RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Program Structure and Course Details

of

B.Tech (Artificial Intelligence and Machine Learning)

Degree Programme

Program Code: 410

Batch: 2022-26

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

Dean
Faculty of Engineering & Technology
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 058.

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

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

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

Programme Specifications

B. Tech. (Artificial Intelligence and Machine Learning) Degree Programme

Programme Code: 410

Faculty of Engineering and Technology

Batch 2022-2026

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Bangalore - 560 054

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

Dean
Faculty of Engineering & Technology
M.S. Ramaiah University of Applied Sciences

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. (Artificial Intelligence and Machine Learning)

Faculty	Engineering and Technology
Department	Computer Science and Engineering
Programme Code	410
Programme Name	B. Tech. (Artificial Intelligence and Machine Learning)
Dean of the Faculty	Prof. Dilip Kumar Mahanty
Head of the Department	Dr. T. P. Pushphavathi

1. **Title of the Award:** B. Tech. (Artificial Intelligence and Machine Learning)
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**

    There is growing evidence from data that there exists a huge need for professionals and scientists in Artificial Intelligence, Machine learning and Data Sciences. The dearth of professionals coupled with the fact that the fields of Artificial Intelligence, Machine learning and Data Sciences rest upon a rich set of theoretical concepts and practical tools that are foundational in nature clearly indicates that there exists a strong need for a B. Tech. Programme in Artificial Intelligence and Machine learning.

    The B. Tech. Programme in Artificial Intelligence and Machine learning aims to lay the foundational background in computer science to start with, to be inter-disciplinary and to seamlessly integrate courses in Artificial Intelligence, Machine learning and Data Sciences to enable a student to effectively apply the learnings in industry and R&D establishments.

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 components or 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 engineering activities 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. (Artificial Intelligence and Machine Learning) 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. (Artificial Intelligence and Machine Learning) 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	MTF201A	Engineering Mathematics – 3	3	1	0	4	100
2	AIC201A	Basics of Operating Systems	3	0	0	3	100
3	AIC202A	Mathematics for Machine Learning I	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	AID201A	Principles of Artificial Intelligence	3	0	0	3	100
7	BAU201A	Innovation and Entrepreneurship	3	0	0	3	100
8	AIL202A	Artificial Intelligence Laboratory	0	0	2	1	50
9	CSL204A	Python & Data Structures Laboratory	0	0	2	1	50
		Total	21	3	4	26	800
		Total number of contact hours per week	28				

Semester 4							
Sl. No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTF202A	Engineering Mathematics-4	3	1	0	4	100
2	AIC203A	Machine Learning-1	3	1	0	4	100
3	AIC204A	Mathematics for Machine Learning-2	3	1	0	4	100
4	CSD206A	Design and Analysis of Algorithms	3	0	0	3	100
5	CSD207A	Programming Paradigms	3	1	0	4	100
6	BTN101A	Environmental Studies	2	0	0	2	50
7	AIL201A	Machine Learning Algorithms Laboratory	0	0	2	1	50
8	CSL208A	Programming Paradigms Laboratory	0	0	2	1	50
		Total	17	3	4	23	650
		Total number of contact hours per week	24				

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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	AIC301A	Machine Learning-2	3	1	0	4	100
2	CSC301A	Data Mining	3	1	0	4	100
3	CSD203A	Microprocessors and Architecture	3	0	0	3	100
4	CSD301A	Computer Networks	3	0	0	3	100
5	CSC302A	Database Systems	3	0	0	3	100
6	CSL205A	Microprocessors Laboratory	0	0	2	1	50
7	CSL301A	Computer Networks Laboratory	0	0	2	1	50
8	CSL302A	Database Systems Laboratory	0	0	2	1	50
		Total	**15**	**2**	**6**	**20**	**650**
		Total number of contact hours per week	**23**				

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	AIC304A	Computer Vision	3	1	0	4	100
3	AIC302A	Natural Language Processing	3	1	0	4	100
4	AIC303A	Deep Learning and Applications	3	0	0	3	100
5	AIC305A	Pattern Recognition	3	1	0	4	100
6	xxxxxxx	Professional Core Elective-1 or Online Course	3	1	0	4	100
7	CSS301A	Seminar	0	0	2	1	50
8	AIL302A	Natural Language Processing Laboratory	0	0	2	1	50
9	AIL303A	Deep Learning and Applications Laboratory	0	0	2	1	50
		Total	**18**	**4**	**6**	**25**	**750**
		Total number of contact hours per week	**28**				

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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 6th and 7th Semester			
Stream	**PCE-1**	**PCE-2**	**PCE-3**
Artificial Intelligence in Healthcare	CSC306A	ISE404A	AIE403A
	Information Security and Protection	Internet of Things	Artificial Intelligence and Healthcare
Artificial Intelligence and Security	CSC306A	MCC309A	CSE408A
	Information Security and Protection	Quantum Computing	Computational Intelligence
Big Data Analytics	AIE301	AIE402A	AIE404A
	Data Engineering	Time Series Analysis	Graph Analytics for Big Data
Blockchain Technologies	CSE302A	MCC309A	ISE405A
	Principles and Practices of Cryptography	Quantum Computing	Blockchain Technologies
Applied Mathematics	MTE302A	MCC301A	MTE403A
	Advanced Mathematics	Optimization Techniques	Advanced Numerical Methods
Data Science and Analytics	CSE411A	CSC301A	CSE431A
	Data Sciences Foundation	Data Mining	Data Analytics

Note:

Students are required to select **three** Professional Core Elective Courses in the 7th Semester, one each from PCE-1 Group.

Students are required to select **one** Professional Core Elective Course in the 6th 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. Teaching and Learning Methods

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 (Subject to endorsement of revised unified academic regulations for 2022-23-report submitted)

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

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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.

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			

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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
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

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25.2.4 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		
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

Schedule of CE Components in a Semester

- Week 6: Test -1 for 25 marks reduced to 15
- Week 8 – Week 10: Multiple Choice Questions Tests on the topics covered – reduced to 10 marks
- Week 12: Test -2 for 25 marks reduced to 15
- Week 13: Written Assignment for 40 marks reduced to 20 marks

