy, Examples: Huffman Codes, 0/1 Knapsack, and Prim and Kruskal's MST Algorithms. Divide and Conquer: Merge Sort, Strassen's algorithm, Branch-and-Bound, Backtracking, Dynamic

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Programming: Concept and methodology, Examples: Matrix chain multiplication, optimal binary search trees, Floyd-Warshall algorithm, n-Queen's problem

Unit 4 (Analysis of Sorting and Searching Algorithms): Bubble sort, selection sort, heap sort, quick sort, insertion sort, sorting strings, topological sort, sorting concepts: order, stability and efficiency of algorithms, linear search, binary search, Depth First Search, Breadth First Search

Unit 5 (Amortized Analysis of algorithms): Introduction and motivation, Approaches: aggregate, accounting, and potential methods. Examples: Stack operations, Dynamic tables (Vectors)

Unit 6 (Computability and Complexity Theory): Tractable and Intractable Problems, Complexity classes-P, NP, Co-NP, NP-complete and NP-hard, Standard NP-hard and NP-complete problems

Unit 7 (Probabilistic analysis of algorithms and Approximation Algorithms): Introduction. Indicator random variables and their use in probabilistic analysis of algorithms. Average Case Analysis. Examples from sorting algorithms.

Unit 8(Approximation Algorithms): Introduction. Approximation algorithms for vertex-cover, TSP, set-cover, and subset-sum problems

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	2	1	1				2	1	3	3	1
CO-2	3	3	2									2	3	2	1
CO-3	3	3	2		3	1	1					1	3	3	1
CO-4					3	1	1			1		2	3	2	1
CO-5					3	1	1			1		1	3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		15
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment

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4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Course Resources**

a. **Essential Reading**

1. Levitin, A. V., 2011, Introduction to Design and Analysis of Algorithms, 3rd edn., Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA.
2. Corman, T. H., Lieserson, C. E. and Rivest, R. L. 2009, Introduction to Algorithms, 3rd edn., Prentice Hall.

b. **Recommended Reading**

1. Kleinberg, J., and Tardos, E., 2005, Algorithm Design, Addison-Wesley.
2. Aho, A. V., Hopcropt, J. E., and Ulman, J. D ,1974, The Design and Analysis of Computer Algorithms, Addison-Wesley.
3. Goodrich, M. T., and Tamassia, R., 2010, Data Structures and Algorithms in Java, 5th edn. Wiley.
4. Skiena, S. S., 2008, The Algorithm Design Manual, 2nd edn., Springer.
5. Knuth, D. E., 2011, The Art of Computer Programming, Volumes 1-4A, Addison-Wesley.
6. Motwani, R., and Raghavan, P., 1995, Randomized Algorithms, Cambridge
7. University Press M. ,2015, Programming Language Pragmatics, 4th edn., Morgan Kaufmann.

c. **Magazines and Journals**

1. ACM Transactions on Algorithms

d. **Websites**

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. **Other Electronic Resources**

1. The Stony Brook Algorithm Repository http://www.cs.sunysb.edu/~algorith/

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Course Specifications: Formal Languages and Automata Theory

Course Title	Formal Languages and Automata Theory
Course Code	CSC209A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to develop an understanding of the concepts of automata theory and formal languages and their relationship to computation models. Students are taught regular, context-free, context-sensitive, and universal languages, their generating grammars and properties along with the related automata and machine models. Formal relationships among machines, languages and grammars are covered. Students are trained to design automata and machine models for given formal language requirements.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe formal languages, automata and models of computation
CO-2. Explain formal relationships among machines, languages and grammars
CO-3. Analyze a given language for arriving at a suitable model of computation
CO-4. Apply automata theory to prove or disprove languages
CO-5. Design a grammar generating a given language and a computing machine that accepts it

4. Course Contents

Unit 1 (Introduction): Alphabets, Strings and Languages, Automata and grammars, introduction to Chomsky hierarchy of languages

Unit 2 (Regular Language and Finite Automata): Regular Language, Deterministic Finite Accepters, and Nondeterministic Finite Accepters, Equivalence of Deterministic and Nondeterministic Finite Accepters

Unit 3 (Regular Expression): Regular expressions, Connection between regular languages and regular expressions, Regular grammar, Properties of regular languages

Unit 4 (Context Free Languages and Pushdown Automata): Context free grammar, Parsing and ambiguity, Simplification of context free grammars, Chomsky Normal Form, Greibach Normal Form, Nondeterministic Pushdown Automata, Deterministic Pushdown Automata, Context free languages

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and Push Down Automata, Properties of context free languages

Unit 5 (Context-Sensitive Languages and Linear Bounded Automata): Context-Sensitive Grammars and languages, Linear bounded automata

Unit 6 (Recursive and Recursively Enumerable Languages and Turing Machines): The standard Turing machine, Turing's thesis, other models of Turing machines, Recursive and recursively enumerable languages

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3											3		
CO-2	3	3											3		
CO-3	3	3	2	2	1					2			3		
CO-4	3	3	2	2	1					2		1	3	3	
CO-5	3	3	2	2	1					2		1	3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. **Course Resources**

   a. **Essential Reading**

      i. Class notes

      ii. Linz, P., 2017, An Introduction to Formal Languages and Automata, India, Jones & Bartlett Learning.

   b. **Recommended Reading**

      i. Hopcroft, J. E., Motwani, R., and Ullman, J. D., 2008, Introduction to Automata Theory, Languages and Computation, India, Pearson Education.

      ii. Sipser, M., 2004, Introduction to the Theory of Computation, United States of America, PWS Publishing.

   c. **Magazines and Journals**

      i. TCS - Theoretical Computer Science

      ii. MST- Theory of Computing Systems

   d. **Websites**

      i. http://www.sigact.org/

      ii. http://www.ieee.org/

      iii. http://www.nptel.ac.in/

   e. **Other Electronic Resources**

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Course Specifications: Programming Paradigms

Course Title	Programming Paradigms
Course Code	CSD207A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at preparing the students to design, develop and test software applications by applying different programming paradigms. The students are taught the features of functional, object oriented and event-driven programming approaches with a sample language for each approach. They apply the constructs of these approaches to design and develop software applications and analyze the usefulness of a programming paradigms based on ease of expression and scale of development effort. Students also learn concepts of user interface design and concurrency in this module. Students are trained to develop applications using appropriate approach, testing them and generate an analytical report.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe and distinguish the concepts and features of various programming paradigms
CO-2. Discuss the features of functional, object oriented and event driven programming paradigms
CO-3. Apply concepts of functional, object oriented and event driven programming
CO-4. Analyze the usefulness of a programming paradigms based on ease of expression and scale of development effort
CO-5. Design software applications using functional, object oriented and event driven approaches
CO-6. Synthesize software applications using functional, object oriented and event driven approaches

4. Course Contents

Unit 1 (Introduction Programming models): State and state changes, Declarative and Imperative approaches. Functional, Concurrent, Logical, Object Oriented, Relational, Imperative and Procedural models and languages. Corresponding simple programs in C, java, Haskell to emphasize concepts. The effects of scale on programming methodology.

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Unit 2 (Object oriented Programming): Introduction, Imperative programming in C and its disadvantages, Evolution of Object-Oriented approach, Classes and subclasses, Functions and Message Passing, Inheritance (overriding, dynamic dispatch), Polymorphism, Encapsulation and information hiding, Class hierarchies, Collection classes and iteration protocols, Exception handling, Interfaces, Generics, Object Oriented Program structure including packages.

Unit 3 (Event Driven and User Interface Development): Event and Triggers, Event handling methods, Introduction to user interface Development, Character User Interface, GUI development as an event driven system, Principles of graphical user interfaces (GUIs), Action-object versus Object-action, User interface events, Exceptions as events, Exception propagation.

Unit 4 (Functional Programming): Declarative programming, Overview and motivation of functional languages, Mathematical Functions, Introduction to Lambda calculus, Fundamentals of Functional Programming Languages (evaluation, type and type checking, data types), Recursion over lists, Higher order functions.

Unit 5 (Application development): Simple desktop applications, simulations and mathematical applications, static and dynamic Web pages.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1			2										
CO-2	1	2													
CO-3	3					3		3		1	1		3		
CO-4	3	3				3	2					2		3	
CO-5			3	3					1		1				2
CO-6					3			2							
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		15
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	15	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course

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1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Deitel, P., and Deitel, H., 2017, Java How to Program, 11th edn., Prentice Hall.
2. Lipovaca, M., 2011, Learn you a Haskell for Great Good!: A Beginner's Guide. No Starch Press.

b. Recommended Reading

8. Roy, P. V., and Haridi, S., 2004, Concepts, Techniques, and Models of Computer Programming. The MIT Press.
9. Thompson S., 2011, Haskell - the Craft of Functional Programming, 3rd edn., Addison-Wesley.
10. Scott, M. ,2015, Programming Language Pragmatics, 4th edn., Morgan Kaufmann.

c. Magazines and Journals

2. ACM Transactions on Programming Languages and Systems
3. Journal of Functional Programming
4. Journal of Functional and Logic Programming
5. Journal of Object Oriented Programming

d. Websites

1. The Haskell Programming Language
2. http://haskell.org/
3. Java
4. https://java.com/
5. Greenfoot
6. http://greenfoot.org

e. Other Electronic Resources

1. JDK 10 Documentation, https://docs.oracle.com/javase/10
2. IBM developerWorks, https://www.ibm.com/developerworks/learn

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Course Specifications: Environmental Studies

Course Title	Environmental Studies
Course Code	BTN101A
Course Type	Ability Enhancement Compulsory Course
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to invoke awareness among students about the burning global environmental issues. The course exposes the students to various problems associated with abuse of natural resources. The concepts of ecosystems, biodiversity and its conservation and environmental pollution will be discussed. The course emphasizes social issues associated with the environment, and the impact of human population on the environment.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Department of Biotechnology
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Illustrate the multidisciplinary nature of environmental studies and recognize the need for public awareness
- **CO-2.** Explain the various natural resources and their associated problems, ecosystem, and environmental pollution
- **CO-3.** Analyse the concept of ecosystem and classify various types
- **CO-4.** Compare biodiversity at local, national and global levels
- **CO-5.** Discuss various social issues pertaining to environment including sustainable development and energy issues

4. Course Contents

Unit 1: Natural resources:

Forest resources: Use and over-exploitation, deforestation, **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. **Energy resources:** Growing energy needs, renewable and non-renewable energy

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sources, use of alternate energy sources. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit 2: Ecosystems:

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries).

Unit 3: Biodiversity and its conservation:

Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical aesthetic and option values Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 5: Environmental Pollution:

Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution, Solid waste management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution. **Disaster management:** floods, earthquake, cyclone and landslides

Unit 6: Social Issues and the Environment:

From unsustainable to sustainable development, Urban problems and related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

Unit 7: Environmental ethics:

Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies, Wasteland reclamation, Consumerism and waste products, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness. Human Population and the Environment: Population growth, variation among nations, Population explosion

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1					3							1	3	
CO-2	1					3							1	3	
CO-3	1					3							1	3	
CO-4	1					3							1	3	
CO-5	1					3							1	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		22
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		03
1. Case Study Presentation	03	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

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Focus of Course Learning Outcomes in each component assessed		
	CE (50% Weightage)	SEE (50% Weightage)
	SC Innovative Assignment	SEE
	25 Marks	25 Marks
CO-1	X	X
CO-2	X	X
CO-3	X	X
CO-4		X
CO-5		X

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

b. Essential Reading

1. Class notes
2. Bharucha, E., 2004, Environmental Studies, New Delhi, University Grants Commission Ahluwalia, V.K., 2013,
3. Environmental Studies: Basic concepts, The Energy and Resources Institute (TERI).

c. Recommended Reading

1. Jadhav, H. and Bhosale, V. M., 1995, Environmental Protection and Laws, New Delhi, Himalaya Publishing House

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d. Magazines and Journals

https://www.omicsonline.org/environmental-sciences-journals-impact-factor-ranking.php

e. Websites

https://www.sciencedaily.com/news/earth_climate/environmental_science

f. Other Electronic Resources

http://www.globalissues.org/issue/168/environmental-issues

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Course Specifications: Mathematics and Computing Laboratory

Course Title	Mathematics and Computing Laboratory
Course Code	MCL201A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to provide an understanding of numerical methods to solve ordinary differential equations. The course trains students to write programs in MATLAB to solve ordinary differential equations. Students are taught the concepts of different numerical methods such as Euler's method, Runge-Kutta method, Milne's method, Adams method and finite difference method to solve ordinary differential equations. The students are trained to solve ordinary differential equations and implementation of the same using MATLAB.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the concept of directional fields and numerical solution of first order ordinary differential equation

CO-2. Determine the solution for ordinary differential equations using MATLAB built-in commands

CO-3. Solve simple mathematical problems associated with first order ordinary differential equation using numerical methods and compare the results with that of solutions obtained by analytical methods

CO-4. Solve boundary value problems of ordinary differential equation using numerical methods

CO-5. Solve complex mathematical problems associated with ordinary differential equation using numerical methods and compare the results with that of solutions obtained using MATLAB

4. Course Contents

1	Row space, column space and null space
2	LU decompositions
3	Thomas Algorithm
4	The Power Method – To determine largest eigenvalue
5	Gram – Schmidt orthogonalization process
6	QR factorization

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7	Singular value decompositions
8	Least squares problems
9	Linear curve fitting
10	Non-linear curve fitting

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2											3		
CO-2	2			3									2	3	
CO-3	3	3											3		
CO-4	3	3											3		
CO-5	3			3									3	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	04	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

1. Class notes
2. R. Burden and D. Faires, 2017, Numerical Analysis, 9th edition, Massachusetts,

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Brooks/Cole

b. Recommended Reading

1. S. Chapra and R. Canale, 2016, Numerical Methods for Engineers, 7th edition, New Jersey, McGraw Hill.
2. S. S. Sastry, 2010, Introductory methods of Numerical Analysis, 4th edition, New Delhi, PHI learning Pvt. Limited
3. Rao V. Dukkipati, 2011, Applied Numerical Methods using Matlab, 1st edition, New Delhi, New Age International

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. NPTEL Course materials

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Course Specifications: Programming Paradigms Laboratory

Course Title	Programming Paradigms Laboratory
Course Code	CSL208A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to develop an understanding of the concepts of automata theory and formal languages and their relationship to computation models. Students are taught regular, context-free, context-sensitive and universal languages, their generating grammars and properties along with the related automata and machine models. Formal relationships among machines, languages and grammars are covered. Students are trained to design automata and machine models for given formal language requirements.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Relate the concepts of programming paradigm with the constructs of the programming language

CO-2. Express the model of an application as a program in functional and object-oriented programming languages

CO-3. Apply event handling and exception handling techniques in programs

CO-4. Analyze a given application and suggest programming approach and language based on ease of expression and scale of development

CO-5. Evaluate the usefulness of a programming approach and language for a given application requirement

CO-6. Document work done and prepared a laboratory report

4. Course Contents

1	Analyze the requirements to develop the application
2	Select a paradigm and language based on the analysis
3	Design and implement the software in the selected language
4	Develop test cases and use them to test and validate the implementation.
5	Create a laboratory report documenting the steps involved
6	UML Diagrams Class and State chart
7	Introduction to Object Oriented Approach: Introductory exercises to basic Object Oriented Programming

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	Introduction to Object Oriented Approach – classes, Objects Development of simple application to demonstrate the use of classes and Objects Object-Oriented Approach- Methods, Encapsulation Development of programs that use methods, getters, setters, constructors Object-Oriented Approach- inheritance (abstract class) Development of simple application to implement single and multi-level inheritance Object-Oriented Approach- inheritance (interface) Development of application to demonstrate Multiple Inheritance with interface Object-Oriented Approach - Polymorphism: Development of programs that use overloading and overriding Object-Oriented Approach - Generic classes, Collections and their uses: Development of application to demonstrate Generic Classes and Collection Object-Oriented Approach –Exception handling: Development of simple application to demonstrate the use of try, catch, throw, finally Event Driven -Introduction to FXML: Development of simple I/O in Graphical User Interface (GUI) Event Driven Development: Development of a software application with GUI and exception handling Functions in Haskell: Development of programs with functions using pattern matching, currying and value orientation

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1			2										
CO-2	1	2													
CO-3	3					3		3		1	1		3		
CO-4	3	3				3	2					2		3	
CO-5			3	3					1		1				2
CO-6					3			2							
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	04	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop /	00	

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Kitchen		
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X		X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course

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1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

i. Deitel, P., and Deitel, H., 2017, Java How to Program, 11th edn., Prentice Hall.
ii. Lipovaca, M., 2011, Learn you a Haskell for Great Good! A Beginner's Guide. No Starch Press.

b. Recommended Reading

i. Roy, P. V., and Haridi, S., 2004, Concepts, Techniques, and Models of Computer Programming. The MIT Press.
ii. Thompson S., 2011, Haskell - the Craft of Functional Programming, 3rd edn., Addison-Wesley.
iii. Scott, M. ,2015, Programming Language Pragmatics, 4th edn., Morgan Kaufmann.

c. Magazines and Journals

i. ACM Transactions on Programming Languages and Systems
ii. Journal of Functional Programming
iii. Journal of Functional and Logic Programming
iv. Journal of Object-Oriented Programming

d. Websites

i. The Haskell Programming Language
ii. http://haskell.org/
iii. Java
iv. https://java.com/
v. Greenfoot
vi. http://greenfoot.org

e. Other Electronic Resources

i. JDK 10 Documentation, https://docs.oracle.com/javase/10
ii. IBM developer Works, https://www.ibm.com/developerworks/learn

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Course Specifications: Additional Mathematics - 2

Course Title	Additional Mathematics - 2
Course Code	MTB212A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with analytical solutions of ordinary differential equations, numerical analysis and data modelling techniques. Students are taught the concepts of fundamentals of ordinary differential equations. The solution procedures for certain standard forms of ordinary differential equations are illustrated. The role, relevance of ordinary differential equations in modelling some of the real world problems are emphasized. The significance of data modelling in applied engineering problems are discussed with the help of MATLAB. Numerical methods for the solution of nonlinear equations and linear systems are elucidated using MATLAB.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	2:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the fundamentals of ordinary differential equations State theorems and solve simple problems in two variable calculus

CO-2. Solve standard forms of ordinary differential equations Illustrate fundamentals ofLinear algebra

CO-3. Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations

CO-4. Apply numerical methods to solve nonlinear equations in one variable, system of linear equations, interpolation and numerical quadrature, and implement the same using MATLAB

CO-5. Solve complex problems associated with nonlinear equations and linear systems, interpolation and numerical integration using MATLAB

4. Course Contents

Unit 1 (First Order Differential Equations): Introduction, basic concepts and geometrical meaning. Separable, linear and exact differential equations. Integrating factors and transformations. Applications of first order ordinary differential equations, orthogonal trajectories, growth/decay problems and mixture problems.

Unit 2 (Higher Order Differential Equations): Introduction, initial and boundary value problems. Linear homogenous/nonhomogeneous differential equations with constant coefficients, method of undetermined coefficients and variation of parameters. Application of

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second order linear differential equations with constant coefficients, mass-spring-dashpot system, electric circuits.

Unit 3 (System of Linear Differential Equations): Homogeneous system of linear differential equations of first order, solutions by matrix method.

Unit 4 (Single Variable Equations and System of Equations): Numerical solution of algebraic and transcendental equations, Newton-Raphson method and error analysis. Numerical solution of linear system of equations, Gauss-Seidel methods.

Unit 5 (Interpolation and Numerical Integration): Interpolation - Lagrange interpolation, Newton's divided difference interpolation. Numerical Integration - Newton-Cotes' quadrature, trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules.

5. Course Map (CO-PO-PSO Map)

			Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2										3		
CO-2	2	3	2										3		
CO-3	3	3	1										3		
CO-4	3	3	2	2	2					1			3	2	1
CO-5	3	3	2	2	2					1			3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	

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5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ►			
Subcomponent Type ►	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ►	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment

14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Shepley Ross, 2007, Introduction to Ordinary Differential Equations, 4th edition, New York, John Wiley & sons
3. Dennis Zill, 2012, A First Course in Differential Equations, 10th edition, Massachusetts, Brooks/Cole
4. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 9th edition, Massachusetts, Brooks/Cole

b. Recommended Reading

1. George Simmons, 2017, Differential Equations with Applications and Historical Notes, 2nd edition, New Jersey, McGraw Hill
2. Steven Chapra and Raymond Canale, 2016, Numerical Methods for Engineers, 7th edition, New Jersey, McGraw Hill

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/
3. https://ocw.mit.edu/index.htm
4. tutorial.math.lamar.edu/

e. Other Electronic Resources

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Course Specifications: Optimization Techniques

Course Title	Optimization Techniques
Course Code	MCC301A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The main aim of this course is to present different methods of solving optimization problems in the three areas of linear programming and nonlinear programming. In addition to theory, there will be some introduction to numerical methods for optimization problems. This course focuses on optimization methods that are commonly used in modern statistical machine learning. The course will cover some theory such as duality, minimax problems, convexity and algorithms like descent algorithms in the nonlinear case, simplex and interior point methods in the linear case.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (Cos)

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

- **CO-1.** Describe fundamental of convex and concave functions, constrained and unconstrained optimization
- **CO-2.** State and explain important classical techniques and numerical methods of optimization
- **CO-3.** Demonstrate the skill to analyze a problem by choosing effective optimization tools
- **CO-4.** Analyze the proofs of theorems to draw meaningful conclusions
- **CO-5.** Apply the theory to solve problems with varying level of difficulty

4. Course Contents

Unit 1 Introduction: Convex and Concave Functions, polytopes and polyhydra. Function of several variables – limits, continuity and differentiability

Unit 2 Linear Programming: Basic Solutions and their properties, Formulation and Geometrical Ideas of Linear Programming Problems using graphical method, Simplex Method, Revised Simplex Method, Duality, Sensitivity Analysis, Transportation and Assignment Problems, Non-Simplex methods — Introduction to Interior-Point Methods, Ellipsoid Method, Karmarkar's Method

Unit 3: Unconstrained optimization: Line search methods – Golden section, Fibonacci, Secant and Newton's method. Unconstrained optimization of functions of several variables, Basictheory, Classical techniques, Numerical methods for unconstrained optimization — Gradient

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methods, Newton's method, Conjugate Direction methods, and Quasi-Newton methods.

Unit 4: Constrained nonlinear optimization: Functions of several variables, Method of Lagrange multipliers, Kuhn-Tucker theory, Convex optimization, Quadratic optimization, Numerical methods for constrained optimization, Dynamic programming.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (Pos)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	3									3		
CO-2	3	2									3		
CO-3	1	2	3								3		
CO-4	2	2	2								2		
CO-5	1	2	3								3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the Cos. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), Cos are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of Cos in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. **Essential Reading**

1. Class notes
2. Dekking, F. M., Kraaikamp, C., Lopuhaa, H. P., and Meester, L. E. (2005) A Modern Introduction to Probability and Statistics, Springer

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b. Recommended Reading

1. Rice, J. A. (2007) Mathematical Statistics and Data Analysis, 3rd edn., Thomson Books/Cole.
2. Ross, S. M. (2014) Introduction to Probability and Statistics for Engineers, 5th edn., Academic Press.
3. Trivedi, K. S. (2016) Probability and Statistics with Reliability, Queuing and Computer Science Applications, 2nd edn., Wiley.
4. Unpingco, J. (2016) Python for Probability, Statistics and Machine Learning, Springer

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

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Course Specifications: Partial Differential Equations

Course Title	Partial Differential Equations
Course Code	MCC302A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to provide an understanding of partial differential equations and its application. The course introduces students to the formation of partial differential equations, concepts in first and second order partial differential equations. Students are taught the applications of 1-dimensional heat, 1-dimensional wave and Laplace equation. This course also discusses the finite difference methods to solve partial differential equations numerically.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Explain the basic principles of partial differential equations.
- **CO-2.** Solve simple mathematical problems associated with first and second order partial differential equation.
- **CO-3.** Apply Fourier series to solve heat, wave and Laplace equations.
- **CO-4.** Apply partial differential equations to model physical phenomenon.
- **CO-5.** Solve complex problems associated with first and second order partial differential equations.

4. Course Contents

Unit 1 (First order partial differential equations): Introduction to the partial differential equations, formation of partial differential equations, classification by linearity. Cauchy problem for first order partial differential equation, solution of first order linear partial differential equation by Lagrange's method, solution of first order non-linear partial differential equation by Charpit's method, Jacobi method, special method of solution to some standard forms (Clairaut's equation).

Unit 2 (Second Order Homogeneous and Non Homogeneous Partial Differential Equations): Second order linear homogeneous and non-homogeneous equation with constant coefficient and variable co-efficient. Classification of second order partial differential equation into elliptic, parabolic and hyperbolic.

Unit-3 (Heat Equation, Wave equation and Laplace Equation): Heat equation: Solution of one-dimensional heat equation by using separation of variables and Fourier series. Wave equation: Solution of one-dimensional wave equation by using separation of variables and Fourier series. Laplace: Solution of one-dimensional Laplace equation by using separation of variables and Fourier

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series.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2								1		3		1
CO-2	3	3	1								1		3		1
CO-3	3	3	2	3							2		3	3	2
CO-4	3	3	2	2							2		3	2	2
CO-5	3	3	2	2							2		3	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document. The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Sneddon I., 1957, Elements of Partial Differential Equations, 1st edition, Bengaluru, Mcgraw-Hill India.

b. Recommended Reading

1. Henner V., Belozerva T. and Khenner M., 2013, Ordinary and Partial Differential Equations, 1st edition, Florida, CRC press.
2. Zachmanoglan E C and Dale W.Thoe, 1987, Introduction to Partial Differential Equations and its Applications.
3. K Sankara Rao, 2011, Introduction to Partial Differential Equations, 3rd edition, Prentice Hall of India.

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c. **Magazines and Journals**
   1. Journal of Partial Differential Equations
   2. Partial Differential Equations and Applications

d. **Websites**
   1. http://nptel.ac.in/
   2. https://ocw.mit.edu/index.htm

e. **Other Electronic Resources**
   1. https://www.khanacademy.org/
   2. tutorial.math.lamar.edu/

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Course Specifications: Applications of Probability and Statistics in Finance

Course Title	Applications of Probability and Statistics in Finance
Course Code	MCC303A
Course Type	Professional Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to introduce the students to the probabilistic models for computational finance. Concepts and mathematical models of Financial Assets, Portfolios, Options and Derivatives are covered. Stochastic Processes and Ito Stochastic Calculus leading to Black-Sholes model are taught. Students are trained to develop program scripts for simple computational finance applications.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Describe the concepts from Probability, Statistics and Stochastic Processes and their application in Finance
- **CO-2.** Explain the concepts and models of Financial Assets, Portfolios and Derivatives
- **CO-3.** Apply probabilistic models for the analysis of financial assets, portfolio management and derivatives
- **CO-4.** Evaluate the performance of financial assets, options and derivatives
- **CO-5.** Develop programming scripts for simple computational financial applications

4. Course Contents

Unit 1 (Probability and Statistics)

Random Variables, Moments, Jensen's Inequality, Multivariate probability models: Covariance, correlation. Method of moments, Maximum Likelihood estimates, Estimators, Interval estimation, Hypothesis testing, Type I and II errors. Regression: Least squares, linear and non-linear regression, heteroscedasticity, multi-colinearity.

Unit 2 (Introduction to Financial Assets)

Investments and Returns. Measurement of performance: Measuring assert performance, measurement of investment performance.

Unit 3 (Portfolios)

Assert portfolios. Application of variance and covariance algebra for assert portfolios. Estimation of stock beta, estimation of efficient frontier.

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Unit 4 (Stochastic Processes and Stochastic Calculus):
Concept of a stochastic process. Discrete time stochastic processes. Random walks. Continuous time stochastic processes. Brownian Motion. Stochastic Integral and Ito's formula.

Unit 5 (Derivatives)
Introduction to derivatives, risk management. puts, calls, payoff diagram, Binomial option placing model, Black-Scholes Model.

Unit 6 (Programming for Financial Computing)
Python and Visual Basic scripting for implementation, simulation and analysis of computational finance models.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1														
CO-2	1	2			2										1
CO-3	3	3		3	3							1	2	2	
CO-4	3	3		2	2							1	3		
CO-5	3	2		2	3				2				3	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		35
Demonstrations		03
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		02
1. Assignment Discussion / Related Activities	02	
2. Case Study Presentation	00	
3. Guest Lecture	00	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	

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6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

1. Class notes
2. Ruppert, D. (2004) Statistics and Finance: An Introduction, Springer.
3. Mikosch, T. (1998) Elementary Stochastic Calculus with Finance in View, World Scientific.

b. Recommended Reading

1. Rachev, S. T., Hochstotter, M., Fabozzi, F. J., and Focardi, S. M. (2010) Probability and Statistics for Finance, John Wiley & Sons.
2. Sclove, S. L. (2013) A Course on Statistics for Finance, CRC Press.
3. Lin, X. S. (2006) Introductory Stochastic Analysis for Finance and Insurance, John Wiley & Sons.
4. Hilspich, Y. (2019) Python for Finance: Mastering Data-Driven Finance, 2nd edn., O'Reily.
5. Rolski, T., Schmidli, H. P., Schmidt, V., and Teugels, J. (1999) Stochastic Processes for Insurance and Finance, John Wiley & Sons.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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Course Specifications: Computer Networks

Course Title	Computer Networks
Course Code	CSD301A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course aims to prepare the students to understand the protocols operating in a typical network stack as well as to develop client server applications using them. Students are taught the basic principles of the network software architecture along with a detailed explanation of the wired and wireless protocols in a computer network. They are trained to design and implement client-server applications using wired and wireless network protocols.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Describe the protocols that operate in the TCP/IP stack and Wireless networks
- **CO-2.** Explain the typical applications of computer networks along with the protocols and security considerations
- **CO-3.** Choose appropriate network protocols for given applications
- **CO-4.** Compare and analyze different wired and wireless network protocols for given application requirements
- **CO-5.** Design different types of servers using appropriate transport layer protocols based on application requirements
- **CO-6.** Synthesize client-server based computer networks using the sockets API

4. Course Contents

Unit 1 (Introduction): Uses of computer networks. Network hardware. Network software. Reference models and their comparison. Network standardization and example networks.

Unit 2 (Physical Layer): Guided and unguided transmission media. Digital and analog signal. Modulation. Multiplexing. Network topologies (Bus, Tree, Star, Mesh, Ring). Local Area Network (LAN), Metropolitan Area Network (MAN), Wide Area Network (WAN). Repeater and Hub. Unicasting, Multicasting and Broadcasting.

Unit 3 (Data Link Layer): Design issues at the Data Link Layer (DLL). Error Detection and Correction.

Parity, Checksum and Cyclic Redundancy Check (CRC). Elementary DLL protocols. Sliding window protocols. Wired network. Virtual LAN (VLAN). SONET/SDH and Passive Optical Networks (PONs).

Unit 4 (Medium Access Control Layer): Issues in medium access control, Carries Sense Multiple Access / Collision Detection (CSMA/CD), Wired LAN, Medium Access Control. Multiple access protocols. Ethernet, Standard and Fast Ethernet, bridge and switch. Broadcast domain and collision domain.

Unit 5 (Network Layer): Design issues at the Network Layer. Routing and congestion control algorithms. Quality of Service. Internetworking. IPv4 and IPv6. Classful and classless addressing. Subnetting and Super netting. Address Resolution Protocol, Bootstrap Protocol, Dynamic Host Configuration Protocol, Internet Control Message Protocol (ICMP) and Network Address Translation (NAT). Routing on the Internet, Multi-Protocol Label Switching (MPLS), Interior and Exterior Gateway Routing Protocols.

Unit 6 (Transport Layer, TCP Congestion and Resource Management): Design issues at the Transport Layer. Elements of transport protocols, congestion control. User Datagram Protocol (UDP), Transmission Control Protocol (TCP) and its variants. Performance issues and Delay Tolerant Networking (DTN) architecture. TCP congestion control, and flow control, variants of TCP, real-time traffic congestion control and Queue Management: Random Early Detection (RED), Explicit Congestion Notification (ECN) and scheduling mechanisms.

Unit 7 (Socket Programming): The client-server paradigm, iterative and concurrent servers. Sockets as a form of Inter-Process Communication (IPC). TCP and UDP sockets, working principle and function calls. Socket options.

Unit 8 (Application Layer): Domain Name System (DNS), Electronic Mail and SMTP. World Wide Web (WWW), File Transfer Protocol (FTP) and Hyper Text Transfer Protocol (HTTP). Streaming audio and video, Real-time Transfer Protocol (RTP) and Real-time Transfer Control Protocol (RTCP).