SEE

- **For Non –NEP SEE for 100 marks reduced to 40 marks**

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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	Engineering Mathematics-3	3	3	3	2	2				1	1			3	2	1
3	Basics of Operating Systems	3	2	3	2	3	3	2	3	1	1	1	1	3	3	2
3	Principles of Artificial Intelligence	3	3	3	2	2	1	1		1	1			3	3	1
3	Mathematics for Machine Learning-1	3	3	2		2				1	1			3	2	1
3	Data Structures using Python	3	3	3	1	3		1		1	3			3	3	2
3	Logic Design	3	2	2	3	2	1	1						3	2	1
3	Artificial Intelligence Laboratory	3	3	3	2	2	2		1	1	1			3	3	1
3	Python & Data Structures Laboratory	3	3	3		2			2	1	1			3	3	1
3	Environmental Studies	1					3							1	3	
3	Additional Mathematics-1	3	3	2	3						2			3	3	2
4	Engineering Mathematics-4	3	3	2		2				1	1			3	2	1
4	Machine Learning-1	3	3	2	2	1	1	1						3	3	1
4	Mathematics for Machine Learning-2	3	3	2	2		1	1		1				3	2	1
4	Design and Analysis of Algorithms	3	3	2	2	3	1	1			1	2	2	3	3	1
4	Programming Paradigms	3	3	3	3	3	2	2	3	1	1	1	2	3	3	2
4	Machine Learning Algorithms Laboratory	3	3	2	2		1	1						3	3	1
4	Programming Paradigms Laboratory	3	3	3	3	3	3	2	3	1	1	1	2	3	3	2
4	Additional Mathematics-2	3	3	2	2	2					1			3	2	1
3	Innovation and Entrepreneurship	1					3							1	3	

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
5	Machine Learning-2	2	3	2	3	1	1	1		1	1			3	3	1
5	Data Mining	3	3	3	2	2				1	1			3	3	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	Database Systems	1	2	1	2	2	2	2	2	1	1	2	2	2	2	2
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
5	Database Systems Laboratory	1	2	1	2	2	2	2	2	1	2	2	2	2	2	2
6	Computer Vision	3	3	3	2	2				1	1			3	3	1
6	Deep Learning and Applications	2	3	2	3		1	1						3	3	1
6	Natural Language Processing	2	3	2	3		1	1		1	1			3	3	1
6	Pattern Recognition	2	3	2	3		1	1						3	3	1
6	Graph Theory and Optimization	3	3	2	3	2	1	1			2			3	2	1
6	Natural Language Processing Laboratory	2	3	2	3	3	1	1			1			3	3	1
6	Deep Learning Applications Laboratory	2	3	2	3	3	1	1		1	1			3	3	1

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
7	Information Security and Protection	1	1	3		3	3	3	3	3		3	1	3	3	1
7	Internet of Things-2	3	3	2	3	2	2	1			2			3	2	1
7	Artificial Intelligence and Healthcare	1	1	2	3	3	3	1	2					3	3	1
7	Quantum Computing	3	3	3	2	2	2	2		1	1	1	1	3	3	1
7	Computational Intelligence	2	3		3	1	1		1	2	1	1	2	3	3	2
7	Data Engineering	2	2	2	3	3				1	1			3	3	1
7	Time Series Analysis	2	2	1	1	1	2	2						3	2	1
7	Graph Analytics for Big Data	3	2	2	1	1	1	2						3	2	1
7	Principles and Practices of Cryptography	3	2	2	3	3	2	1	2	2	2	1	2	3	3	2
7	Blockchain Technologies	2	2	1	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	2	2	1	1	1	2	2						3	2	1
7	Data Mining	3	3	3	2	2				1	1			3	3	1
7	Data Analytics	2	2	1	1	1	2	2						3	2	1
7	Seminar	3	1		2		1		1	2	2	3			2	2
8	Internship	1	1		2		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	

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

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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. (Artificial Intelligence and Machine Learning) Degree Programme

Programme Code: 410

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.

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

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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.

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, 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.

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.

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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, 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.

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.					

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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	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.

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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 straight lines (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		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, SC3), 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	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.

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.

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.

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	--

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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/

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

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	

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.

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
	Analytical Skills	Assignment

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4.		
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

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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	

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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.

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.

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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. 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

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															

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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		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.

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.					

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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. 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

1. MULTISIM/ PROTEUS

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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 to the 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		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 (SC1, SC2 or SC3), COs are assessed as illustrated in the following Table.

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/

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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;

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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		
1. Case Study Presentation	02	06
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:

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: Engineering Mathematics -3

Course Title	Engineering Mathematics – 3
Course Code	MTF201A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Engineering and Technology

1. Course Summary

This course deals with vector calculus, various transform techniques in the context of engineering problems. The rudimentary principles and important theorems in vector calculus are taught in this course. The assumptions, principles and distinguishing features of Fourier series, Fourier transform and Laplace 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 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, transforms and vector integral calculus

CO-2. Solve simple problems in Fourier series, transforms and vector calculus

CO-3. Apply Fourier series, transforms and vector calculus in solving complex real world engineering problems

CO-4. Implement the programs to solve system of linear equations and non-linear equations of single variable using MATLAB

CO-5. Apply interpolation and numerical integration method in analyzing some real world problems

4. Course Contents

Unit 1 (Fourier Series and Fourier Transform): 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. Fourier Transform - Definition, Fourier transform of elementary functions, properties. Inverse Fourier transform, solution of initial value problems.

Unit 2 (Vector Calculus): Review of vector algebra, vector and scalar fields, derivatives of vector valued functions, curves, tangents, arc length. Gradient of a scalar field, directional derivatives, divergence and curl of a vector field. Polar, Cylindrical and Spherical coordinates systems. Line integral, double integral and triple integral, Green's theorem, Stokes' theorem, Gauss divergence theorem.

Unit 3 (MATLAB): Introduction to MATLAB, Basic algebraic and matrix operations, built-in and command line functions, Plots Scripts and functions. Interpolation - Lagrange interpolation, Newton's divided difference interpolation, Newton-Raphson method and Numerical solution of system of linear equations by Gauss Seidel method, MATLAB function for real Fourier series, complex Fourier series and harmonic series, Newton-Cotes' quadrature, trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules, and Gaussian quadrature.

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	2	1
CO-2	3	3											3		
CO-3	3	3											3		
CO-4	3	3	3		2				1	1			3	2	1
CO-5	3	3	3		2				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		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	
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
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	--

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12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Glyn James, 2016, Advanced Modern Engineering Mathematics, 4th edition, Pearson Dennis Zill, 2012.
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.

b. Recommended Reading

1. L. Chanparro, 2018, 3rd edition, Signals and Systems using MATLAB, Academic Press
2. S.D. Stearns and D. R. Hush, 2011, Digital Signal Processing with Examples in MATLAB, CRC Press

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: Basics of Operating Systems

Course Title	Basics of Operating Systems
Course Code	AIC201A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course on Basics of Operating Systems deals with essential concepts of operating systems, its structure, services and key aspects by example. The students are exposed to some popular operating systems and are trained to use Shell commands, system calls, Android user APIs at the user level.

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.** Explain the basic concepts, principles of operating systems and different types of operating systems
- **CO-2.** Discuss the structure of operating system, its services and system calls used for various services such as Process management, Memory management, File Management, I/O management, Directory management and File system management
- **CO-3.** Apply learning from system calls, shell commands and Android user API's for the suitability of an application
- **CO-4.** Analyze the requirements and develop simple user interface application on Android platform

4. Course Contents

Unit 1 (Introduction to operating System): Computer hardware review, operating system concepts and principles, Basic Linux Shell Commands

Unit 2 (Types of operating systems): Mainframe Operating Systems, Server Operating Systems, Multiprocessor Operating Systems, Personal Computer Operating Systems, Handheld Computer Operating Systems, Embedded Operating Systems, Sensor-Node Operating Systems, Real-Time Operating Systems, Smart Card Operating Systems

Unit 3 (Structure of operating Systems): Monolithic Systems, Layered Systems, Microkernels, Client-Server Model, Virtual Machines, and Exokernels

Unit 4 (Services of operating system): Process management, memory management, file system management, directory management, I/O management, system calls, device driver, interrupts handler

Unit 5 (Introduction to Android operating System): Architecture, application frame work, system services, hardware abstraction Layer, Linux Kernel

Unit 6 (Introduction to Android app development): App Development tool kit, app development procedure, user APIs, simple user interface app development.

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			1						1	2	1
CO-2	1			1	1		1	1					1	2	1
CO-3	1			1	1		3		2				1	2	1
CO-4	1		2	1			3			1		1	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		05
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	02	
Numeracy		00
1. Solving Numerical Problems	00	
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	
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
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	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 work, Examination
7.	Group Work	Assignments, Laboratory work
8.	Self-Learning	Assignments, Examination
9.	Written Communication Skills	Assignments, Examination
10.	Verbal Communication Skills	Laboratory work, Examination
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction, peer Interaction peers, instructors and

		tutors
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	Self-study using unsupervised learning method

9. Course Resources

a. **Essential Reading**

1. Class notes
2. Tanenbaum, A. S., &Bos, H., 2015. Modern operating systems. Pearson

b. **Recommended Reading**

1. Silberschatz, A., Galvin, P.B., and Gagne, G., 2008, Operating Systems Concepts, 8th edn. Wiley Publications

c. **Magazines and Journals**

1. ACM Operating Systems Review
2. Dr. Dobb's Journal

d. **Websites**

1. https://www.kernel.org
2. https://android.googlesource.com/kernel/common/

e. **Other Electronic Resources**

1. NPTEL Course Materials

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Course Specifications: Mathematics for Machine Learning-I

Course Title	Mathematics for Machine Learning-I
Course Code	AIC202A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course on Mathematics for Machine Learning I aims to enable students to learn and apply techniques of vector calculus, linear algebra and probability and statistics making connections to concepts of machine learning, for example, Regression and Dimensionality reduction. A mind map of the concepts of linear algebra, vector calculus and probability statistics and where they are applied 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. To explain the foundations and pillars of Machine Learning along with the mind map of concepts of linear algebra, vector calculus and probability and statistics with applications in machine learning; also to explain and apply the concepts of set theory, functions and relations.

CO-2. To apply the concepts of linear algebra and explain its application to machine learning

CO-3. To apply the concepts of Analytic Geometry and explain its application to Machine learning

CO-4. To discuss the concepts of Vector Calculus and its role in Gradient Descent Algorithm

CO-5. To apply basic concepts of probability, Baye's Rule and explain their role in Machine Learning

4. Course Contents

Unit 1 (Introduction): Overview of foundations and pillars of machine learning; mind map of concepts of linear algebra, vector calculus and probability and statistics with applications in machine learning. Overview of Discrete Mathematics: Set theory, functions; relations; lattices; groups and rings

Unit 2 (linear algebra): Motivating applications of linear algebra in machine learning, for example, role of linear algebra in linear regression and dimensionality reduction. Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces.

Unit 3 (Analytic Geometry): Motivating applications of Analytic Geometry with an overview of the notions of similarity and distances used in the development of Support Vector Machines. Norms, Inner products, Lengths and distances, Angles and orthogonality, Orthonormal basis, Orthogonal complement, Inner product of functions, Orthogonal Projections and Rotations

Unit 4 (Matrix Decomposition): Applications of Matrix Decomposition in Dimensionality Reduction. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky decomposition, Eigen decomposition and diagonalization, Singular Value decomposition and Matrix Approximation

Unit 5 (Vector Calculus): Motivating Vector Calculus through an application in Gradient Descent Algorithm. Differentiation of Univariate functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-order derivatives, Linearization and Multivariate Series

Unit 6 (Probability and Distributions): Probability and Distributions; Construction of a Probability Space, Probability Axioms, Discrete Continuous Probabilities, Baye's 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	3							1	1			3	2	
CO-2	3	3											3	2	
CO-3	3	3											3	2	
CO-4	3	3	2		2				1	1			3	2	1
CO-5	3	3	2		2				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		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	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

Others		
1. Case Study Presentation	00	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	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	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

3. Class notes
4. Marc Peter Deisen roth, A. Aldo Faisal, Cheng Soon Ong., Mathematics for Machine Learning, Draft Copy, to be published by MIT Press

b. Recommended Reading

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. NPTEL Course Materials

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

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	
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. 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,

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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

1. Class Notes
2. 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: 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, 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	
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		**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	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

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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. Russell, S. J., and Norvig, P., 2010, Artificial Intelligence: A Modern Approach, 3rd edn. Prentice Hall.
3. 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: Innovation and Entrepreneurship

Course Title	Innovation and Entrepreneurship
Course Code	BAU201A
Course Type	Core Theory
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 necessary inputs for creation of new ventures and scaling up existing startups. The students are also introduced to design thinking processes 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 Entrepreneurships - 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	

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5. Hospital	00	
6. Model Studio	00	
Others		15
1. Case Study Presentation	05	
2. Guest Lecture	01	
3. Industry / Field Visit	02	
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 is 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 (CE or SEE) or subcomponent of CE (SC1, SC2), 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 ▸			
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	Classroom lectures
2.	Understanding	Classroom lectures

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3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom, 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**

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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
4	Reasoning by intelligent agents
5	Planning by intelligent agents
6	Neural Network taking different bias value and activation functions

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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**

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	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	--

9. Course Resources

a. **Essential Reading**

1. Laboratory Manual
2. Russell, S. J., and Norvig, P. (2010) Artificial Intelligence: A Modern Approach, 3rd edn. Prentice Hal

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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: 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

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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 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	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

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c. **Essential Reading**

3. Laboratory Manual
4. 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	
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 variables, 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 calculi
- **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 those 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.