Unit 9 (Network Security): Cryptography. Symmetric key and public key algorithms. Communication security and authentication protocols. Email and web security.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
CO-6	3	3	3		2				1	1			3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30

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Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
CO-6		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

i. Classnotes

ii. Tanenbaum, A., and Wetherall, D., 2010, Computer Networks, 5th edn., Boston, Prentice Hall.

iii. Forouzan, B., 2013, Data Communications and Networking, 5th edn., New York, MacGraw-Hill.

b. Recommended Reading

i. Olifer, N., and Olifer, V., 2010, Computer Networks, New Delhi, Willy India.

ii. Stevens W., Fenner B., and Rudoff, A., 2007, The Sockets Networking API, Boston, Addison-Wesley.

iii. Cordeiro, C., and Agrawal, D., 2011, Ad Hoc and Sensor Networks, Hackensack, World Scientific.

iv. Stallings, W., 2011, Cryptography and Network Security, 5th edn., Boston, Prentice Hall.

c. Magazines and Journals

i. ACM Transactions on Networking

ii. IEEE Transactions on Communications

d. Wireless Networks Websites

i. IEEE Communication Society, http://www.comsoc.org

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ii. IEEE, http://www.ieee.org
iii. ACM, http://www.acm.org

e. Other Electronic Resources

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Course Specifications: Microprocessors and Architecture

Course Title	Microprocessors and Architecture
Course Code	CSD203A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to provide a thorough knowledge of the concepts and components of computer organization and architecture to students using modern microprocessors as case studies. It introduces the architecture and operation of CPU, memory and I/O. The students are also exposed to assembly language programming, modern computing systems and their scope for engineering applications.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the architecture of CPU, memory and I/O subsystems
CO-2. Explain the concepts and working of computer architectural subsystems
CO-3. Apply concepts of architecture to design simple architectural components
CO-4. Analyze, test and validate simple processor design
CO-5. Design the main functional units of architectural subsystems
CO-6. Select appropriate architectural features for a given application

4. Course Contents

Unit 1 (Introduction): Organization and Architecture, Structure and Functions, Brief history of computers, Designing for performance, RISC and CISC architectures

Unit 2 (Evolution of IA-32 Platform): Core parts of IA-32 platform, Advanced IA-32 Features, The IA-32 Processor families, Introduction to Assembly Language, High level Languages, Components of Assembly Language, and Introduction to GNU Assembler

Unit 3 Computer Arithmetic: The Arithmetic and Logic Unit (ALU), Integer Representation, Integer Arithmetic, Floating-Point Representation, Floating-Point Arithmetic

Unit 5 (Instruction Set for IA-32 Platform): Data transfer instructions, Data processing Instructions, Control Instructions, A sample Assembly Program

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Unit 6 (Computer Function and Interconnection): Computer components, Computer function, Interconnection structures, Bus Interconnection, PCI

Unit 7 (Cache Memory): Computer memory system overview, Cache memory principles, Elements of cache design, Pentium 4 cache organization

Unit 8 (Internal and External Memory Technology): Semiconductor main memory, Error correction, Advanced DRAM organization, Magnetic disk, RAID, Optical memory, Magnetic tape

Unit 9 (Input/Output): External Devices, I/O Modules, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access, I/O channels and processors

Unit 10 (Operating System Support): Operating system overview, Scheduling, Memory management, Pentium Memory Management.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2		2					1	1			2		
CO-2	2	2											2		
CO-3	2	2											2		
CO-4		2	2		2				1	2			2		
CO-5	2	2		2	2				1	2		1	2	2	2
CO-6	2	2	2	2	2				1	2	1	1	2	2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	10	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00

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1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
CO-6	X	X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment

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4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

6. Class notes
7. Stallings, W., 2010, Computer Organization and Architecture: Designing for Performance, Upper Saddle River, NJ, Prentice Hall.
8. Blum, R., 2005, Professional Assembly Language, Indiana, Wiley.

b. Recommended Reading

1. Hamacher, C. V., Vranesic, Z., and Zakay, S., 2002, Computer Organization, New York, McGraw-Hill series

c. Magazines and Journals

3. IEEE Transactions on Computers
4. IEEE Micro

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

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Course Specifications: Principles of Artificial Intelligence

Course Title	Principles of Artificial Intelligence
Course Code	AID201A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at providing theoretical and hands-on exposure to intelligent agents and their applications. The principles of knowledge representation, search strategies, learning, reasoning and planning will be covered in detail. Application of the principles of artificial intelligence in machine learning, robotics and perception will be discussed. There will be a special emphasis on the analysis and synthesis of intelligent agent-based applications of artificial intelligence.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the concepts of artificial intelligence and intelligent agents
CO-2. Explain the principles of knowledge representation, search strategies, learning, reasoning and planning
CO-3. Apply the principles of knowledge representation, search strategies, learning, reasoning and planning to design intelligent agents
CO-4. Analyze a scenario and identify strategies for knowledge representation, search, learning, reasoning and planning
CO-5. Synthesize an intelligent agent for a given scenario
CO-6. Evaluate the performance of an intelligent agent based on appropriate measures of performance

4. Course Contents

Unit 1 (Search strategies): Intelligent agents, environments, rationality, the nature of environments, the structure of agents, problem-solving agents, searching for solutions, uninformed and informed (heuristic) search strategies, heuristic functions, local search algorithms and optimization problems, local search in continuous spaces, searching with nondeterministic actions, searching with partial observations, online search agents and unknown environments, adversarial search and games,

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constraint satisfaction problems, backtracking and local search methods

Unit 2 (Knowledge, reasoning, and planning): Logical agents, logic and propositional logic, agents based on propositional logic, syntax and semantics of first-order logic, knowledge representation knowledge engineering in first-order logic, inference in first-order logic, forward and backward chaining algorithms for planning as state-space search, planning graphs and other approaches, planning and acting in the real world, time, schedules, and resources. Multi-agent planning

Unit 3 (Uncertain knowledge and reasoning): Uncertainty, probabilistic reasoning, probabilistic reasoning over time, making simple and complex decisions

Unit 4 (Machine learning): Examples, general statistical-based learning, parameter estimation maximum likelihood, inductive logic programming, supervised learning- learning decision trees, learning neural networks, support vector machines. Ensembles, nearest-neighbor algorithms, unsupervised learning and clustering. Semi-supervised learning. Learning graphical models, performance evaluation-cross-validation and area under ROC curve. Learning theory, reinforcement learning-exploration vs. Exploitation trade-off, value and policy iteration.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	2		2		1	1						3	3	1
CO-2	1	2		2		1	1						3	3	1
CO-3	1	2		2		1	1						3	3	1
CO-4	1	2	2	2		1	1						3	3	1
CO-5	1	2	2	2		1	1						3	3	1
CO-6	1	2	2	2		1	1	1					3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		03
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	02	
Numeracy		12
1. Solving Numerical Problems	12	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures

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2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

9. Class notes
10. Russell, S. J., and Norvig, P., 2010, Artificial Intelligence: A Modern Approach, 3rd edn. Prentice Hall.
11. Rich E. and Knight K., 2009, Artificial Intelligence, 3rd edn. Tata McGraw Hill.

b. Recommended Reading

1. Nilsson, N. J., 1998, Artificial Intelligence: A New Synthesis, Morgan Kaufmann
2. Neapolitan, R. E. and Jiang X., 2012, Contemporary Artificial Intelligence, CRC Press
3. Luger G. and Stubblefield W., 2004, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Benjamin/Cummings

c. Magazines and Journals

1. AI Magazine
2. Elsevier Journal of Artificial Intelligence
3. The Knowledge Engineering Review
4. Journal of Automated Reasoning

d. Websites

1. https://www.tutorialspoint.com/artificial_intelligence/index.html
2. https://www.ibm.com/developerworks/library/cc-beginner-guidemachine-learning-ai-cognitive/index.html

e. Other Electronic Resources

1. https://in.udacity.com/course/intro-to-artificial-intelligence--cs271
2. https://www.udemy.com/artificial-intelligence-az/

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Course Specifications: Artificial Intelligence Laboratory

Course Title	Artificial Intelligence Laboratory
Course Code	AIL202A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at providing hands-on exposure to artificial intelligence, intelligent agents and their applications. This specialization is designed to enable students to build intelligent machines, software, or applications with a cutting-edge combination of machine learning, analytics and visualization technologies. The knowledge representation, search strategies, learning, reasoning and planning will be applied in detail. Application of the principles of artificial intelligence in machine learning, robotics and perception will be discussed. There will be a special emphasis on the analysis and synthesis of intelligent agent-based applications of artificial intelligence.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the process of modelling, design and synthesis of artificial intelligence applications
CO-2. Explain the principles of artificial intelligence and intelligent agents
CO-3. Apply the principles of knowledge representation, search strategies, learning, reasoning and planning to design intelligent agents
CO-4. Analyze a scenario and identify methods for knowledge representation, search, learning, reasoning and planning
CO-5. Synthesize an intelligent agent for a given scenario
CO-6. Evaluate the performance of an intelligent agent based on appropriate measures of performance

4. Course Contents

1	Knowledge Representation
2	Applications of various search strategies
3	Basic and advanced machine learning

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4	Reasoning by intelligent agents
5	Planning by intelligent agents
6	Neural Network taking different bias value and activation functions
7	Probability Bayesian model, Markov model and Hidden Markov Models
8	NLP, Machine vision and perception
9	Robotics applications

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	2	2	2		1	1	1					3	3	1
CO-2	1	2	2	2		1	1	1					3	3	1
CO-3	1	2	2	2		1	1	1					3	3	1
CO-4	1	2	2	2		1	1	1					3	3	1
CO-5	1	2	2	2		1	1	1					3	3	1
CO-6	1	2	2	2		1	1	1					3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X		X
CO-5		X	
CO-6		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Demonstration using videos
2.	Understanding	Computer Laboratory
3.	Critical Skills	Computer Laboratory, Lab Manual
4.	Analytical Skills	Computer Laboratory, Lab Manual
5.	Problem Solving Skills	Computer Laboratory, Examination
6.	Practical Skills	Computer Laboratory
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Lab Manual, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Lab Manual
14.	Personal Management	--
15.	Leadership Skills	--

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a. Essential Reading

3. Laboratory Manual
4. Russell, S. J., and Norvig, P. (2010) Artificial Intelligence: A Modern Approach, 3rd edn. Prentice Hal

b. Recommended Reading

1. Alpaydin, E. (2010) Introduction to Machine Learning, 2nd edn. The MIT Press
2. Huth, M. and Ryan, M. (2004) Logic for Computer Science: Modelling and
3. Reasoning about Systems, 2nd edn. Cambridge University Press

c. Magazines and Journals

1 ieee.org

d. Websites

1 https://www.tutorialspoint.com/artificial_intelligence/
2 https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-034-artificial-intelligence-fall-2010/
3 https://web.stanford.edu/class/cs221/#coursework
4 https://www.technologyreview.com/artificial-intelligence/

e. Other Electronic Resources

1. https://nptel.ac.in

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Course Specifications: Computer Networks Laboratory

Course Title	Computer Networks Laboratory
Course Code	CSL301A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to train the students to model, design, implement and analyze client- server based computer networks using appropriate Data Link Layer (DLL) & Network Layer protocols and the Linux Sockets API. Application requirements are analyzed to arrive at the design requirements of the network, such as type of server and transport layer protocol, which are appropriately implemented. The course also focuses on developing C programs to demonstrate the working of PHY, DLL & Network Layer protocols and simulation of various wired and wireless network protocols. Testing and validation are an integral part of the learning and evaluation. Students are required to generate laboratory reports documenting the complete effort.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Relate the algorithms used by DLL and Network layers to their use in higher layer protocols
CO-2. Express client-server applications as a set of appropriate function calls, as well as algorithms and/or flowcharts
CO-3. Apply the Linux sockets API in the development of client-server-based computer networks
CO-4. Choose between different types of servers and appropriate transport layer protocols
CO-5. Design and implement applications using appropriate algorithms at PHY, DLL and Network Layers along with client-server interactions and create a laboratory report documenting the complete effort.

4. Course Contents

1	Error Detection and correction codes and Frame sorting technique used in buffers
2	Congestion control algorithms, Neighbor table determination and Distance Vector Routing

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3	TCP Socket programming, UDP Socket programming and concurrent server programming
4	Alpha-numeric ciphers and Mono- and polyalphabetic substitution ciphers

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	04	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	--
13.	Information Management	Laboratory Manual
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. Essential Reading

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i. Tanenbaum, A., and Wetherall, D., 2010, Computer Networks, 5th edn., Boston, Prentice Hall.
ii. Forouzan, B., 2013, Data Communications and Networking, 5th edn., New York, MacGraw-Hill.

b. Recommended Reading

i. Olifer, N., and Olifer, V., 2010, Computer Networks, New Delhi, Willy India.
ii. Stevens W., Fenner B., and Rudoff, A., 2007, The Sockets Networking API, Boston, Addison-Wesley.
iii. Cordeiro, C., and Agrawal, D., 2011, Ad Hoc and Sensor Networks, Hackensack, World Scientific.
iv. Stallings, W., 2011, Cryptography and Network Security, 5th edn., Boston, Prentice Hall.

c. Magazines and Journals

i. ACM Transactions on Networking
ii. IEEE Transactions on Communications 3. Wireless Networks

d. Websites

i. IEEE Communication Society, http://www.comsoc.org
ii. IEEE, http://www.ieee.org
iii. ACM, http://www.acm.org

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Course Specifications: Microprocessors Laboratory

Course Title	Microprocessors Laboratory
Course Code	CSL205A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to train the students in design and development of assembly language programs, basic peripheral interfacing and inline assembly statements in C. Students are trained to design software logic as algorithms and implement the software using assembly language. They are trained to develop assembly language programs that manipulate hardware registers, analyze their performance and test the developed programs. Students are required to generate a report documenting the laboratory work.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the elements of assembly language programming
CO-2. Discuss the various tools and techniques used for assembly language programming
CO-3. Apply assembly language constructs to optimize C programs
CO-4. Synthesize programs using inline assembly statements in C
CO-5. Analyze, test and validate developed assembly programs
CO-6. Document work done and prepare a laboratory report

4. Course Contents

1	Introduction to GAS, GDB and GNU tool chain
2	Development of programs using instructions for data transfer operations
3	Development of programs using arithmetic and Logical operations

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4	Development of programs using conditional instructions
5	Development of programs using array manipulation algorithms on Integers such as sorting, searching
6	Development of programs using string manipulation algorithms such as reversal, comparison, update of string
7	Development of programs optimized high level language code with inline assembly blocks
8	Interfacing basic devices like LEDs, push buttons, keypad. Interfacing with basic sensors and actuators

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2		2	2				1	1			3		
CO-2	2	2											3		
CO-3	2	2											3		
CO-4		2	2		2				1	1			3		
CO-5	2	2		2	2				1	1	3		3	3	1
CO-6											2				
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		04
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	04	
Numeracy		0
1. Solving Numerical Problems	00	
Practical Work		26
1. Course Laboratory	26	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10

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Total Duration in Hours	**40**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (60% Weightage)		Component 2: SEE (40% Weightage)
Subcomponent Type ▶	Conduct of Experiments	Laboratory Report + Viva	Laboratory SEE
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory Record
10.	Verbal Communication Skills	Viva-Voce
11.	Presentation Skills	Laboratory Record
12.	Behavioral Skills	
13.	Information Management	Laboratory Manual

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14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

f. Essential Reading

1. Class notes
2. Stallings, W., 2010, Computer Organization and Architecture: Designing for Performance, Upper Saddle River, NJ, Prentice Hall.
3. Blum, R., 2005, Professional Assembly Language, Indiana, Wiley

g. Recommended Reading

1. Brey, B. B., 2009, The Intel Microprocessors, 8th edn. Pearson Education

h. Magazines and Journals

5. IEEE Transactions on Computers
6. IEEE Micro

i. Websites

3. https://www.coursera.org/
4. http:// nptel.ac.in/

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Course Specifications: Graph Theory and Optimization

Course Title	Graph Theory and Optimization
Course Code	CSC305A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course intends to teach the concepts, techniques and applications of graph theory and discrete optimization. Basic graph theory and applications of optimization theory for efficient solution of graph problems arising in Computer Science and Engineering as well as Discrete Optimization techniques for Integer Linear Programming and Combinatorial Optimization and their applications are dealt in detail. Local Search and Metaheuristic approaches to combinatorial optimization problems are taught. Random Graphs and Spectral Theory ofGraphs are covered. Students are trained to apply discrete optimization and graph theory to design and analyze solutions for problems in Computer Science and Engineering.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the concepts, theories and techniques of graph theory and discrete optimization

CO-2. Explain the principles of graph theory, discrete optimization and their applications in Computer Science and Engineering

CO-3. Identify and apply appropriate approach from graph theory and discrete optimisation to formulate a given problem

CO-4. Design graph theory and discrete optimisation based algorithms to solve problems in Computer Science and Engineering

CO-5. Synthesize efficient algorithms for problems in Computer Science and Engineering using graph structures and discrete optimisation methods

CO-6. Evaluate the utility of discrete optimisation and graph structures for modelling and analysis of computing systems

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4. Course Contents

Unit 1 (Graph Theory): Basic definitions, breadth-first and depth-first search, trees, connectivity, connected components, paths, cycles, tours and tournaments. Planar Graphs: Embeddings and Euler formula. Characterisation. Graph Colouring: Vertex colourings. Structure of k-chromatic graphs. Colouring of planar graphs. Line graphs. Edge-colouring. Hamiltonian cycles. Planarity, colouring and cycles.