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 is 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	--

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: Engineering Mathematics - 4

Course Title	Engineering Mathematics - 4
Course Code	MTF202A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Mathematical and Physical Sciences

1. Course Summary

The course introduces the basic concepts of complex analysis and partial differential equations. The course encompasses the essentials of statistics, probability theory and numerical solution of differential equations. Students are taught the probability theory and statistical distributions needed to quantify uncertainty and accuracy of information. The significance and use of numerical methods for solution of ordinary and partial differential equations are emphasized in this course. The utility of complex analysis to solve complex engineering problems and that of partial differential equations in modeling real world problems are highlighted. The students will be able to implement probabilistic /numerical techniques to solve a diverse range of applied mathematical problems 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.** Define and explain the concepts of correlation, regression, random variables, probability distribution, partial differential equations and complex analysis
- **CO-2.** State theorems and solve simple problems in partial differential equations, complex analysis, probability, probability distributions
- **CO-3.** Apply numerical methods to solve ordinary and partial differential equations using MATLAB
- **CO-4.** Solve complex engineering problems associated with numerical methods using MATLAB
- **CO-5.** Analyze real world problems associated with probability, probability distributions, partial differential equations and complex analysis
- **CO-6.** Construct the Bar chart, pie chart, Histogram, Boxplot and fitting of curves by using MATLAB

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4. Course Contents

Unit I (Partial differential equations): Basic concepts, classification of first order partial differential equations. Solutions by Lagrange's method. Classification of second order linear partial differential

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equations. Solutions of heat, wave, and Laplace's equations by method of separation of variables.

Unit II (Probability and Probability distribution): Review of basics of probability, conditional probability, and Bayes' theorem. Random variables, probability distributions. Probability density function and cumulative density function. Mean and variance of distributions. Binomial, exponential, and normal distributions.

Unit III (Complex analysis): Complex valued functions, limits, continuity, and differentiability. Analytic functions and Cauchy-Riemann equations. Construction of analytic functions, Harmonic functions. Complex line integral, Cauchy's integral theorem and integral formula. Taylor and Laurent series. Singularities and residues, Cauchy's residue theorem.

Unit IV (Correlation and Regression): Review of statistics. Contingency, correlation, and regression Curve fitting: Least squares method - polynomial, exponential, and power fit.

Unit V (Numerical Methods): Types of errors, numerical solution of ordinary differential equations by single-step methods – Euler's, modified Euler's and Runge-Kutta methods. Multistep methods – Milne's and Adams' methods. Solution by MATLAB built-in function ode45.

Unit VI (Finite Difference Method): Finite differences, explicit methods for one dimensional heat and wave equations, stability conditions. Implicit method for one dimensional heat equation. Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain.

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	2	2	2										2		
CO-3	3	3	2							1			3		1
CO-4	3	3	2		2				1	1			3	2	1
CO-5	3	3	2		2					1			3	2	1
CO-6	3	3			1				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		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		**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

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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. Dennis Zill and Patrick Shanahan, 2013, Complex Analysis, 3rd edition, Jones, and Bartlett
2. Richard Burden and Douglas Faires, 2017, Numerical Analysis, 10th edition, Massachusetts, Brooks/Cole
3. Erwin Kreyszig, 2015, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons Inc

b. Recommended Reading

1. Rao V. Dukkipati, 2021, Applied Numerical Methods using MATLAB, 2nd edition, New Delhi, New Age, M. K. Jain, S.R.K. Iyengar, and R.K. Jain, 2008, Numerical Methods, New Delhi, New Age
2. James Brown and Ruel Churchill, 2019, Complex Variables and Applications, 9th edition, McGraw Hill Education
3. Sheldon Ross, 2013, A first course in probability, 9th edition, Pearson education
4. Richard A. Johnson, 2019, Miller and Freund's – Probability and Statistics for Engineers, 9th edition, Prentice Hall India

c. Magazines and Journals

d. Websites

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

e. Other Electronic Resources

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

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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.

Unit 4 (k-Nearest-Neighbor): Similarities: Nearest-Neighbor Classifiers The k-Nearest-Neighbor Rules, 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	
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
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	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Classroom 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: Mathematics for Machine Learning-II

Course Title	Mathematics for Machine Learning-II
Course Code	AIC204A
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. To explain the foundations and pillars of Machine Learning along with the mind map of concepts of probability and statistics and Optimization with applications in machine learning Classify and describe types of digital circuits

CO-2. To apply the concepts of probability and statistics further using concepts such as Bayes' theorem, Gaussian distribution and explain applications to machine learning Analyze practical problems and develop logic design to solve the problems

CO-3. To discuss optimization from the perspective of machine learning using univariate, bivariate and multi-variate optimization techniques

CO-4. To apply the concepts of optimization such as Stochastic Gradient Descent used in Regression and Support Vector Machines; to discuss least-squares regression problem

CO-5. To discuss Advanced Optimization Solutions, Constrained Optimization and Duality; to discuss basics of computational graphs

4. Course Contents

Unit 1: Overview of foundations and pillars of machine learning; mind map of concepts of probability and statistics and optimization

Unit 2: Bayes' theorem; Summary statistics and Independence; Gaussian distribution; Conjugacy and the Exponential family; Change of variables / Inverse Transform

Unit 3: Optimization Basics from the perspective of Machine Learning: Univariate Optimization, Gradient Descent, Bivariate Optimization, Multi-variate Optimization, Convex Objective Functions, The Minutiae of Gradient Descent, Properties of Optimization in Machine Learning

Unit 4: Linear Regression: Optimization with Numerical Targets, Tikhonov Regularization, Stochastic Gradient Descent, The Use of Bias, Optimization Models for Binary Targets: Least Squares Classification: Regression on Binary Targets, The Support Vector Machine: Computing Gradients, Stochastic Gradient Descent, Logistic regression: Computing Gradients, Stochastic Gradient Descent; Optimization Models for the Multiclass Setting, Coordinate Descent

Unit 5: Advanced Optimization Solutions, Constrained Optimization and Duality; basics of computational graphs

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		1				3	3	
CO-2	3	3	2	2		1	1		1				3	3	1
CO-3	3	3	2	2		1	1						3	3	1
CO-4	3	3	2	2		1	1		1				3	3	1
CO-5	3	3	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		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	
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	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, 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	Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Classroom Interaction
13.	Information Management	Assignments, Examination
14.	Personal Management	Assignments
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

4. Class notes
5. Marc Peter Deisen roth, A. Aldo Faisal, Cheng Soon Ong., Mathematics for Machine Learning, Draft Copy, to be published by MIT Press
6. Charu C.Aggarwal, Linear Algebra and Optimization for Machine Learning, Springer, 2020

b. Recommended Reading

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

1. NPTEL Course Materials

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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 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	
Others		
1. Case Study Presentation	00	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
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

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/

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 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 approaches, 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 paradigm 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.

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	

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:

Head 9/20

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. 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

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

c. Magazines and Journals

1. ACM Transactions on Programming Languages and Systems
2. Journal of Functional Programming
3. Journal of Functional and Logic Programming
4. 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

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 the 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

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.

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	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 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. 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).

b. **Recommended Reading**

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

c. **Magazines and Journals**

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

d. **Websites**

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

e. **Other Electronic Resources**

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

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Course Specifications: Machine Learning Algorithms Laboratory

Course Title	Machine Learning Algorithms Laboratory
Course Code	AIL201A
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 Machine Learning algorithms for real world applications. Machine Learning algorithm is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention. The field of Machine Learning represents a variety of methods and applications. Fueled by the latest advances in computational capabilities and availability of data, such methods demonstrate themselves to be very efficient in different kinds of tasks: computer vision, natural language processing, and many others.

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.** Getting to know fundamentals of TensorFlow
- **CO-2.** Illustrate the working of Decision Tree with TensorFlow
- **CO-3.** Develop algorithms and programs to solve a given problem using MLP
- **CO-4.** Design and develop naïve Bayesian Classifier model.
- **CO-5.** Design and develop k-Means algorithm.
- **CO-6.** Design and develop K-Nearest Neighbors algorithm.
- **CO-7.** Document work done and prepare a laboratory report

4. Course Contents

1	Read the training data from a .CSV file.
2	The decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
3	Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
4	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

5	The naïve Bayesian Classifier model to perform this task. Calculate the accuracy, precision, and recall for your data set.
6	Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.
7	K-Nearest Neighbors algorithm to classify the iris data set. Print both correct and wrong predictions.
8	Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

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	1			3	3	1
CO-2	3	3		2		1	1						3	3	1
CO-3	3	3		2		1	1						3	3	1
CO-4	3	3	3	2		1	1		1	1			3	3	1
CO-5	3	3	3	2		1	1		1	1			3	3	1
CO-6	3	3	3	2		1	1		1	1			3	3	1
CO-7	3	3	3	2		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		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 (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
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	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. Dipanjan Sarkar Raghav Bali Tushar Sharma, (2018), Practical Machine Learning with Python, Apress.

b. **Recommended Reading**

i. Michael Bowles, (2015), Machine Learning in Python, Wiley.

c. **Magazines and Journals**

i. Machine Learning, Quanta Magazine.

d. **Websites**

i. https://www.zdnet.com/article/what-is-machine-learning-everything-youhttps://www.zdnet.com/article/what-is-machine-learning-everything-you-need-to-know/need-to-know/

ii. https://www.sas.com/en_in/insights/analytics/machine-learning.html

e. **Other Electronic Resources**

i. https://ocw.mit.edu/index.htm

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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

	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	

Kitchen		
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.

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

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	
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 is 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 of Linear 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 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	
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:

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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. 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: Machine Learning-II

Course Title	Machine Learning-II
Course Code	AIC301A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience. In recent years many successful machine learning applications have been developed, ranging from data-mining programs that learn to detect fraudulent credit card transactions, to information-filtering systems that learn users' reading preferences, to autonomous vehicles that learn to drive on public highways. At the same time, there have been important advances in the theory and algorithms that form the foundations of this field Machine Learning largely models its methods using human ability to distinguish features and create a knowledge base.

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. Discuss the concepts of Neural networks.
CO-2. Discuss the principles of Back propagation Algorithm.
CO-3. Discuss the concepts of Radial Basis Neural networks
CO-4. Discuss the principles of Support Vector Machines.
CO-5. Discuss Unsupervised Learning Techniques.

4. Course Contents

Unit 1 (Neural Networks): Neural networks, the perceptron, the learning rate, 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, the pima indian dataset, preprocessing: data preparation, linear regression, linear regression.

Unit 2 (Back-propagation): Going backwards: back-propagation of error, the multi-layer perceptron algorithm, initialising the weights, different output activation functions, sequential and batch training ,local minima, picking up momentum, minibatches and stochastic gradient descent, other improvements, the multi-layer perceptron in practice, amount of training data, number of hidden layers, when to stop learning, examples of using the mlp, a regression problem, classification with the mlp, a classification example: the iris dataset, time-series prediction, data compression: the auto-associative network, deriving back-propagation, the network output and the error, the error of the network, requirements of an activation function, back-propagation of error, the output activation functions, an alternative error function.

Unit 4 (Radial Basis Functions): Receptive fields, the Radial basis function (RBF) network, training the RBF network, interpolation and basis functions, bases and basis expansion, the cubic spline, fitting the spline to the data, smoothing splines, higher dimensions, beyond the bounds.

Unit 5 (Support Vector Machines): Support vector machines, optimal separation, the margin and support vectors, a constrained optimisation problem, slack variables for non-linearly separable problems, kernels, and choosing kernels, the support vector machine algorithm, implementation, extensions to the SVM, multi-class classification, SVM regression, and other advances.

Unit 6 (Unsupervised Learning): Unsupervised learning, the k-means algorithm, dealing with noise, the k-means neural network, normalization, a better weight update rule, example: the iris dataset again, using competitive learning for clustering, vector quantization, the self-organizing feature map, neighborhood connections, self-organization, network dimensionality and boundary conditions

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	3	2		1					1		3	2	2
CO-2	2	2	3	2		1					1		3	2	2
CO-3	2	2	3	2		1					1		3	2	2
CO-4	2	2	3	2		1					1		3	2	2
CO-5	2	2	3	2		1					1		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		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	
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	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	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. Bishop, C. M. (2006). Pattern Recognition and Machine Learning, Springer.

b. Recommended Reading

i. Seliski, R. (2010). Computer Vision: Algorithms and Application. New York: Springer-Verlag Inc.

c. Magazines and Journals

i. http://www.journals.elsevier.com

ii. http://ieeexplore.ieee.org

d. Websites

i. https://www.coursera.org/

ii. http://nptel.ac.in/

iii. Oracle Documentation, docs.oracle.com

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Course Specifications: Data Mining

Course Title	Data Mining
Course Code	CSC301A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. 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.

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 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

4. 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 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 (Outliers): 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

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
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		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		**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	
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

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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. 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: 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

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		
1. Case Study Presentation	00	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
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. 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.

b. Recommended Reading

1. Hamacher, C. V., Vranesic, Z., and Zakay, S., 2002, Computer Organization, New York, McGraw-Hill series

c. Magazines and Journals

1. IEEE Transactions on Computers
2. IEEE Micro

d. Websites

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

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 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
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

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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 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

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   i. ACM Transactions on Networking
   ii. IEEE Transactions on Communications

d. **Wireless Networks Websites**
   i. IEEE Communication Society, http://www.comsoc.org
   ii. IEEE, http://www.ieee.org
   iii. ACM, http://www.acm.org

e. **Other Electronic Resources**

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Course Specifications: Database Systems

Course Title	Database Systems
Course Code	CSC302A
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 principles, design, programming and applications of database systems. The concepts of databases along with the challenges of effective design of database systems are taught. Data modelling, schemas, normalization, and query languages are covered in detail. The physical organization of databases, indexing structures and transaction processing are covered. Multidimensional data modelling and OLAP concepts are introduced. Database administration, management and interfacing are covered. Students are trained to design, implement and interface databases for data-centric software applications.