Unit 2 (Linear Programming): Optimisation in engineering. Optimisation Problems. Classification. Linear Programming. Geometry of Linear Programming algorithms. Discrete optimisation: Problems. Complexity issues. Overview of solution approaches: exact solutions, approximations and heuristics. Integer Linear Programming: Formulation. LP and Lagrangian Relaxations. Bounds for ILP solutions. Cutting-plane method. Branch-and-bound for ILP. Branch-and-bound strategies. Dynamic programming.

Unit 3 (Optimisation Problems over Graphs): Formulation, applications and algorithms for: Spanning Trees, Shortest Paths, Network Flows: Maximum Flow and Minimum Cost Flow, Matchings: Maximum and Weighted Matching. Matriods and greedy algorithm, generalisations. Approximation Algorithms: NP-Hard graph problems. Set-cover, Max-cut, Colouring problems. Approximation schemes. Knapsack, Bin-packing, Multi-commodity Flows, Network Design, Travelling Salesman and Facility Location problems.

Unit 4 (Heuristics): General heuristics. Greedy heuristics. Heuristics exploiting the problem structure. Local Search and Metaheuristics-Trajectory and population based methods. Local Search: Methodology-Initial solution, neighbours, search strategy, stopping criterion. Neighbourhood function. Neighbourhood operators. Evaluating function, feasibility and acceptance strategy. Search landscapes, local and global optima, basin of attraction. Examples. Design of neighbourhood operators. Escaping local optima: Restart, random moves, moves to lower quality solutions, memory (search history) based search diversity and intensification, changing the landscape-changing neighbourhood or evaluation function. Metaheuristics: Exploration and exploitation of the search space. Motivations from nature-inspired problem solving approaches. Metaheuristic approaches. Overview of Major metaheuristic approaches: Simulated Annealing, Genetic Algorithms, Evolutionary Algorithms, Ant Colony Optimisation, Particle Swarm Optimisation, Tabu Search, Neural Networks.

Unit 5 (Topics in Graph Theory): Random Graphs: Concepts, motivation and applications. Properties of almost all graphs. Threshold function. Evolution and graph parameters. Connectivity, cliques and colouring of random graphs. Spectral Theory of Graphs: Motivation. The characteristic polynomial. Eigenvalues and graph parameters. Eigenvalues of regular graphs. Eigenvalues and expanders. Eigenvalues of strongly regular graphs. Applications.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1		3												2	
CO-2		3												2	
CO-3	3	3		3										2	
CO-4	3	3	2	3	2					2			3		1
CO-5	3		2	3	2	1	1			2			3		1
CO-6	3		2			1	1			2			3		1

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3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution

Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	
CO-6		X	X

The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

8. Course Resources

a. Essential Reading

1. Class notes
2. West, D. B., 2009, Introduction to Graph Theory, PHI.
3. Korte, B., and Vygen, J., 2018, Combinatorial Optimization: 6th edn., Springer.

b. Recommended Reading

1. Deo, N., 2016, Graph Theory with Applications to Engineering and Computer Science, PHI.
2. Papadimitriou, C., and Steglitz, K., 1987, Combinatorial Optimization: Algorithms and Complexity, PHI.
3. Chung, F. R. K., 1996, Spectral Graph Theory, American Mathematical Society.

c. Magazines and Journals

1. SIAM Journal of Optimization
2. Journal of Optimization and Applications (JOTA), Springer
3. ACM Journal of Algorithms
4. Discrete Optimization, Elsevier

d. Websites

1. Decision Tree for Optimization Software: http://plato.asu.edu/guide.html
2. Sony Brook Algorithm Repository: http://www.cs.sunysb.edu/~algorith/

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3. NEOS: http://www-neos.mcs.anl.gov/neos/

e. Other Electronic Resources

1. Optimization Online: http://www.optimization-online.org/

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Course Specifications: Information Security and Protection

Course Title	Information Security and Protection
Course Code	CSC306A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at teaching the students the principles of security and protection of information and information resources. Students are taught elements of information security and models of security policies and mechanisms. The course discusses security attacks on information systems and networks and their counter measures. Students would be trained to analyze an information system and identify security requirements, apply appropriate models for security policies and suggest effective security mechanisms.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-6. Describe elements and components of information security and protection

CO-7. Describe security attacks and defense mechanisms

CO-8. Explain the requirements, principles and models of security policies

CO-9. Analyze the security properties of a given model

CO-10. Analyze a given scenario, application or system and recommend appropriate security policies and mechanisms

CO-11. Develop security policies and mechanisms for a given scenario, application or system

4. Course Contents

Unit 1 (Introduction): Historical overview of information security; Information security system: CIA triad, CNSS model and security system components; Security threats: classification and common types of threats; Security policies and security mechanisms; Role of assumptions and trust in security and protection; Assurance; Operational and Human issues in security systems; Design and implementation of security systems; Security in software development lifecycle

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Unit 2 (Foundations):
Access Control Matrix (ACM) model: Protection State; ACM Model: Subjects, Objects and Rights; Protection State Transitions, Primitive Operations and Commands, Conditional Commands; Special rights: copying, owning and Principle of Attenuation of Privilege.
Fundamental Results: General Security Question, basic results on its solution; Take-Grant Model, Schematic Protection and other typed models. Expressive Power of models. Comparing security properties of models.

Unit 3 (Security Policy Models):
Security Policies: Nature and types of security policies; Types of Access Control; Policy Languages; Security and Precision
Confidentiality Policies: Goals of confidentiality policies; Bell-LaPadula Model: Security Clearances and Security Classifications, Dominance, Simple Security Condition and *-Property, Tranquility: Strong and weak tranquility, declassification principles; impact and legacy of Bell-LaPadula Model.

Unit 4 (Security Policy Models, Cont'd.)
Integrity Policies: Goals: Lipner's requirements of a commercial systems; Biba Model; Lipner's Integrity Matrix Model; Clark-Wilson Integrity Model; Trust Models
Hybrid Policy Models: Chinese Wall Model; Clinical Information Systems Security Model; Originator Controlled Access Control; Role-Based Access Control; Break-the-Glass Policies

Unit 5 (Security Mechanisms):
Cryptography: Basics of encryption and cryptography; Cipher techniques; private, public and hybrid key cryptographic systems; key management and exchange mechanisms.
Systems: Principles of secure design; Identity and trust in systems and on the Web; Access Control mechanism; Information Flow and Confinement.

Unit 6 (Attacks and Defense):
Network Security: Vulnerabilities and Attacks; Denial of Service (DoS) and Distributed DoS (DDos) attacks; Intrusion Detection Systems; Firewalls, DMZ and secure network organization, Web, mobile and Cloud security.
Operating System security: Vulnerabilities, back doors, OS hardening.

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	1											2	1	
CO-2	1	1											2	2	
CO-3	2	2	1		2				1		1		2	2	1
CO-4	3	3	2	2	2	1		1		1	1		2	3	1
CO-5	3	3	3	2	3	1		2	2	2	1	1	3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

7. Whitman, M. E., and Mattord, H. J., 2017, Principles of Information Security, 6th edn., Cengage Learning.
8. Bishop, M., 2018, Computer Security Art and Science, 2nd edn., Addison Wesley.

b. Recommended Reading

1. Harper,A., Regalado, D., Linn R,, Sims, S., Spasojevic, B., Martinez, L., Baucom, M., Eagle, C., Harris, S., 2018, Gray Hat Hacking, 5th edn., McGraw Hill.
2. Davis C., Schiller M., and Wheeler K., 2020, IT Auditing Using Controls to Protect Information Assets, 3 rd edn., McGraw Hill.
3. Nelson, B., Phillips, A., and Steuart, C., 2018, Guide to Computer Forensics and Investigations, 6th edn., Cengage Learning.
4. Singh, S., 2000, The Code Book: The Science of Secrecy from Ancient Egypt to Quantum Cryptography, Anchor.

c. Magazines and Journals

1. ACM Transactions on Information and System Security
2. IEEE Transactions on Information Forensics and Security
3. International Journal of Information Security
4. IET Information Security

d. Websites

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1. The SANS Institute, www.sans.org
2. Information Systems Security Association, www.issa.org
3. 3. Information Systems Audit and Control Association, www.isaca.org
4. 4. Resource Center for Cyber Forensics - India, www.cyberforensics.in

e. Other Electronic Resources

1. Kali Linux Tutorials, https://kali.org/category/tutorials/

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Course Specifications: Quantum Computing

Course Title	Quantum Computing
Course Code	MCC309A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course teaches the concepts, principles, algorithms and structures of Quantum Computing and Quantum Information Processing. Fundamental aspects of quantum computers and programming are covered. Major quantum algorithms are covered in detail. Quantum Information Theory, its fundamental role in design of quantum computers and quantum communication are taught. Quantum circuits, gates and approaches to building quantum machines are discussed. Students are trained to analyse simple quantum circuits and design quantum algorithms.

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the quantum mechanical, computational and information theoretical concepts underlying quantum computing
CO-2. Describe the concepts of quantum computation, quantum circuits and quantum information theory
CO-3. Explain the architectural and programming principles of quantum computing
CO-4. Explain the principles of quantum algorithms and their applications
CO-5. Analyse simple quantum computing circuits and algorithms
CO-6. Design quantum algorithms for a given application

4. Course Contents

Unit 1 (Background): Quantum Mechanics: Postulates. Measurement. Phase. Composite systems. Density operator and reduced density operator. EPR paradox and Bell inequality. Computing: Turing machines. Computational Circuits. Complexity classes. Energy for computation. Information Theory: Shannon theory. Coding theorems and capacities.

Unit 2 (Quantum Programming): Quantum Computational Models: Quantum Turing Machines, Quantum Finite State Automata, Quantum Computational Circuits and Quantum Random Access Machines (RAM). Properties of quantum computational models. Quantum

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Computing Architectures: Architectural elements, programming and scheduling. Quantum Programming Environment: Quantum Programming Languages, Quantum Programming Paradigms.

Unit 3 (Quantum Algorithms): Quantum parallelism. Deutsch-Jozsa algorithm. Bernstein-Vazirani algorithm. Period finding and Simon's algorithm. Order finding and Shor's algorithm. Solving NP-complete problems. Quantum Fourier Transform and phase estimation. Amplitude amplification and Glover's search algorithm. Quantum Random Walks. Adiabatic Quantum Algorithm. Quantum algorithm complexity classes. Circuit complexity of quantum algorithms.

Unit 4 (Quantum Information): Quantum Information Theory. Quantum Teleportation. Quantum Coding. Quantum Error Correction. Quantum Communication. Quantum Key Distribution. Quantum Cryptography

Unit 5 (Quantum Computing Machines): Quantum gates and quantum probabilistic processors. Decoherence problem. Stabilizer codes and fault tolerant quantum computation and circuits. Implementation schemes of real-life quantum computers.

Unit 6 Special Topics: Quantum Machine Learning, Quantum Signal Processing, Simulation using Quantum Computers.

Tutorials: Demonstrations, Algorithm design and numerical problem solving exercises.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1														1
CO-2	1	2													1
CO-3	2	3	1	1						1					1
CO-4	2	3	1	1						1					1
CO-5	3	3	2	1	1	1						1	3	2	1
CO-6	3	3	2	1	1	1						1	3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop /	00	

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Kitchen		
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Assignment Discussion / Related Activities	08	
2. Case Study Presentation	00	
3. Guest Lecture	02	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	
6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document. The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X		X
CO-5		X	X
CO-6		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments

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4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioural Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Handouts from books and published literature.

b. Recommended Reading

1. Nielson, M. A., and Chuang, I. L., 2010, Quantum Computing and Quantum Information, 10th Anniversary edn., Cambridge University Press.
2. Williams, C. P., 2011, Explorations in Quantum Computing, 2nd edn., Springer.
3. Miszczak, J. A., 2012, High-level Structures for Quantum Computing, Lecture #6, Synthesis Lectures in Quantum Computing, Morgan & Claypool.
4. Metodi, T. S., Faruque, A. I., and Chong, F. T., 2011, Quantum Computing for Computer Architects, 2nd edn., Lecture #13, Synthesis Lectures on Computer Architecture, Morgan & Claypool.
5. Lanzagorta, M., and Uhlmann, J., 2009, Quantum Computer Science, Lecture #2, Synthesis Lectures in Quantum Computing, Morgan & Claypool.
6. Chen, C., et al., 2007, Quantum Computing Devices: Principles, Designs, and Analysis, Chapman & Hall/CRC

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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Course Specifications: Machine Learning-I

Course Title	Machine Learning-I
Course Code	AIC203A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course on Mathematics for Machine Learning II aims to enable students to learn and apply principles of probability and statistics and optimization, making connections to concepts of machine learning. A mind map of the concepts of probability statistics and optimization along with an overview of applications in machine learning is discussed.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the principles of Machine learning
CO-2. Analyze the performance parameters of machine Learning
CO-3. Apply naive Bayes' classifier or Nearest-Neighbor Classifiers to solve simple classification problems
CO-4. Apply Linear Regression to solve the regression problems
CO-5. Apply dimensionality reduction techniques.
CO-6. Apply the k-means algorithm for Unsupervised Learning.

4. Course Contents

Unit 1 (Introduction): Motivation for machine learning, types of machine learning, supervised learning, regression, classification, the machine learning process, a note on programming

Unit 2 (Evaluation): Testing machine learning algorithms, overfitting, training, testing, and validation sets, the confusion matrix, accuracy metrics, the receiver operator characteristic (roc) curve, unbalanced datasets, measurement precision

Unit 3 (Naive Bayes Classifiers): Turning data into probabilities, minimizing risk, the naïve bayes' classifier, some basic statistics, averages, variance and covariance, the Gaussian, the bias-variance tradeoff.

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Unit 4 (k-Nearest-Neighbor): Similarities: Nearest-Neighbor Classifiers The k-Nearest-Neighbor Rule, Measuring Similarity, Irrelevant Attributes and Scaling Problems, Performance Considerations, Weighted Nearest Neighbors, Removing Dangerous, Removing Redundant Examples.

Unit 5 (Perceptron): The perceptron The Learning Rate η The Bias Input the Perceptron Learning Algorithm an Example of Perceptron Learning: Logic Functions Implementation, Linear separability The Perceptron Convergence Theorem The Exclusive Or (XOR) Function A Useful Insight Another Example: The Pima Indian Dataset Preprocessing: Data Preparation, Linear regression.

Unit 6 (Discriminant Analysis): linear discriminant analysis (lda), principal components analysis (pca), relation with the multi-layer perceptron, kernel pca, factor analysis, independent components analysis (ica),

Unit 7 (Decision Tree): Using decision trees, constructing decision trees, quick aside: entropy in information theory, implementing trees and graphs in python, implementation of the decision tree dealing with continuous variables, computational complexity, classification and regression trees (cart), gini impurity, regression in trees, classification, decision by committee: ensemble learning, boosting, adaboost, stumping, bagging, subagging, random forests, comparison with boosting, different ways to combine classifiers.