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, design and applications of database systems
- **CO-2.** Explain the principles of data modelling, querying, storage, transactions and optimization of database systems
- **CO-3.** Analyse the schema and use appropriate normalization techniques for relational databases
- **CO-4.** Develop queries using query languages for a given database system
- **CO-5.** Apply principles of database systems to model data and create queries
- **CO-6.** Design and implement an efficient database system and interface it with a given application

4. Course Contents

Unit 1 (Introduction to Database Systems): Purpose of database systems, characteristics of database approaches, history of database applications, classification of DBMS, database users, architectures for DBMS, recent database applications, data models, schemas, data independence, database design and implementation process.

Medha Rao

Unit 2 (Entity Relationship Model): E-R diagrams, entities, attributes, relationships, roles and constraints, Enhanced Entity-Relationship (EER) diagrams, sub classes and super classes, specialization and generalization.

Unit 3 (Relational Data models): Relational schema, relational model constraints, keys, relational database design, relational algebra, relational calculus.

Unit 4 (Query Languages):SQL- data definition and data types, query formulation, constraints in SQL, basic queries in SQL, complex queries in SQL, QBE, query processing, database programming - techniques and issues, embedded SQL, using JDBC, database stored procedures.

Unit 5 (Normalization for Relational Databases): Functional dependency, normal forms, decomposition of a schema, multivalued dependencies, join dependencies, dependency preservation, inclusion dependencies.

Unit 6 (File Organization and Storage): Basic file structure, RAID technology, hashing techniques, indexing structures, types of single level ordered indexes, multi-level indexes, B+ trees.

Unit 7 (Transaction Processing): Transaction processing systems, transaction states, ACID properties, characterizing schedules, recoverability and serializability of schedules, concurrency control, locking techniques, time stamp ordering, database recovery techniques, shadow pages, ARIES recovery algorithm, database security and authorization.

Unit 8 (Multidimensional Data Modeling): Logical multidimensional data model, cubes, dimensions, measures, OLAP servers, ROLAP- fact and dimension tables, star and snowflake schemas.

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		
CO-2							2				2		2		
CO-3	1	2		2			1							2	
CO-4	1	2				2		2						2	2
CO-5	1		1	2	2	2	2	2	1	1		2		2	2
CO-6	1		1	2	2	2			1	1	2	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		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	

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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	X
CO-4	X	X	X
CO-5	X	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
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. Elmasri, R., and Navathe, S.B., 2010, Fundamentals of Database Systems, Pearson Education.

b. Recommended Reading

i. Silberschatz, A., Korth, H.F., and Sudarshan, S., 2011, Database System Concepts, Tata McGraw Hill.
ii. Ponnaiah, P., 2007, Data Modeling Fundamentals, Wiley.
iii. Simson, G., and Witt, G., 2005, Data Modelling Essentials, Morgan Kaufmann.
iv. Ramakrishnan, R., and Gehrke, J., 2003, Database management system, McGraw-Hill.
v. Date, C.J., 2003, An Introduction to Database Systems, Addison Wesley.
vi. Rafanelli, M., 2003, Multidimensional Databases: Problems and Solutions, Idea Group Publishing.
vii. Thomsen, E., 2002, OLAP Solutions, Building Multidimensional Information Systems, Wiley.

c. Magazines and Journals

i. ACM Transactions on Database Systems
ii. IEEE Transactions on Knowledge and Data Engineering
iii. The VLDB Journal
iv. Information Systems Research
v. Data & Knowledge Engineering

d. Websites

i. https://www.coursera.org/
ii. http://nptel.ac.in/
iii. Oracle Documentation, docs.oracle.com

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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
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

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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
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
14.	Personal Management	--
15.	Leadership Skills	Laboratory Work

9. Course Resources

a. 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

b. Recommended Reading

1. Brey, B. B., 2009, The Intel Microprocessors, 8th edn. Pearson Education

c. Magazines and Journals

1. IEEE Transactions on Computers
2. IEEE Micro

d. Websites

1. https://www.coursera.org/
2. http:// 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
3	TCP Socket programming, UDP Socket programming and concurrent server programming
4	Alpha-numeric ciphers and Mono- and polyalphabetic substitution ciphers

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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	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.

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.

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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

9. Course Resources

a. Essential Reading

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: Database Systems Laboratory

Course Title	Database Systems Laboratory
Course Code	CSL302A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of this course is to train the students to design, implement and optimize a database system for a given data-centric application. Students are trained to perform data modeling and design queries. They are trained to implement the database using a database management system and interface it with an application. Students are trained to generate technical reports 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 components of database systems
- **CO-2.** Explain the principles of database design and implementation
- **CO-3.** Design a database system for a given application
- **CO-4.** Implement a database using DBMS and interface it with an application
- **CO-5.** Test and validate the developed database system
- **CO-6.** Create a laboratory report documenting the work

4. Course Contents

1	Analyze and perform data modeling for a given application
2	Convert the data model into a relational model
3	Use DDL and DML commands in SQL queries
4	Develop SQL commands to create and maintain database structure
5	Interface application to the developed database system
6	Multidimensional data modelling

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				2

CO-2							2			1	2				2
CO-3	1	2	1	2	2				1				2	2	
CO-4	1	2		2	2	2	2	2	1		2	2	2	2	
CO-5	1	2			2	2		2				2	2	2	
CO-6	1		1		2		2	2		2	2	2	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		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.

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.

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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**

i. Class notes

ii. Elmasri, R., and Navathe, S.B., 2010, Fundamentals of Database Systems, Pearson Education.

b. Recommended Reading

i. Silberschatz, A., Korth, H.F., and Sudarshan, S., 2011, Database System Concepts, Tata McGraw Hill.
ii. Ponnaiah, P., 2007, Data Modeling Fundamentals, Wiley.
iii. Simson, G., and Witt, G., 2005, Data Modelling Essentials, Morgan Kaufmann.
iv. Ramakrishnan, R., and Gehrke, J., 2003, Database management system, McGraw-Hill.
v. Date, C.J., 2003, An Introduction to Database Systems, Addison Wesley.
vi. Rafanelli, M., 2003, Multidimensional Databases: Problems and Solutions, Idea Group Publishing.
vii. Thomsen, E., 2002, OLAP Solutions, Building Multidimensional Information Systems, Wiley.

c. Magazines and Journals

i. ACM Transactions on Database Systems
ii. IEEE Transactions on Knowledge and Data Engineering
iii. The VLDB Journal
iv. Information Systems Research
v. Data & Knowledge Engineering

d. Websites

i. https://www.coursera.org/
ii. http://nptel.ac.in/
iii. Oracle Documentation, docs.oracle.com

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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 of Graphs 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

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

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		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.

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.

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. 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

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2. Sony Brook Algorithm Repository: http://www.cs.sunysb.edu/~algorith/
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: Computer Vision

Course Title	Computer Vision
Course Code	AIC304A
Course Type	Core Theory
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.