Unit 8 (Unsupervised learning): Unsupervised learning, the k-means algorithm

5. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3		2									3		
CO-3	3	3		2									3		
CO-4	3	3	3	2	2				1	1			3		
CO-5	3	3	3	2	2				1	1			3	3	1
CO-6	3	3	3	2	2				1	1			3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	

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3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

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The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Class Room Lectures, Assignments
2.	Understanding	Class Room Lectures, Assignments
3.	Critical Skills	Class Room Lectures, Assignments
4.	Analytical Skills	Class Room Lectures, Assignments
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

i. Class notes

ii. Miroslav_Kubat (2017), An Introduction to Machine Learning, Second Edition, Springer

iii. Stephen Marsland (Nov 2014) Machine Learning: An Algorithmic Perspective. http://www.amazon.com/Machine-Learning-Algorithmic-perspectiveRecognition/dp/1420067184.

iv. Bishop, C. M. (2006). Pattern Recognition and Machine Learning, Springer.

v. Tom Mitchell (1997), Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.htm

b. Recommended Reading

i. Ethem Alpaydin. (2017), Introduction to Machine Learning, third edition, PHI.

c. Magazines and Journals

i. https://www.quantamagazine.org/tag/machine-learning

ii. https://www.springer.com/journal/10994

d. Websites

i. https://www.javatpoint.com/machine-learning

e. Other Electronic Resources

i. https://towardsdatascience.com/introduction-to-machine-learning-forbeginners-eed6024fdb08

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Course Specifications: Parallel Algorithms for Scientific Computing

Course Title	Parallel Algorithms for Scientific Computing
Course Code	MCC310A
Course Type	Core Theory Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course is aimed at designing parallel algorithms for scientific and engineering applications. Students are taught to design algorithms that exploit the underlying parallel computer architecture. The design of multi-core architectures, programming multi-core and shared memory multiprocessors and OpenCL are covered

2. Course Size and Credits

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Discuss approaches to serial and parallel algorithm design
CO-2. Explain parallelism present in scientific and engineering problems
CO-3. Design algorithms for multi-core and shared memory multiprocessors
CO-4. Use MPI and OpenCL
CO-5. Apply parallel program design concepts to Scientific and Engineering problems

4. Course Contents

Unit 1: Motivation for Parallel Programming; Overview of Parallel Systems

Unit 2: Programming Multi-core and Shared Memory Multiprocessors using OpenMP; MPI Processes and Messaging; OpenCL for massively parallel Graphic Processors

Unit 3: Application of parallel algorithm design concepts to scientific and Engineering problems; Examples of Parallel computation; Matrix computations and parallelism; parallelization of seam carving; study of performance of parallel programs

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (Pos)												Programme Specific Outcomes (PSOs)			
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4

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CO-1	3	3		2					1	1			3			
CO-2	3	3											3			
CO-3	3	3											3			
CO-4	3	3	3		2				1	1			3			
CO-5	3	3	3		2				1	1			3	3	1	1
CO-6	3	3	3		2				1	1			3	3	1	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution																

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		02
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		03
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the Cos. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), Cos are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	

CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. **Essential Reading**

1. Course notes
2. Roman Trobec, Bostjan Slivnik, Patricio Bulic, Borut Robic, 2018, Introduction to Parallel Computing From Algorithms to Programming on State-of-the-Art-Platforms, Springer.

b. **Recommended Reading**

c. **Magazines and Journals**

1. IEEE Transactions on Parallel and Distributed Systems Websites

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Course Specifications: Seminar

Course Title	Seminar
Course Code	CSS301A
Course Type	Seminar
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is aimed at providing a platform to the students for Material Collection, Analysis and Presentation on a contemporary Computer Science related topic, approved by the CSE Dept. The students can choose their own topic, get it approved from the HOD, chose a Mentor (any faculty in the Department who is working/having interest in the area) and Collect Material from Open Sources available under the guidance of the Mentor. The Student has to prepare a Seminar Report not exceeding 20 Pages which is to be presented by the students to a selected audience of the CSE Department in the Presence of the Mentor at the end of the ensuing session as per the plan of the Dept. The duration of Presentation may be 15-20 minutes per student. Individual and grouping of a maximum two students is permitted for the course.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	28
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Demonstrate the understanding of Selection of relevant Topics for Presentations
- **CO-2.** Get exposed to the Collection of Material, Reading and Comprehension
- **CO-3.** Learn to make a Report in a given format and Prepare Presentation on the Report
- **CO-4.** Get into Facing an Audience while presenting their Work and managing a Q&A Session

4. Course Contents

Unit 1 (Briefing): Brief the Students on Topic Selection, Material Collection, Study, Report and Presentation Preparation.

Unit 2 (Review): Reviewing the works of the Students and Steering, required if any.

Unit 3 (Presentation and Report Submission): The students have to Present their work to a decided audience and submit the Report. The Presentation and the Report will be evaluated by a Panel constituted by the Dept.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	1		2		1		1	2	2	3			2	2
CO-2	3	1		2		1		1	2	2	3			2	2
CO-3	3	1		2		1		1	2	2	3			2	2
CO-4	3	1		2		1		1	1	1				2	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		28
1. Case Study Presentation	20	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	08	
Term Tests, Laboratory Examination/Written Examination, Presentations		02
Total Duration in Hours		**30**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (30% Weightage)				Component 2: SEE (70% Weightage)
Subcomponent ▸	SC1	SC2	SC3	SC4	
Subcomponent Type ▸	Interim Presentation	-	-	-	35 Marks
Maximum Marks ▸	15				
CO-1	▯				▯
CO-2	▯				▯
CO-3	▯				▯
CO-4	▯				▯
CO-5					
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Mentor assigned to the Students in consultation with the Head of the Department, shall provide the focus of COs in the component of assessment in the above template at the beginning of the semester and the entire semester, at regular intervals, till the conduct of Presentation and submission of the Seminar Report.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Open Source, Discussion with Mentor
2.	Understanding	Self-Study, Discussion with Mentor
3.	Critical Skills	Self-Study, Discussion with Mentor
4.	Analytical Skills	Discussion with Mentor
5.	Problem Solving Skills	-
6.	Practical Skills	Self-Study & Work
7.	Group Work	Self-Study & Work, Discussion in Group
8.	Self-Learning	Self-study
9.	Written Communication Skills	Report Writing
10.	Verbal Communication Skills	Discussion with Mentor and Group Members
11.	Presentation Skills	Interim and Final Presentation
12.	Behavioral Skills	Discussions with Mentor and Group Members
13.	Information Management	Report Preparation
14.	Personal Management	--
15.	Leadership Skills	Group Discussions from Start to End.

9. Course Resources

a. Essential Reading

1. Weissman, J., 2009, Presenting to Win, Pearson Education.
2. Atkinson, C., 2015, Beyond Bullet Points, Microsoft.
3. Gibrjelle, B. R., 2010, Speaking Powerpoint, Insights Publishing.
4. Reynolds, G., 2012, Presentation Zen Design, 2nd edn., New Riders.

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b. **Recommended Reading**
   1. Will be suitably advised based on chosen topic
c. **Magazines and Journals**
   1. Will be suitably advised based on chosen topic
d. **Websites**
   1. Will be suitably advised based on chosen topic
e. **Other Electronic Resources**
   1. Will be suitably advised based on chosen topic

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Course Specifications: Numerical Analysis Laboratory

Course Title	Numerical Analysis Laboratory
Course Code	MCL301A
Course Type	Core Laboratory Course
Department	Mathematics and Statistics
Faculty	Engineering & Technology

1. Course Summary

The aim of the course is to provide an understanding of numerical methods to solve ordinary differential equations. The course trains students to write programs in MATLAB to solve ordinary differential equations. Students are taught the concepts of different numerical methods such as Euler's method, Runge-Kutta method, Milne's method, Adams method and finite difference method to solve ordinary differential equations. The students are trained to solve ordinary differential equations and implementation of the same using MATLAB.

2. Course Size and Credits

Number of Credits	01
Credit Structure (Lecture: Tutorial: Practical)	0:0:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the concept of directional fields and numerical solution of first order ordinary differential equation

CO-2. Determine the solution for ordinary differential equations using MATLAB built in commands

CO-3. Solve simple mathematical problems associated with first order ordinary differential equation using numerical methods and compare the results with that of solutions obtained by analytical methods

CO-4. Solve boundary value problems of ordinary differential equation using numerical methods

CO-5. Solve complex mathematical problems associated with ordinary differential equation using numerical methods and compare the results with that of solutions obtained using MATLAB.

4. Course Contents

- Direction fields
- Built in functions dsolve and ode45 to solve ordinary differential equation,
- Numerical solution of first order ordinary differential equation using Euler's method,
- Numerical solution of first order ordinary differential equation using Euler's modified method,

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- Numerical solution of first order ordinary differential equation using Runge-Kutta method I
- Numerical solution of first order ordinary differential equation using Runge-Kutta method II
- Numerical solution of first order ordinary differential equation using Milne's predictor-corrector method,
- Numerical solution of first order ordinary differential equation using Adams-Bashforth predictor-corrector method,
- Numerical solution of system of ordinary differential equation
- Numerical solution of boundary value problems using finite difference method

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	2	2	1	3	2						2	3	
CO-2	2	2	1	3	2						2	3	
CO-3	2	2	1	3	2						2	3	
CO-4	2	3	1	3	2						2	3	
CO-5	2	3	1	3	2						2	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		07
Demonstrations		06
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	06	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		17
1. Course Laboratory	00	
2. Computer Laboratory	17	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**40**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of CO son each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent▸	SC1				
Subcomponent Type ▸	Laboratory work record/Laboratory Manual Report				50 Marks
Maximum Marks▸	50				
CO-1	▯				▯
CO-2	▯				▯
CO-3	▯				▯
CO-4	▯				▯
CO-5	▯				
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory Instruction
2.	Understanding	Laboratory Instructions and experiments
3.	Critical Skills	Laboratory Work
4.	Analytical Skills	Laboratory Work
5.	Problem Solving Skills	Laboratory Work
6.	Practical Skills	Laboratory Work
7.	Group Work	Laboratory Work
8.	Self-Learning	Laboratory Work
9.	Written Communication Skills	Laboratory Work, Examination
10.	Verbal Communication Skills	Laboratory Examination
11.	Presentation Skills	--
12.	Behavioral Skills	Laboratory Work

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13.	Information Management	Laboratory Work
14.	Personal Management	Laboratory Work
15.	Leadership Skills	--

9. **Course Resources**
   a. **Essential Reading**
      1. Course notes
      2. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 9th edition, Massachusetts, Brooks/Cole.
   b. **Recommended Reading**
      1. Steven Chapra and Raymond Canale,2016, Numerical Methods for Engineers, 7th edition, New Jersey, McGraw Hill.
      2. S. S. Sastry, 2010, Introductory methods of Numerical Analysis, 4th edition, New Delhi, PHI learning Pvt. Limited.
      3. Rao V. Dukkipati, 2011, Applied Numerical Methods using Matlab, 1st edition, New Delhi, New Age.
   c. **Magazines and Journals**
   d. **Websites**
   e. **Other Electronic Resources**

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Course Specifications: **Project Work-1**

Course Title	Project Work-1
Course Code	CSP401A
Course Type	Core Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualise a solution, perform basic design calculations, model, solve, analyze and demonstrate its performance in a virtual environment and or prototype. The students are expected to work in a team of not more than 4 members and are required to develop an appropriate solution by identifying a problem for which a better or new engineering solution is required. The team needs to demonstrate the working of the solution and write a technical report. Student are required to choose a project from student's projects database available.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total number of hours available per student	120
Total number of hours for the team of 4 members	480
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Recognise the need for developing a new or improving an existing engineering product/system through an organised survey of literature and requirement analysis
- **CO-2.** Define engineering design specifications based on the software requirements specification
- **CO-3.** Design, model, synthesise, analyse the solution to meet the design specifications
- **CO-4.** Evaluate the performance of the modelled system and justify its performance
- **CO-5.** Demonstrate the system working in a virtual environment and make a presentation
- **CO-6.** Write a project report

4. Course Contents

Unit 1: Interaction with the users and collection of data

Unit 2: Collection of relevant literature and review of literature

Unit 3: Data Analysis, Formulation of a problem of suitable size

Unit 4: Create a Software Requirements Specification document providing statements of requirements

Unit 5: Create the design specifications using appropriate CASE tool

Unit 6: Product development planning, cost calculations

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Unit 7: Detailed design
Unit 8: Choosing a development environment, learning the appropriate tools and techniques
Unit 9: Implementation, test and analysis of design
Unit 10: Defining performance parameters, Evaluation of performance, presentation performance characteristics, Verification of results
Unit 11: Developing a working model, testing the model and evaluating its performance
Unit 12: Demonstration to the defined audience and making a presentation to the assessing team making a Technical presentation
Unit 13: Writing project report

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	2				2	2	1	1	3	2	
CO-2	3	3	2	2	2				2	2	1	1	3	2	
CO-3	3	3	2	3	2				2	2	1	1	3	2	
CO-4	3	3	3	3	2				2	2	1	1	3	2	
CO-5	3	3	3	3	3				2	2	1	1	3	2	
CO-6	3	3	3	3	3				2	2	1	1	3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Approximate Duration in Hours
Literature collection, Review of literature, Deciding the sample, For data collection, Developing a questionnaire, Data collection, Analysis of data, Problem formulation and Defining specifications	20
Development of design concept, Basic design calculations	40
Selection of tools, techniques and learning on how to use them	20
Modelling, Simulation, Analysis	40
Evaluation, Verification of results	20
Demonstration, Presentation and Technical Report Writing	20
Total Duration in Hours	160

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Robotics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1 and SC2), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: Project Report (SEE) (50% Weightage)
Subcomponent ▸	SC1	SC2	
Subcomponent Type ▸	Interim Presentation	Final Presentation	100 Marks
Maximum Marks ▸	30	70	
CO-1	▯	▯	▯
CO-2	▯	▯	▯
CO-3	▯	▯	▯
CO-4		▯	▯
CO-5		▯	▯
CO-6			▯
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.			

The Course Leader / coordinator / mentor / guide assigned to the course /student group, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Project work
2.	Understanding	Project work
3.	Critical Skills	Project work
4.	Analytical Skills	Project work
5.	Problem Solving Skills	Project work
6.	Practical Skills	Project work
7.	Group Work	Project work
8.	Self-Learning	Project work
9.	Written Communication Skills	Project Report
10.	Verbal Communication Skills	Project Presentation,Viva-Voce
11.	Presentation Skills	Project Presentation
12.	Behavioral Skills	Project work
13.	Information Management	Project Report
14.	Personal Management	Project work
15.	Leadership Skills	Project work

9. Course Resources

a. **Essential Reading**

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of Project work"

b. **Recommended Reading**

1. Class notes, manuals of tools and techniques chosen to solve the design problem

c. **Magazines and Journals**

1. Will be suitably advised based on chosen topic

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d. **Websites**
   1. Will be suitably advised based on chosen topic
e. **Other Electronic Resources**
   1. Will be suitably advised based on chosen topic

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Course Specifications: Internship

Course Title	Internship
Course Code	CSI401A
Course Type	Core course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Students are required to undergo an internship session of 40 Days during the vacation post the completion of 6th Semester, in an industry which may be a business organization, research organization or any other university/technical institution. The students are expected to work in an area / topic of relevance which need to have prior approval from the Dept Head and Dean of the Faculty.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	160
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Understand the Process Stock of the Industry
- **CO-2.** Gain experience of the Process Stock by working on an ongoing Project in the Industry
- **CO-3.** Learn to manifest the work done in the form of a Report in a given format.
- **CO-4.** Get experienced on Presenting the Work Done and Facing an Audience while presenting their Work.

4. Course Contents

Unit 1 (Work Approval): The Student has to prepare a write up (not exceeding five pages) regarding the Industry and area of which he has chosen to undertake the Internship. He has to apply for approval of the Internship to the Dean through HOD with the sanction letter of the Industry/Institution and the write up prepared.

Unit 2 (Working in Industry): The student will work in the approved Industry/Institution/area for the complete period of Internship.

Unit 3 (Presentation and Report Submission): The students have to Submit a Report of their work to the CSE Dept and present it (the work) to a decided audience to that effect. The Presentation and the Report will be evaluated by a Panel constituted by the Dept.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	1		2		1	2	2	2	2	3		1	2	3
CO-2	1	1		2		1	2	2	2	2	3		1	2	3
CO-3	1	1		2		1	2	2	2	2	3		1	2	3
CO-4	1	1		2		1	2	2	2	2	3		1	2	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	01	
3. Demonstration on a Computer	03	
Numeracy		00
1. Solving Numerical Problems	0	
Practical Work		160
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		00
Total Duration in Hours		**160**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (30% Weightage)				Component 2: SEE (100% Weightage)
Subcomponent ▸	SC1	SC2	SC3	SC4	
Subcomponent Type ▸			-	-	100 Marks
Maximum Marks ▸					
CO-1					
CO-2					
CO-3					
CO-4					
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Mentor assigned to the Students in consultation with the Head of the Department, shall provide the focus of COs in the component of assessment in the above template at the beginning of the semester and the entire semester, at regular intervals, till the conduct of Presentation and submission of the Industry Work Done Report.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Industry/Institution Resources
2.	Understanding	Self Study, Discussion in Industry
3.	Critical Skills	Emulating from Personnel while in Internship
4.	Analytical Skills	Industry Team
5.	Problem Solving Skills	Industry Team
6.	Practical Skills	Emulating from Personnel while in Internship
7.	Group Work	Working in the Group assigned in the Industry
8.	Self-Learning	Self-Study and Learning from Personnel Working in Industry
9.	Written Communication Skills	Report Writing and Communicating with Industry Experts
10.	Verbal Communication Skills	While Communicating with Industry Personnel.
11.	Presentation Skills	Final Presentation
12.	Behavioral Skills	Dealing with Industry Officials and Personnel.
13.	Information Management	Report Preparation, Taking Notes and Presenting to Industry Panel.
14.	Personal Management	Working in Industry for a considerable period of 40 Days.
15.	Leadership Skills	Working with Industry sections/heads.

9. Course Resources

a. Essential Reading

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of

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Project work"

b. **Recommended Reading**
   1. Will be suitably advised based on chosen topic
c. **Magazines and Journals**
   1. Will be suitably advised based on chosen topic
d. **Websites**
   1. Will be suitably advised based on chosen topic
e. **Other Electronic Resources**
   1. Will be suitably advised based on chosen topic

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Course Specifications: Project Work-2

Course Title	Project Work-2
Course Code	CSP402A
Course Type	Core Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to give students an experience of identifying an engineering problem, conceptualise a solution, perform basic design calculations, model, solve, analyze and demonstrate its performance in a virtual environment and or prototype. The students are expected to work in a team of not more than 4 members and are required to develop an appropriate solution by identifying a problem for which a better or new engineering solution is required. The team needs to demonstrate the working of the solution and write a technical report. Student are required to choose a project from student's projects database available.