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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, 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		
1. Case Study Presentation	00	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

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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: Natural Language Processing

Course Title	Natural Language Processing
Course Code	AIC302A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course enables the students to understand and apply the theory and methods of natural language processing (NLP) in practice. NLP systems understand and produce human language for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialog systems. The course covers knowledge-based and statistical approaches to language processing for syntax (language structures), semantics (language meaning), and pragmatics/discourse (the interpretation of language in context). Students will gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information.

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 fundamental mathematical models and algorithms for NLP.
- **CO-2.** Explain major natural language processing challenges in various domains.
- **CO-3.** Discuss statistical language models and machine learning algorithms to extract information from various text data.
- **CO-4.** Apply mathematical models and algorithms in the design and implementation for NLP.
- **CO-5.** Recommend natural language processing tools currently available for unstructured text processing.
- **CO-6.** Implement methods for syntax and semantic analysis in NLP.

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4. Course Contents

Unit 1 (Introduction): NLP tasks in syntax, semantics, and pragmatics, Applications such as information extraction, question answering, and machine translation, The problem of ambiguity, The role of machine learning, Brief history of the field

Unit 2 (Regular Expressions, Text Normalization, Edit Distance, N-gram Language Models): Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance. N-Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, Kneser-Ney Smoothing

Unit 3 (Vector Semantics): Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Applications of the TF-IDF vector model, Optional: Pointwise Mutual Information (PMI), Word2vec, Visualizing Embedding.

Unit 4 (Grammar): Markov Models, Hidden Markov Models, Part-of-Speech Tagging: The Information Sources in Tagging, Markov Model Taggers, Hidden Markov Model Taggers, Probabilistic Context Free Grammars: The Probability of a String, Probabilistic Parsing

Unit 5 (Syntactic Parsing, Semantic Parsing): Ambiguity, CKY Parsing: A Dynamic Programming Approach, Partial Parsing, Statistical Parsing, Probabilistic Context-Free Grammars, Dependency Parsing; Semantic Parsing: Information Extraction, Named Entity Recognition, Relation Extraction, Extracting Times, Extracting Events and their Times

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	3	2	3		1	1		1	1			3	3	1
CO-2	2	3	2	3		1	1		1	1			3	3	1
CO-3	2	3	2	3		1	1		1	1			3	3	1
CO-4	2	3	2	3		1	1		1	1			3	3	1
CO-5	2	3	2	3		1	1		1	1			3	3	1
CO-6	2	3	2	3		1	1		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	04	

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2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		5
1. Solving Numerical Problems	15	
Practical Work		5
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	
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. (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
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 and Demonstrations
2.	Understanding	Classroom Lectures, Tutorials, Assignment and Demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom Lectures, Tutorials and Assignment
5.	Problem Solving Skills	Tutorials and Assignment
6.	Practical Skills	Tutorials and Assignment
7.	Group Work	Assignment, Tutorials
8.	Self-Learning	Assignment
9.	Written Communication Skills	Tests, Examination and Assignment
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Interaction with peers, instructors and tutors
13.	Information Management	Assignment and Examination
14.	Personal Management	Peer interaction
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Jurafsky, D., and Martin, J.H. (2008). Speech and Language Processing (2nd Edition). Upper Saddle River, NJ: Prentice Hall
3. Manning, C. D., Manning, C. D., & Schütze, H. (1999). Foundations of statistical natural language processing. MIT press.

b. Recommended Reading

1. Bird, S., Klein, E. and Loper, E., (2009). Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.".

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2. Martin, J. H., & Jurafsky, D. (2009). Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. Upper Saddle River: Pearson/Prentice Hall.
3. Mitkov, R. (Ed.). (2004). The Oxford handbook of computational linguistics. Oxford University Press.
4. Deng, L., & Liu, Y. (Eds.). (2018). Deep Learning in Natural Language Processing. Springer

c. Magazines and Journals

1. ACM Transactions on Algorithms
2. Journal of Algorithms

d. Websites

1. NPTEL Course Materials
2. www.ieee.org
3. https://www.coursera.org/

e. Other Electronic Resources

1. https://www.coursera.org/

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Course Specifications: Deep Learning and Applications

Course Title	Deep Learning and Applications
Course Code	AIC303A
Course Type	Core Theory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Deep learning has become an extremely active area of research. It is paving the way for modern machine learning. Students will be taught both theory and practical applications of deep learning including topics such as Convolutional Neural Networks, Representation learning, Models for Sequence analysis and deep reinforcement learning.

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. To discuss traditional machine learning techniques that have had an influence on deep learning algorithms; to discuss foundations of neural networks.

CO-2. To use TensorFlow to implement neural networks; to manage problems that arise as networks are made deeper.

CO-3. To discuss convolution operator and the building blocks for convolutional network architectures; to build neural networks that analyze complex images, detect and locate objects.

CO-4. To discuss and apply practical design process for deep learning applications; to perform sequence analysis to examine language.

CO-5. To apply deep reinforcement learning techniques.

CO-6. To apply deep Generative model techniques.

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4. Course Contents

Unit 1 (Introduction): Introduction for Deep Learning, Motivation for Deep Learning, Deep Artificial Neural Networks, Regularization for Deep Learning, Introduction to TensorFlow, Neural networks in TensorFlow.

Unit 2 (Optimization for training models): Gradient Descent optimization technique, Back propagation Optimizing technique, Analysis of Backpropagation technique in weight space. Challenges and next steps.

Unit 3 (Representation learning): Principal Component Analysis, Autoencoders, The word2vec framework, The Skip-Gram Architecture.

Unit 4 (Sequence Analysis): Analyzing Variable Length Inputs, Tackling seq2seq with Neural N-Grams, Parts of Speech tagger, Recurrent Neural networks, The challenges with vanishing Gradients, Long Short Term Memory (LSTM) Units. Sentiment analysis model, Recurrent and Recursive nets.

Unit 5 (Memory Augmented Neural Networks): Neural Turning Machines, Attention-Based Memory Access, NTM memory addressing mechanisms, Differential Neural Computers.

Unit 6 (Deep Reinforcement Learning): Introduction to Deep Reinforcement Learning, Markov Decision Process, policy, Future Return, Discounted Future Return, Policy verses value learning, QLearning and Deep Q-networks, The Bellman Equation.

Unit 7: Introduction to Generative models, Deep Generative Models, Generative Adversarial Networks, Training the GAN, GAN Challenges

Unit 8: Practical Methodology, Case Studies.

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	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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00

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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	
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

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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	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

1. Class Notes
2. Learning, MIT Press.Nikhil Buduma(2017), Fundamentals of Deep Learning-Designing Next Generation Machine Intelligence Algorithms, O'Reilly.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning.

b. Recommended Reading

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

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1. NPTEL Course Materials
2. www.ieee.org

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Course Specifications: Pattern Recognition

Course Title	Pattern Recognition
Course Code	AIC305A
Course Type	Core Theory
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 the 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)

	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	
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 is 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
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.