2. Course Size and Credits

Number of Credits	08
Credit Structure (Lecture: Tutorial: Practical)	0:0:8
Total number of hours available per student	240
Total number of hours for the team of 4 members	960
Number of Weeks in a Semester	15
Department Responsible	Mechanical and Manufacturing Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Recognise the need for developing a new or improving an existing engineering product/system through an organised survey of literature and requirement analysis
- **CO-2.** Define engineering design specifications based on the software requirements specification
- **CO-3.** Design, model, synthesise, analyse the solution to meet the design specifications
- **CO-4.** Evaluate the performance of the modelled system and justify its performance
- **CO-5.** Demonstrate the system working in a virtual environment and make a presentation
- **CO-6.** Write a project report

4. Course Contents

Unit 1: Interaction with the users and collection of data

Unit 2: Collection of relevant literature and review of literature

Unit 3: Data Analysis, Formulation of a problem of suitable size

Unit 4: Create a Software Requirements Specification document providing statements of requirements

Unit 5: Create the design specifications using appropriate CASE tool

Unit 6: Product development planning, cost calculations

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Unit 7: Detailed design
Unit 8: Choosing a development environment, learning the appropriate tools and techniques
Unit 9: Implementation, test and analysis of design
Unit 10: Defining performance parameters, Evaluation of performance, presentation performance characteristics, Verification of results
Unit 11: Developing a working model, testing the model and evaluating its performance
Unit 12: Demonstration to the defined audience and making a presentation to the assessing team making a Technical presentation
Unit 13: Writing project report

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	2				2	2	1	1	3	2	
CO-2	3	3	2	2	2				2	2	1	1	3	2	
CO-3	3	3	2	3	2				2	2	1	1	3	2	
CO-4	3	3	3	3	2				2	2	1	1	3	2	
CO-5	3	3	3	3	3				2	2	1	1	3	2	
CO-6	3	3	3	3	3				2	2	1	1	3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Approximate Duration in Hours
Literature collection, Review of literature, Deciding the sample, For data collection, Developing a questionnaire, Data collection, Analysis of data, Problem formulation and Defining specifications	20
Development of design concept, Basic design calculations	40
Selection of tools, techniques and learning on how to use them	20
Modelling, Simulation, Analysis	40
Evaluation, Verification of results	20
Demonstration, Presentation and Technical Report Writing	20
Total Duration in Hours	160

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1 and SC2), COs are assessed as illustrated in the following Table.

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Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: Project Report (SEE) (50% Weightage)
Subcomponent ▸	SC1	SC2	
Subcomponent Type ▸	Interim Presentation	Final Presentation	100 Marks
Maximum Marks ▸	30	70	
CO-1	▯	▯	▯
CO-2	▯	▯	▯
CO-3	▯	▯	▯
CO-4		▯	▯
CO-5		▯	▯
CO-6			▯
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.			

The Course Leader / coordinator / mentor / guide assigned to the course /student group, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Project work
2.	Understanding	Project work
3.	Critical Skills	Project work
4.	Analytical Skills	Project work
5.	Problem Solving Skills	Project work
6.	Practical Skills	Project work
7.	Group Work	Project work
8.	Self-Learning	Project work
9.	Written Communication Skills	Project Report
10.	Verbal Communication Skills	Project Presentation,Viva-Voce
11.	Presentation Skills	Project Presentation
12.	Behavioral Skills	Project work
13.	Information Management	Project Report
14.	Personal Management	Project work
15.	Leadership Skills	Project work

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9. Course Resources

a. Essential Reading

1. Presentations made by the Head of the Department on "Importance of Project work and The Methodology to be followed for successful Completion of Project work"

b. Recommended Reading

1. Class notes, manuals of tools and techniques chosen to solve the design problem

c. Magazines and Journals

1. Will be suitably advised based on chosen topic

d. Websites

1. Will be suitably advised based on chosen topic

e. Other Electronic Resources

1. Will be suitably advised based on chosen topic

10. Course Organization

Course Code	20MCP401A		
Course Title	Project Work-2		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	49065555
		E-mail:	hod.cs.et@msruas.ac.in
Course Specifications Approval Date		23-Oct-2020	
Next Course Specifications Review Date		May-2024	

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Course Specifications: Information Theory and Coding

Course Title	Information Theory and Coding
Course Code	MTE301A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the concepts of information theory and coding. Students are taught various encoding techniques for digital data representation and processing, performance limits and Shannon theorems. The course also emphasizes entropy, information measures and various error detection and correction techniques as applied to data storage, retrieval/transmission, reception and processing.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe the types of information sources, encoding techniques, channels and channel capacity
CO-2. Explain the basic concepts of information theory, Shannon's theorems, and various encoding techniques
CO-3. Solve simple problems to compute entropy, information measures and evaluate various codes
CO-4. Design encoders and decoders for error control coding techniques
CO-5. Solve complex problems to compute entropy, information measures and evaluate various codes
CO-6. Evaluate the performance of error detection and correction codes

4. Course Contents

Unit 1 Information Theory: Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Markov model for information source, Entropy and information rate of Markov source.

Unit 2 Source Coding: Encoding of the source output, Shannon's encoding algorithm. Communication Channels, Discrete communication channels, Continuous channels. Source encoding: Encoding of the source output, Shannon's encoding theorem and algorithm. Shannon-Fano codes, Huffman coding, Arithmetic coding, The Lempel–Ziv coding, Run length encoding.

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Unit 3 Fundamental Limits on Performance: Source coding theorem, Huffman coding, Discrete memory less Channels, Mutual information, Channel Capacity. Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity theorem.

Unit 4 Discrete communication channel: Models, Mutual information, Channel coding theorem, Channel capacity theorem. Continuous channel: Differential entropy, Mutual information, Channel capacity.

Unit 5 Error Control Coding: Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding. Finite fields, Binary Cycle Codes, Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation. BCH codes. RS codes, Golay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes. Convolution Codes: Time domain approach, Transform domain approach. Viterbi decoding, feedback decoding, sequential decoding, Turbo Codes. Introduction to Space-Time Coding.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1														
CO-2	1	2			2										1
CO-3	3	3	1	1	3										
CO-4	3	3	3	2	2			1					3		
CO-5	3	3	3	2	3			1	1			1	3	2	
CO-6	3	3	2	2	3			1	1			1	3	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		20
1. Solving Numerical Problems	20	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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6. Model Studio	00	
Others		10
1. Assignment Discussion / Related Activities	05	
2. Case Study Presentation	03	
3. Guest Lecture	02	
4. Industry / Field Visit	00	
5. Brain Storming Sessions	00	
6. Group Discussions	00	
7. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document. The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Assignments
4.	Analytical Skills	Assignments
5.	Problem Solving Skills	Assignments, Examination
6.	Practical Skills	Assignments

7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignments
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Shanmugam, K. S. (1996) Digital and Analog Communication Systems, John Wiley & Sons.

b. Recommended Reading

1. Cover, T. M., and Thomas, J. A. (2006) Elements of Information Theory, 2nd edn., John Wiley & Sons.
2. Neubauer, A., Freudenberger, J., and Kuhn, V. (2007) Coding Theory: Algorithms, Architectures and Applications, John Wiley & Sons.
3. Haykin, S. (2008) Digital Communication, John Wiley India Pvt. Ltd.
4. Gallagar, R. G. (2008) Principles of Digital Communication, Cambridge University Press.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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Course Specifications: Introduction to Real Analysis

Course Title	Introduction to Real Analysis
Course Code	MTE303A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to introduce students the basic concepts of real analysis. This course involves properties of real numbers, real sequences, series and real valued functions. Here we will develop in students, the concepts of convergence of sequence and series of real numbers, limit, continuity and differentiability of real valued functions, uniform convergence of sequence of real functions. The students are introduced to important theorems and rigorous proofs. This course is a foundation for further study of mathematical analysis.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe fundamental properties of real numbers, sequences, series and functions
CO-2. State and explain important theorems and ideas in real numbers, sequences, series and functions
CO-3. Demonstrate the skill to construct rigorous mathematical proofs
CO-4. Demonstrate the ability to communicate mathematical ideas and proofs
CO-5. Analyze the proofs of theorems to draw meaningful conclusions
CO-6. Apply the theory to solve problems with varying level of difficulty

4. Course Contents

Unit 1 (The Real Numbers): Algebraic and order properties, absolute value, infimum and supremum, completeness property, Archimedean property
Unit 2 (Sequences of real numbers): Definitions and examples, convergence of sequences, limit theorems, bounded and monotone sequences, subsequences, Bolzano-Weierstrass theorem, Cauchy convergence criterion, divergent sequences.
Unit 3 (Series of real numbers): Definition and examples, tests for convergence of series of positive terms: comparison test, integral test, ratio test, and root test, alternating series, Leibniz's test, Dirichlet's and Abel's test for convergence of alternating series, absolute and conditional convergence.
Unit 4 (Continuity and differentiability): Continuous functions on intervals, uniform continuity,

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monotone and inverse functions, derivative of real functions, mean value theorems and Taylor's theorem.

Unit 5 (Sequence and series of functions): Pointwise convergence, uniform convergence and Weierstrass M-test, uniform convergence and continuity, uniform convergence and Riemann integration, uniform convergence and differentiation.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2								1		3		1
CO-2	3	2	1								1		3		1
CO-3	2	3	2								2		3		2
CO-4	3	3	2	3							2		3	3	2
CO-5	3	3	2	3							2		3	3	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

1. Course Notes
2. Bartle, R.G. and Sherbert, R.D. (2011) Introduction to Real Analysis, 4th edition, John Wiley and Sons Inc.

b. Recommended Reading

1. Rudin, W. (1976) Principles of Mathematical Analysis, 3rd edition, McGraw Hill.
2. Apostal, T. M. (1988) Mathematical Analysis, 2nd edition, Narosa publishing house.
3. Pugh, C.C. (2002) Real Mathematical Analysis, Springer.
4. Kolmogorov, A.N., Fomin, S.V. and Silverman, R.A. (1998) Introductory Real Analysis, Dover Publications.

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm
2. https://www.khanacademy.org/
3. tutorial.math.lamar.edu/

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Course Specifications: Computer Vision

Course Title	Computer Vision
Course Code	AIC304A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course focuses on study of algorithms and techniques to analyze and interpret the visible world around us. This includes understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis, visual geometric modelling, stochastic optimization etc. Knowledge of these concepts will enable students to understand and develop applications using existing tools in the field of computer vision. Applications range from biometrics, medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Discuss fundamentals of Digital Images with Image Formation and processing
- **CO-2.** To Discuss Image processing Techniques
- **CO-3.** Analyze and apply Image processing algorithms to solve recent computer vision problems.
- **CO-4.** Gather a basic understanding about the geo-metric relationships between 2D images world.
- **CO-5.** Apply classification, clustering algorithms for a given computer vision application
- **CO-6.** Implement machine learning algorithms for computer vision applications

4. Course Contents

Unit 1: Introduction: History of Computer Vision, Applications of Computer Vision, Challenges in Computer Vision, market survey on Computer Vision, Block diagram of Computer Vision.

Unit 2: Digital Image Fundamentals: Human Visual System, A simple image model, Image Acquisition, Sampling and quantization, Color models and Color imaging, Pixels, Image Coordinates, Basic Relationships Between Pixels, Identify Individual Objects.

Unit 3: Digital Image Formation and processing Overview: Human Visual System, A simple image model, Image Acquisition, Sampling and quantization, Color models and Color imaging, Pixels,

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Image Coordinates, Basic Relationships Between Pixels, Identify Individual Objects. Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, Morphological operations.

Unit 4: Texture Analysis Overview, Textures Features, Texture Representation, Grey level Co-occurrence matrix, Binary Local Pattern, Gabor Filters, Law's Texture Energy Measures. Dimensionality Reduction: PCA, LDA, ICA.

Unit 5: Image Segmentation: Region Growing, Region Merging, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Object detection.

Unit 6: Machine Learning Models for Images: Supervised- Artificial Neural Network, Gradient Descent algorithm, Backpropagation Algorithm Convolution Neural Network. Unsupervised- K-Means, Rein enforcement learning.

Unit 7: Case studies: Automated diagnosis, Inspection (Factory monitoring: Analyse components for deviations, Robot vision, Obstacle avoidance.

5. **Course Map (CO-PO-PSO Map)**

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
CO-6	3	3	3										3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. **Course Teaching and Learning Methods**

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1. Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the Cos. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), Cos are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	-
8.	Self-Learning	Self-study

9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Course Resources**

a. **Essential Reading**

1. Class notes
2. R.C. Gonzalez and R.E. Woods, 1992, Digital Image Processing, Addison-Wesley.
3. M. C. Bishop, 2006, Pattern Recognition and Machine Learning, Springer
4. S. Theodoridis, K. Koutroumbas, 2008, Pattern Recognition, Academic Press

b. **Recommended Reading**

1. R. Szeliski, 2010, Computer Vision: Algorithms and Application, Springer-Verlag Inc.
2. D. A. Forsyth, J. Ponce, 2003, Computer Vision: A Modern Approach, Pearson Education.

c. **Magazines and Journals**

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.

d. **Websites**

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. **Other Electronic Resources**

1. https://ocw.mit.edu/index.htm

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Course Specifications: Software Architecture

Course Title	Software Architecture
Course Code	CSC301A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Complex software systems require abstraction and analysis at an architectural level of abstraction. In this course we study, typical software system structures (architectural styles), techniques for designing and implementing these structures, models for characterizing and reasoning about architectures, and tools architectural modelling.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Department of Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain the concept of software architecture and design patterns
CO-2. Describe the principle behind software patterns and application of fundamental patterns
CO-3. Summarize the need for software architecture and principles of classical architectural styles
CO-4. Outline the major approaches to integrate patterns into software design **CO-5.** Apply software design patterns for various practical scenarios

4. Course Contents

Unit 1 (Introduction to software architecture): Common architectural styles including Pipes and Filters, OO, Event based invocations, Layered systems, Repositories, Table driven interpreters and heterogeneous architectures. Some case studies in software architecture.

Unit 2 (Creational design patterns): Software design patterns, OO design principles, Creational patterns: Abstract Factory, Builder, Factory Method, Prototype, and Singleton.

Unit 3 (Structural design Patterns): Concepts and Applications of Structural Patterns: Adapter, Bridge, Composite, Decorator, Facade, Flyweight, Proxy, Case studies.

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Unit 4 (Case Studies): Chain of responsibility, Command, Interpreter, Iterator, and Mediator. Overview, Applications, case studies are dealt with respect to specified design patterns

Unit 5 (Behavioral patterns): Memento, Observer, State, Strategy, Template Method, Visitor. UML modelling for different problem scenarios are illustrated.

Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2		2	2	2					3	2	2	3	2	1
CO-2											2	2	3		
CO-3	2										2	2	3		
CO-4		2									2	2	3		
CO-5											2	2	3		

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		05
1.Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	

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2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component(CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination

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6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Len Bass, Paul Clement, Rick Kazman, "Software Architectures in Practice", 3rd Edition, Pearson, 2013.
3. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal, "Pattern Oriented Software Architecture: A System of Patterns", John Wiley and Sons, Volume 1, Reprinted February 2001.

b. Recommended Reading

1. Alan Shalloway, James R Trott, Design Patterns Explained, A New Perspective on Object Oriented Design, 2nd Edition, Addison Wesley

c. Websites

1. www.sciencedirect.org
2. www.ieee.org

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Course Specifications: Advanced Mathematics

Course Title	Advanced Mathematics
Course Code	MTE302A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to provide an understanding of tensors, differential geometry, Riemannian geometry, special functions and its applications to engineering problems. In this course, the students will be taught the concepts of differential geometry and Riemannian geometry such as curves, surfaces, orthogonal curvilinear coordinates, vectors, tensors, and manifolds. The utility of to solve complex engineering problems of Legendre's and Bessel differential equation in modeling real world problems are highlighted. The significance and use of curvilinear coordinates, curvature, torsion, Tangent vectors, Tangential space, manifolds, tensors and coordinate transformation for tensors are emphasized.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Define and explain Legendre and Bessel differential equation, curvature, torsion, geodesics, manifolds and tensors
- **CO-2.** State the results and theorems and solve simple problems in Legendre differential equations, Bessel differential equation, theory of curves and surfaces
- **CO-3.** Apply differential geometry techniques to compute Gaussian curvature, mean curvature, principal curvature and torsion
- **CO-4.** Solve complex engineering problems associated with Bessel differential equation, theory of curves and surfaces, orthogonal curvilinear coordinates and spherical curvilinear system
- **CO-5.** Analyze real world problems associated with Bessel differential equation and curvature of space curves

4. Course Contents

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Unit 1 (Tensors): summation convention, dummy index, free index, Kronecker tensor(special tensor), Alternate tensor(special tensor), scalar , vectors, definition of tensor, covariant vectors, contravariant vectors , coordinate transformation for tensors, zero tensor, tensor of order second, covariant tensors of order two, contravariant tensor of order two, mixed tensor of order two, Algebra of tensors-multiplication of tensors, addition and subtraction of tensors, multiplication of tensors, Equality of tensors, symmetric and skew symmetric tensor, contraction of tensor, Quotient law.

Unit 2 (Differential geometry):
Theory of curves and surfaces: tangent vector, normal and binomial vectors to a space curve, arc-length, curvature, torsion, fundamental theorem of curves, orthogonal curvilinear coordinates, and spherical curvilinear system. Local theory of surfaces, parametric representation of surfaces, gauss map, Gaussian, mean and principle curvature.

Unit 3 (Manifolds): Differential manifolds, coordinate charts, examples of differentiable manifolds, Tangent spaces, diffeomorphisms, Riemannian metric, Riemannian curvature, Ricci curvature, Geodesics.

Unit 4 (Special functions): Bessel differential equation and Bessel function , generatingfunction, recurrence relations involving Bessel functions, orthogonality, applications of Bessel functions; Legendre's differential equation and Legendre polynomials, generating function for Legendre polynomials, recurrence relation for Legendre polynomials, orthogonality, zeros of Legendre polynomials.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2								1		1	1	
CO-2	3	3	1								1		1	1	
CO-3	3	3	2	3							2		1	2	
CO-4	3	3	2	2							2		1	2	
CO-5	3	3	2	2							2		1	1	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	

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3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course

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1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Barrett O' Neil, 1966, Elementary Differential Geometry, Academic Press, New York and London
3. Peter V. O'Neil, 2012, Advanced Engineering mathematics, Cengage Learning India Private Limited
4. Nazrul Islam, 2006, Tensors and their Applications, New age International limited Publishers

b. Recommended Reading

1. Andrew Pressley, 2001, Elementary Differential Geometry, Springer-verlag, London
2. T.J. Willmore, 1959, An introduction to Differential Geometry. Clarendon Press, Oxford
3. John M. Lee, 1997, Riemannian manifolds an introduction to curvature, Springer-Verlag, New York
4. U.C De, A.A Shaikh and Joydeep Sengupta, 2004, Tensor Calculus, Narosa Publishing House

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/
2. http://www.geometry.org/

e. Other Electronic Resources

1. https://www.khanacademy.org/
2. tutorial.math.lamar.edu/

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Course Specifications: Computational Number theory and Algebra

Course Title	Computational Number theory and Algebra
Course Code	MTE402A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to describe the algorithms used for efficient computations of the problems in number theory and algebra. In the course, we see how results in number theory and algebra are used to design algorithms for certain problems in arithmetic of integers and finite field; like, integer and polynomial factoring, integer and matrix multiplication, primality testing etc.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Describe the concepts of integer arithmetic, arithmetic of finite fields, arithmetic of polynomials over finite fields and primes.
- **CO-2.** State and explain theorems/results on modular arithmetic, arithmetic of finite fields, and arithmetic of polynomials over finite fields and prime numbers.
- **CO-3.** Explain algorithms for fast multiplication, fast factorization, GCD, primality testing.
- **CO-4.** Apply the algorithms in solving problems which arise in modular arithmetic, polynomial over finite fields, primality testing and integer factorization
- **CO-5.** Analyze time complexity of the algorithms discussed.

4. Course Contents

Unit 1 (Arithmetic of Integers): Arithmetic of integers - Basic arithmetic operations, greatest common divisor, congruences and modular arithmetic, linear congruence, quadratic and polynomial congruences, multiplicative orders, running times of arithmetic algorithms.

Unit 2 (Arithmetic of finite field): Existence and uniqueness of finite fields, representation of finite fields, implementation of finite field arithmetic, properties of finite fields, alternative representations of finite fields, computing isomorphisms among representations.

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Unit 3 (Polynomials): Arithmetic of polynomials over finite fields, finding roots of polynomials over finite fields, factoring polynomials over finite fields.

Unit 4 (Primality Testing): Introduction, complexity of primality testing, probabilistic primality testing: Fermat test, Solovay – Strassen test, deterministic primality testing: AKS test, primality tests for numbers of special forms

Unit 5 (Integer Factorization): Integer factorization - Trial division, Pollard's rho method, Dixon's method, Quadratic sieve method, Cubic sieve method, Number-field sieve method.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	1									1	3		1
CO-2	2	2	1									1	2		1
CO-3	2	1	3									1	3		1
CO-4	2	2	2	3								1	2	3	1
CO-5	2	2	2	2								1	2	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		5
1. Solving Numerical Problems	5	
Practical Work		10
1. Course Laboratory	00	
2. Computer Laboratory	10	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	

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Term Tests, Laboratory Examination/Written Examination, Presentations	10
Total Duration in Hours	**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--

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15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course Notes
2. Abhijit Das, Computational Number Theory, CRC Press, 2016.

b. Recommended Reading

1. I. Niven, S. Zuckerman and H. L. Montgomery, An Introduction to the Theory of Numbers, 5th Ed., Wiley-India, 1991.
2. J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1998.
3. Henri Cohen, A Course in Computational Algebraic Number Theory, Springer-Verlag Berlin Heidelberg 1993.
4. Victor Shoup, A computational introduction to number theory and algebra, version 2.

c. Magazines and Journals

d. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

e. Other Electronic Resources

1. https://www.khanacademy.org/

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Course Specifications: Topology

Course Title	Topology
Course Code	MTE405A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Module Summary

The aim of this course is to provide the student with a foundation in fundamental concepts of Topology. We shall formally define countable and uncountable sets with examples. We shall discuss about topological spaces, continuous functions, and Homeomorphisms on a topological spaces. Properties and special topological spaces, also, will be discussed.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Understand definitions and theorems related to topological spaces.
- **CO-2.** Demonstrate ability and understanding of notions such as continuity, compactness, connectedness, countability, and separation axiom in topological spaces.
- **CO-3.** Use continuous map and homeomorphism to understand structure of topological spaces
- **CO-4.** Create new topological spaces using subspaces, product, and quotient topological spaces.
- **CO-5.** Analyze the proofs of theorems to draw meaningful conclusions
- **CO-6.** Apply the theory to solve problems with varying level of difficulty

4. Course Contents

Unit I (Introduction): Sets – Countable and uncountable sets.

Unit II (Topological Spaces Topological spaces and continuous functions): Topological spaces, Basis for a topology, Limit points and closure of a set, Subspace topology, Product and quotient spaces, Continuous maps and homeomorphism.

Unit III (Connectedness and compactness): Connected spaces, connected subspaces of the real line, compact spaces, compact subspaces of the real line, local compactness.

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Unit IV (Countability and Separation axioms): Countability and Separation axioms, Normal spaces.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	1											1		
CO-2	1	2											2		
CO-3	1	2											2		
CO-4	1	2											2		
CO-5	2	1											2		
CO-6	3	3											3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the

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Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. **Module Resources**
    a. **Essential Reading**
        1. Course notes
        2. James R. Munkres, Topology, Second Edition, Prentice Hall, 1999.
    b. **Recommended Reading**
        1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963
        2. Stephan Willard, General Topology, Dover, 2004.
        3. James Dugundji, Topology, McGraw Hill, 1966.
    c. **Magazines and Journals**
    d. **Websites**
        1. http://ocw.mit.edu/courses/mathematics/18-100c-real-analysis-fall-2012/
        2. http://www.math.louisville.edu/~lee/RealAnalysis/
    e. **Other Electronic Resources**
        1. http://ramanujan.math.trinity.edu/wtrench/texts/TRENCH_REAL_ANALYSIS.PDF

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Course Specifications: Pattern Recognition

Course Title	Pattern Recognition
Course Code	AIC305A
Course Type	Professional Core Elective Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course focuses on the underlying principles, methods and techniques of pattern recognition used to develop pattern recognition applications in the real world. This course enables the students to build a classifier that can determine the class of an input pattern. The classifier may take a form of a function, an algorithm, a set of rules, etc. This course also covers building and applying the classifiers in various applications such as data mining, image processing and signal processing.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Discuss concepts of pattern recognition and machine learning
CO-2. Discuss the concept of Bayesian inference and decision theory.
CO-3. Discuss the concepts of dimensionality reduction, principal component analysis and linear discriminant analysis.
CO-4. Build classifiers for various pattern recognition applications.
CO-5. Apply pattern recognition and machine learning algorithms for image processing applications.
CO-6. Apply pattern recognition algorithms to solve problems and to mathematically model simple applications from engineering.

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4. **Course Contents**

Unit 1: Introduction to pattern recognition, Problems of classification and Regression, Issues of over fitting and under fitting, Applications of pattern recognition.

Unit 2: **Component analysis and Dimensionality reduction: Principal Component Analysis, Fischer** Linear Discriminant, Multidimensional Scaling, Local Linear Embedding

.

Unit 3: Regression Techniques: Bayesian Regression and relations to Least Squares with regularization, Gaussian Process Regression Support Vector Machine for classification and regression problems, Case studies.

5. **Course Map (CO-PO-PSO Map)**

This course focuses on the underlying principles, methods and techniques of pattern recognition used to develop pattern recognition applications in the real world. This course enables the students to build a classifier that can determine the class of an input pattern. The classifier may take a form of a function, an algorithm, a set of rules, etc. This course also covers building and applying the classifiers in various applications such as data mining, image processing and signal processing.

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	3	2	3			1	1					3	3	1
CO-2	2	3	2	3			1	1					3	3	1
CO-3	2	3	2	3			1	1					3	3	1
CO-4	2	3	2	3			1	1					3	3	1
CO-5	2	3	2	3			1	1					3	3	1
CO-6	2	3	2	3			1	1					3	3	1

6. **Course Teaching and Learning Methods**

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		5
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	

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3. Demonstration on a Computer	03	
Numeracy		5
1. Solving Numerical Problems	11	
Practical Work		5
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Tech. (Artificial Intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Bishop C. M. (2007). Pattern Recognition and Machine Learning. Springer.
3. Berg B. A. (2004). Markov Chain Monte Carlo Simulations and their Statistical Analysis. World Scientific

b. Recommended Reading

1. Hastie, T., Tibshirani, R., Friedman, J. The Elements of Statistical Learning, 2nd edition. Springer, 2009.

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2. Murphy, K. Machine Learning: A Probabilistic Perspective. - MIT Press, 2012

c. **Magazines and Journals**

1. IEEE Machine Learning

d. **Websites**

1. Coursera - machine learning
2. http://dags.stanford.edu/projects/scenedataset.html
3. http://cds.iisc.ac.in/academics/mtechcds/#CourDesc
4. http://courseworks.columbia.edu

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Course Specifications: Principles and Practices of Software Testing

Course Title	Principles and Practices of Software Testing
Course Code	CSE405A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aims to enable students to detect bugs in a cost-effective manner using both black-box as well as white-box testing techniques. Emphasis shall be laid upon test adequacy and coverage during test design and execution. Test design methods applicable to different phases of testing (unit, integration and system) shall be discussed both in the context of procedural and object-oriented software.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

fter the successful completion of this course, the student will be able to:

- **CO-1.** Explain unit, integration and system test phases along with the nature of defects that the respective phases can detect
- **CO-2.** Illustrate the process of designing tests for software program validation using functional testing techniques such as equivalence class partitioning, boundary value analysis and decision tables ensuring test adequacy
- **CO-3.** Design tests for software program validation using structural and data-flow testing techniques satisfying coverage criteria
- **CO-4.** Apply appropriate testing methods to validate Graphical User Interface based software
- **CO-5.** Apply test methodologies including model-based testing for validation of object-oriented software at different levels
- **CO-6.** Apply test-driven development methods to create software programs

4. Course Contents

Unit 1 (Introduction): Software testing phases namely unit, integration and system testing. Nature of defects that can be detected in each phase and relation of the test phases to development phases with illustrative examples. Error and Fault taxonomies

Unit 2 (Black-box Testing): Functional testing techniques such as equivalence class partitioning,

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boundary value analysis and decision tables. Robustness, worst-case and special value testing in the context of boundary value testing. Weak normal, Strong normal, Weak robust and Strong robust equivalence class testing. All pairs testing

Unit 3 (White-box Testing and Unit Testing): Structural testing, Data-flow testing (define/use, slice-based testing), Unit testing guided by functional test techniques. Test drivers and test stubs. Code coverage criteria such as statement, branch and condition coverage

Unit 4 (Integration and System Testing): Integration testing and system testing with illustrative examples. Levels of testing. Decomposition, Call-graph and Path based integration testing. Test design and test adequacy. Regression test selection. Mutation Testing. Model based testing.GUI (Graphical User Interface) testing

Unit 5 (Object-oriented Software Testing): Object-oriented testing, Class testing. Testing methods, testing inheritance and testing polymorphism. Object-oriented integration testing and Object-oriented system testing

Unit 6 (Advanced Topics): Test-driven development. Introduction to Non-functional requirements testing

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3							1	1			3	3	1
CO-2	3	3											3	3	1
CO-3	3	3											3	3	1
CO-4	3	3	3		2				1	1			3	3	1
CO-5	3	3	3		2				1	1			3	3	1
CO-6	3	3	3		2								3	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		10
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	10	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

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Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Computer Science and Engineering) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
CO-6		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, Assignments
2.	Understanding	Classroom lectures, Assignments
3.	Critical Skills	Classroom lectures, Assignments
4.	Analytical Skills	Classroom lectures, Assignments, Tutorials
5.	Problem Solving Skills	Classroom lectures, Assignments, Tutorials
6.	Practical Skills	Examination, Assignment
7.	Group Work	Assignment

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8.	Self-Learning	Assignment
9.	Written Communication Skills	Test, Examination, Assignment
10.	Verbal Communication Skills	Course Work, Group Discussion
11.	Presentation Skills	--
12.	Behavioral Skills	Interaction with peers, instructors and tutors
13.	Information Management	Course Work, Assignment, Presentation
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Jorgenson P. C., 2010, Software Testing A Craftsman's Approach, Indian Reprint, Auerbach Publications
2. Class Notes

b. Recommended Reading

1. Meyers G., 2011, The Art of Software Testing, Wiley Publishing.

c. Magazines and Journals

1. IEEE Journals

d. Websites

1. http://www.testing.com/

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Course Specifications: Optimization Techniques

Course Title	Optimization Techniques
Course Code	MCC301A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The main aim of this course is to present different methods of solving problems in the areas of linear programming and constraint nonlinear optimization. In addition to theory, there will be some introduction to numerical methods for optimization problems and transportation problems. This course focuses on optimization methods that are commonly used in modern statistical machine learning. The course will cover some theory such as duality, simplex, convexity and algorithms related to non-simplex problems like Karmarkar's Method and Kuhn-Tucker theory are covered.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Describe fundamentals of convex and concave functions, linear programming and constraint nonlinear optimization
CO-2. State and explain important classical techniques and numerical methods of constraint optimization
CO-3. Demonstrate the skill to analyze a problem by choosing effective optimization tools
CO-4. Apply optimization techniques to model real world problems
CO-5. Solve complex problems associated with linear programming and constraint optimization of function of several variables

4. Course Contents

Unit 1 Introduction: Convex and Concave Functions, polytopes and polyhydra. Function of several variables – limits, continuity and differentiability

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Unit 2 Linear Programming: Basic Solutions and their properties, Formulation and Geometrical
Ideas of Linear Programming Problems using graphical method, Simplex Method, Revised Simplex Method, Duality, Sensitivity Analysis, Transportation and Assignment Problems, NonSimplex methods - Introduction to Interior-Point Methods, Ellipsoid Method, Karmarkar's Method

Unit 3 Constrained nonlinear optimization of functions of several variables, Method of Lagrange multipliers, Kuhn-Tucker theory, Convex optimization, Quadratic optimization, Numerical methods for constrained optimization, Dynamic programming.

5. **Course Map (CO-PO-PSO Map)**

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3											3		
CO-2	2	2											2		
CO-3	2	2									2		2		2
CO-4			3			1					1		3	1	1
CO-5			3			1					1		3	1	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. **Course Teaching and Learning Methods**

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the
Programme Specifications document pertaining to the B. Tech. (Artificial intelligence and Machine Learning) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.
The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Course Resources**

   a. **Essential Reading**

      1. Class notes
      2. Chong, E.K.P., Zak, S.H. (2013): An Introduction to Optimization, 4th Edn., Wiley.

   b. **Recommended Reading**

      1. Luenberger, David G., Ye, Yinyu (2016) Linear and Non Linear Programming., 2th Edn., Springer International publication.
      2. Rao, S. S. (2009) Engineering Optimization: Theory and Practice; Revised 4th Edn., Wiley.

   c. **Magazines and Journals**

      1. https://www.springer.com/journal/10957
      2. https://www.springer.com/journal/11081
      3. https://www.tandfonline.com/toc/gopt20/current

   d. **Websites**

      1. https://www.coursera.org/
      2. http://nptel.ac.in/

   e. **Other Electronic Resources**

      1. https://ocw.mit.edu/index.htm

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Course Specifications: Data Mining

Course Title	Data Mining
Course Code	CSC301A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

10.Course Summary

The course is intended to teach the principles, methods and techniques of data mining and its applications. Data mining algorithms, tuning them for a given application and actionable interpretations are emphasised. Students are trained to analyse, visualise and interpret the data and associated implicit insights.

11. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

12. Course Outcomes (COs)

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

CO-1. Describe the conceptual framework of classification and clustering
CO-2. Explain the principles of supervised and unsupervised learning algorithms, training and test data
CO-3. Apply machine learning techniques to solve problems of practical importance
CO-4. Analyse the given data using classification and clustering algorithms
CO-5. Synthesise and solve data mining problems of practical importance using theoretical analysis and software tools

13. Course Contents

Unit 1(Introduction to Data mining): Data mining, kinds of data mining, patterns, technologies. Getting to know your data. Description of data, data visualization, measuring the similarity and dissimilarity. Data Preprocessing: An overview of data preprocessing, data cleaning, integration, reduction, transformation and discretization.

Unit 2 (Mining Frequent Patterns): Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods, Data Warehousing and Online Analytical Processing, Data Cube

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Technology

Unit 3 (Classification): Basic Concepts, Decision Tree Induction, Bayes Classification Methods, Rule-Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy.

Unit 4 (Clustering): Basic Concepts and Methods, Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods and Evaluation of Clustering.

Unit 5 (Outlier): Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches, Mining Contextual and Collective Outliers.

Unit 6 (Dimension reduction): Principal and independent component analysis Case studies from text mining, recommender systems, image and video processing, data warehousing. Data Mining Trends and Research Frontiers: Data Mining Applications, Data Mining and Society

14. CO-PO Mapping

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

15. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		15
1. Course Laboratory	00	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	

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2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

16. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment is presented in the Programme Specifications document pertaining to the B. Tech. Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

17. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination

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6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

18. Course Resources

a. Essential Reading

i. Classnotes

ii. Jiawei Han, Kamber Jian Pei Simon (2012), Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann Publishers

b. Recommended Reading

i. Witten, I. H., Frank, E., and Hall, M. A. (2011) Data Mining: Practical Machine Learning Tools and Techniques, 3rd edn. Morgan Kaufmann

ii. Torgo, L. (2011) Data Mining with R: Learning with Case Studies. Chapman & Hall

iii. Kecman, V. (2001) Learning and Soft Computing. The MIT Press

iv. Bramer, M. (2007) Principles of Data Mining, Springer.

c. Magazines and Journals

i. https://www.kdd.org/

ii. https://www.springer.com/journal/10618

d. Websites

i. http://www.cs.waikato.ac.nz/ml/weka

ii. https://www.coursera.org/learn/data-patterns?specialization=datamining

iii. https://www.coursera.org/specializations/data-mining

e. Other Electronic Resources

i. https://www.kdd.org/

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Course Specifications: Number Theory and Elliptic Curve Cryptography

Course Title	Number Theory and Elliptic Curve Cryptography
Course Code	MTE404A
Course Type	Professional Core Elective Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course aims to provide a strong mathematical background on number theory and elliptic curve cryptography concepts. Demonstrations of applications of ECC through examples in class and tutorial sessions shall be carried out.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Explain topics in elementary number theory
CO-2. Describe the mathematical background of concepts such as Finite Fields and Quadratic Residues
CO-3. Analyze cryptographic primitives with examples
CO-4. Solve numerical problems in number theory, cryptographic primitives and elliptic curves
CO-5. Apply cryptographic toolkit to solve problems in Elliptic Curve Cryptography

4. Course Contents

Unit 1 Topics in elementary number theory: Time estimates for doing arithmetic, Divisibility and Euclidean algorithms. Congruences, Some applications to factoring

Unit 2 Finite fields and Quadratic residues: Finite fields, Quadratic residues and reciprocity

Unit 3 Cryptography: Some simple cryptosystems, Enciphering matrices

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Unit 4 Public Key Cryptography: The ideal of public cryptography, discrete logarithm, RSA, Knapsack, Zero-knowledge protocols and oblivious transfer

Unit 5 Elliptic Curve Cryptosystems: Introduction, Elliptic Curve Cryptosystems, Introduction to the ECDSA, Elliptic Curve Diffie–Hellman and Elliptic Curve Integrated Encryption algorithms.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2								1		3		1
CO-2	3	2	1								1		3		1
CO-3	2	3	2								2		3		2
CO-4	3	3	2	3							2		3	3	2
CO-5	3	3	2	3							2		3	3	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

1. Course notes
2. Washington, L. C. (2008) Elliptic Curves: Number Theory and Cryptography, Chapman & Hall/CRC.

b. Recommended Reading

1. Hankerson, D., Vanstone, S., and Menezes, A. (2004) Guide to Elliptic Curve Cryptography, Springer.
2. Koblitz, N. (1994) A Course in Number Theory and Cryptograph, 2nd edn., Springer.

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. NPTEL Course material

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Course Specifications: Computational Number theory and Algebra

Course Title	Computational Number theory and Algebra
Course Code	MTE402A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

10. Course Summary

The aim of the course is to describe the algorithms used for efficient computations of the problems in number theory and algebra. In the course, we see how results in number theory and algebra are used to design algorithms for certain problems in arithmetic of integers and finite field; like, integer and polynomial factoring, integer and matrix multiplication, primality testing etc.

11. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

12. Course Outcomes (COs)

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

- **CO-6.** Describe the concepts of integer arithmetic, arithmetic of finite fields, arithmetic of polynomials over finite fields and primes.
- **CO-7.** State and explain theorems/results on modular arithmetic, arithmetic of finite fields, and arithmetic of polynomials over finite fields and prime numbers.
- **CO-8.** Explain algorithms for fast multiplication, fast factorization, GCD, primality testing.
- **CO-9.** Apply the algorithms in solving problems which arise in modular arithmetic, polynomial over finite fields, primality testing and integer factorization
- **CO-10.** Analyze time complexity of the algorithms discussed.

13. Course Contents

Unit 1 (Arithmetic of Integers): Arithmetic of integers - Basic arithmetic operations, greatest common divisor, congruences and modular arithmetic, linear congruence, quadratic and polynomial congruences, multiplicative orders, running times of arithmetic algorithms.

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Unit 2 (Arithmetic of finite field): Existence and uniqueness of finite fields, representation of finite fields, implementation of finite field arithmetic, properties of finite fields, alternative representations of finite fields, computing isomorphisms among representations.

Unit 3 (Polynomials): Arithmetic of polynomials over finite fields, finding roots of polynomials over finite fields, factoring polynomials over finite fields.

Unit 4 (Primality Testing): Introduction, complexity of primality testing, probabilistic primality testing: Fermat test, Solovay – Strassen test, deterministic primality testing: AKS test, primality tests for numbers of special forms

Unit 5 (Integer Factorization): Integer factorization - Trial division, Pollard's rho method, Dixon's method, Quadratic sieve method, Cubic sieve method, Number-field sieve method.

14. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	1									1	3		1
CO-2	2	2	1									1	2		1
CO-3	2	1	3									1	3		1
CO-4	2	2	2	3								1	2	3	1
CO-5	2	2	2	2								1	2	2	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

15. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		5
1. Solving Numerical Problems	5	
Practical Work		10
1. Course Laboratory	00	
2. Computer Laboratory	10	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	

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3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

16. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X	X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

17. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--

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11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

18. Course Resources

f. Essential Reading

1. Course Notes
2. Abhijit Das, Computational Number Theory, CRC Press, 2016.

g. Recommended Reading

1. I. Niven, S. Zuckerman and H. L. Montgomery, An Introduction to the Theory of Numbers, 5th Ed., Wiley-India, 1991.
2. J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1998.
3. Henri Cohen, A Course in Computational Algebraic Number Theory, Springer-Verlag Berlin Heidelberg 1993.
4. Victor Shoup, A computational introduction to number theory and algebra, version 2.

h. Magazines and Journals

i. Websites

1. https://www.coursera.org/
2. http://nptel.ac.in/

j. Other Electronic Resources

1. https://www.khanacademy.org/

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Course Specifications: AI and Healthcare

Course Title	Artificial Intelligence and Healthcare
Course Code	AIE403A
Course Type	Professional Core Elective Course
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Students shall be taught the role of Artificial intelligence in various Healthcare specialities, like use of data mining in clinical data analysis, discuss of pattern recognition in medical image analysis, role of NLP in extracting information from medical records, application of deeplearning in diagnosis and ethical aspects and transfer learning methods to solve problems in healthcare. The course aim is to understand the real-world challenges, use algorithms to outline the framework, methodology and develop models for diverse types of healthcare data to select, prepare, analyze, interpret, evaluate, and present clinical and operational data for the purposes of improving outcomes (quality, effectiveness, efficiency, safety).

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. To describe the role and assess the benefits and risks of Artificial Intelligence in Healthcare

CO-2. To describe data mining in clinical data analysis

CO-3. To discuss the role of deep learning and machihe learning for diverse types of healthcare data

CO-4. To discuss and apply pattern recognition in medical image analysis for disease diagnosis

CO-5. To apply Natural Language Processing methods to extract information from Electronic Health Records

4. Course Contents

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Unit 1 Role of Artificial Intelligence in Healthcare, benefits and risks, AI in major healthcare specialties such as Radiology, Pathology, Surgery, Cardiology, Dermatology, Ophthalmology, Pharmacy and Orthopedics;

Unit 2 Apply data mining for clinical data preparation, cleaning and extract information; Application of apply pattern recognition in medical image analysis such as radiology, pathologyetc. for disease diagnosis;

Unit 3 Use of text mining or NLP on speech therapy, Psychotherapy and on Electronic Healthrecords to extract information, causal inference;

Unit 4 Application of machine learning and deep learning in healthcare; and ethical considerations in using AI in Healthcare.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	

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4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	
8.	Self-Learning	Self-study

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9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Module Resources**
   a. **Essential Reading**
      1. Course notes
      2. Mahajan , P. S., (2018). Artificial Intelligence in Healthcare Paperback
      3. Panesar, A., (2019), Machine learning and AI for Healthcare-Big Data for Improved Health Outcomes, A Press.
   b. **Recommended Reading**
      1. Topol, E., (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, 1st Edition.
      2. MIT Critical Data, (2016). Secondary Analysis of Electronic Health Records, Springer Publisher
   c. **Magazines and Journals**
   d. **Websites**
      1. www.sciencedirect.org
      2. www.ieee.org
      3. https://www.altexsoft.com/blog/datascience/7-ways-data-science-is-reshaping-healthcare/
      4. http://www.himss.org/
      5. https://www.dhis2.org/
   e. **Other Electronic Resources**
      1. NPTEL Course Materials

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Course Specifications: Service Oriented Architecture

Course Title	Service Oriented Architecture
Course Code	CSE407A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Service-oriented architecture (SOA) is a software architectural concept that defines the use of services to support business requirements. In an SOA, resources are made available to other participants over the network as independent services that are accessed in a standardized way. Service oriented architecture (SOA) enables efficient communication among multiple computer programs and databases. Software developers and other technology professionals assess the technical communication needs of various organizations, then design computer and networking systems that can address customized SOA objectives.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Computer Science and Engineering
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Intended Learning Outcome
- **CO-2.** Explain software oriented architectures
- **CO-3.** Design medium scale software project development using SOA principles
- **CO-4.** Develop SOA messages from business use cases
- **CO-5.** Design and implementation of modern SOA and SOA-specific methodologies,technologies and standards
- **CO-6.** Create composite services by applying composition style

4. Course Contents

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Unit 1 (Introduction and Evolution Of SOA:) Fundamental SOA; Common Characteristics of contemporary SOA; Common tangible benefits of SOA; An SOA timeline (from XML to Web services to SOA); The continuing evolution of SOA (Standards organizations and Contributing vendors); The roots of SOA (comparing SOA to Past architectures).

Unit 2 (Web Services and Primitive SOA:) The Web services framework· Services (as Web services); Service descriptions (with WSDL); Messaging (with SOAP).

Unit 3 :(Web Services And Contemporary SOA – I and SOA-2:) Message exchange patterns; Service activity; Coordination; Atomic Transactions; Business activities; Orchestration; Choreography. Addressing; Reliable messaging; Correlation; Polices; Metadata exchange; Security; Notification and eventing.

Unit 4 **(Principles Of Service – Orientation and Service Layers)** Services orientation and the enterprise; Anatomy of a service oriented architecture; Common Principles of Service orientation; How service orientation principles interrelate; Service orientation and object orientation; Native Web service support for service orientation principles. Service orientation and contemporary SOA; Service layer abstraction; Application service layer, Business service layer, Orchestration service layer; Agnostic services; Service layer configuration scenarios.

Unit 5 **(Business Process Design and SOA Platforms)** WS-BPEL language basics; WS Coordination overview; Service oriented business process design; WS addressing language basics; WS Reliable Messaging language basics. SOA platform basics; SOA support in J2EE; SOA support in. ET; Integration considerations.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-
CO-1	3	3		2					1	1			3		
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3		
CO-5	3	3	3		2				1	1			3	3	1
CO-6	3	3	3										3	3	1
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	

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3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Tech. (Mathematics and Computing) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▸			
Subcomponent Type ▸	**Term Tests**	**Assignments**	**100 Marks**
Maximum Marks ▸	**50**	**50**	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading
   i. Class Notes.
   ii. Thomas Erl, Service-Oriented Architecture: Concepts, Technology and Design,Prentice Hall Publication, 2005.
   iii. Michael Rosen, Boris Lublinsky, Applied SOA Service Oriented Architecture andDesign Strategies, Wiely India Edition, 2008.

b. Recommended Reading
   i. Eric Newcomer, Greg Lomow: Understanding SOA with Web Services, PearsonEducation, 2005.

c. Websites
   i. www.sciencedirect.org
   ii. www.ieee.org

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Course Specifications: Advanced Numerical Methods

Course Title	Advanced Numerical Methods
Course Code	MTE403A
Course Type	Professional Core Elective Course
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

The module aims at training students in handling various aspects numerical computations. In this specialization module, the students learn the basics of numerical methods to solve non-linear ordinary and partial differential equations. Numerical techniques like finite difference, and finite element methods to solve partial differential equations are discussed. The module aims at training students in handling various aspects numerical computations.

2. Course Size and Credits

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Illustrate various methods of numerical computation of Eigen values
CO-2. Illustrate various methods to solve partial differential equations
CO-3. Apply numerical methods to solve partial differential equations using MATLAB
CO-4. Analyze real world problems associated with computing eigenvalues and partial differential equations
CO-5. Solve complex problems arising in real world using finite volume and finite elements methods to solve partial differential equations

4. Course Contents

Unit 1 (Linear Algebra): Eigenvalue computations. Power methods, Subspace iteration, Inverse

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iteration and Rayleigh quotient iteration for symmetric and non-symmetric problems. QR algorithm for symmetric problems. Jacobi methods and tridiagonal methods for symmetric problems.

Unit 2 (Finite Volume Method): Finite volume method to solve hyperbolic PDEs and a linear system of hyperbolic PDEs. General formulation of conservation laws. Advection equation, characteristics and Riemann problem for linear hyperbolic equations. Necessary components for convergence and CFL conditions, Lax-Wendroff method and upwind method.

Unit 3 (Finite Element Approximation): Triangulations and polynomial approximation. Finite element methods for elliptic problems, variational formulation for the Poisson problem. Discretization of the Poisson problem in one dimension, formulation, theory and implementation. FEM for the Poisson problem in two dimensions.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3											2	1	
CO-2	2	2											2		
CO-3	3	3	1										3	2	
CO-4	3	3			2					2			3	3	
CO-5	3	3			2					2			3	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution															

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	

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5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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Subcomponent ▸			
Subcomponent Type ▸	Term Tests	Assignments	100 Marks
Maximum Marks ▸	50	50	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4		X	X
CO-5		X	X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

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4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--

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12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Kincaid, D and W. Cheney, W. (2002) Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed, Brooks/Cole
3. Leveque, R. J. (2004) Finite Volume Methods for Hyperbolic Problems, Cambridge University Press.
4. Reddy, J. N. (2005) An Introduction to the Finite Element Method, 3rd edition, McGraw-Hill Higher Education.

b. Recommended Reading

1. Smith, G. D. (1978) Numerical Solutions of Partial Differential Equations, 2nd edition, Oxford University Press.

c. Magazines and Journals

d. Websites

1. http://nptel.ac.in/

e. Other Electronic Resources

1. https://ocw.mit.edu/index.htm

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