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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. 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.
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: 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 (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▸			
Subcomponent Type ▸	Presentation		100 Marks
Maximum Marks ▸	50		
CO-1	X		X
CO-2	X		X
CO-3	X		X
CO-4	X		X
The details of number of tests and assignments to be conducted are presented in the Academic Regulations and 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. Gibrielle, 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: Natural Language Processing Laboratory

Course Title	Natural Language Processing Laboratory
Course Code	AIL302A
Course Type	Laboratory
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Natural Language Processing is an interdisciplinary field dealing with human-computer interaction and computer aided processing of human language. It combines major concepts from computer science, artificial intelligence, and linguistics. The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in the field. The experiments in this lab are arranged in a logical sequence to inculcate a new concept at every step, starting from very basic ones to advanced ones.

2. Course Size and Credits:

Number of Credits	01
Credit Structure (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 mathematical models and algorithms for NLP.
CO-2. Illustrate the working of syntactic and semantic analysis in NLP
CO-3. Develop algorithms and programs for Rule-based Natural Language Processing
CO-4. Design and develop solution for Statistical Natural Language Processing
CO-5. Evaluate the empirical performance of implemented Vector Semantics and embedding algorithms
CO-6. Document work done and prepare a laboratory report.

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4. Course Contents

1. Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance.Ngram Language Models,
2. Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF, Word2vec, Visualizing Embedding,
3. Markov Models, Hidden Markov Models, Part-of-Speech Tagging: The Information Sources in Tagging, Markov Model Taggers, Hidden Markov Model Taggers, Probabilistic Context Free Grammars,
4. Syntactic Parsing: Ambiguity, CKY Parsing,
5. Semantic Parsing: Information Extraction, Named Entity Recognition, Relation Extraction, Extracting Times, Extracting Events and their Times

i. Select and document appropriate implementations of NLP algorithms for solving the problem based on the analysis
ii. Develop test cases and use them to test and validate the implementation
iii. Create a laboratory report documenting the steps involved

Practical/Laboratory content:

1. Introduction to NLTK
2. Word Analysis, Word Generation
3. Morphology
4. N-Grams, N-Grams Smoothing
5. POS Tagging: Hidden Markov Model
6. POS Tagging: Viterbi Decoding
7. Building POS Tagger
8. Chunking
9. Building Chunker
10. Named Entity Recognition (NER)
11. Bag of Words, TF-IDF, Embedding

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	3	2	3	3	1	1			1			3	3	1
CO-2	2	3	2	3	3	1	1			1			3	3	1
CO-3	2	3	2	3	3	1	1			1			3	3	1
CO-4	2	3	2	3	3	1	1			1			3	3	1
CO-5	2	3	2	3	3	1	1			1			3	3	1
CO-6	2	3	2	3	3	1	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		00
Demonstrations		00
1. Demonstration using Videos	04	
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	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	
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. (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 (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 work and Demonstrations
2.	Understanding	Laboratory work and Demonstrations
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work, Demonstration and
5.	Problem Solving Skills	Examination
6.	Practical Skills	Laboratory work, Demonstration and
7.	Group Work	Examination
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory work
10.	Verbal Communication Skills	Laboratory work, viva voce
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Presentation and Demonstration of work
14.	Personal Management	Interaction with peers, instructors and tutors
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Jurafsky, D., and Martin, J.H. (2008). Speech and Language Processing (2nd Edition). Upper Saddle River, NJ: Prentice Hall
3. Manning, C. D., Manning, C. D., & Schütze, H. (1999). Foundations of statistical natural language processing. MIT press.

b. Recommended Reading

1. Bird, S., Klein, E. and Loper, E., (2009). Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.".
2. Chaitanya, V., Sangal, R. and Bharati, A., 1996. Natural language processing:
   a Paninian perspective. Prentice-Hall of India.

c. Magazines and Journals

1. ACM Transactions on Algorithms
2. Journal of Algorithms

d. Websites

1. NPTEL Course Materials
2. https://www.nltk.org/
3. https://www.coursera.org/

e. Other Electronic Resources

1. https://www.coursera.org/

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Course Specifications: Deep Learning and Applications Laboratory

Course Title	Deep Learning and Applications Laboratory
Course Code	AIL303A
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 Deep Learning algorithms for real world applications. The field of Deep Learning represents a variety of methods and applications based on building machine learning models consisting of multiple levels of composition. Fueled by the latest advances in computational capabilities and availability of data, such methods demonstrate themselves to be very efficient in different kinds of tasks: computer vision, natural language processing, and many others. Deep Learning can already be considered one of the biggest advances in 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. Getting to know fundamentals of TensorFlow
CO-2. Illustrate the working of Gradient Descent with TensorFlow
CO-3. Develop algorithms and programs to solve a given problem using MLP
CO-4. Design and develop Convolutional Neural Networks.
CO-5. Design and develop Natural Language Processing using LSTM.
CO-6. Design and develop Dimensionality reduction techniques.
CO-7. Document work done and prepare a laboratory report

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4. Course Contents

1. TensorFlow Demo, Creating Your First Graph and Running It in a Session, Managing Graphs, Lifecycle of a Node Value.
2. Implementing Gradient Descent, Feeding Data to the Training Algorithm, Saving and Restoring Models, Visualizing the Graph and Training Curves Using TensorBoard, Name Scopes, Modularity, Sharing Variables.
3. Employee Training an MLP with TensorFlow's High-Level API, Training a DNN Using Plain TensorFlow, Fine-Tuning Neural Network Hyperparameters.
4. Avoiding Overfitting through Regularization, Practical Guidelines. 5. The a Convolutional Layer, Pooling Layer, CNN Architectures 6. LSTM Cell, GRU Cell, Natural Language Processing.
7. Efficient Data Representations, Performing PCA with an Undercomplete.
8. Stacked Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Variational Autoencoders.
9. Learning to Optimize Rewards, Policy Search.
10. Introduction to OpenAI Gym, Neural Network Policies,
11. Evaluating Actions: The Credit Assignment Problem, Policy Gradients, Markov Decision Processes, Deep Q-Learning.Course Map (CO-PO-PSO Map)

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	3	2	3	3	1	1		1	1			3	3	1
CO-2	2	3	2	3	3	1	1		1	1			3	3	1
CO-3	2	3	2	3	3	1	1		1	1			3	3	1
CO-4	2	3	2	3	3	1	1		1	1			3	3	1
CO-5	2	3	2	3	3	1	1		1	1			3	3	1
CO-6	2	3	2	3	3	1	1		1	1			3	3	1
CO-7	2	3	2	3	3	1	1		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		00
Demonstrations		00
1. Demonstration using Videos	04	
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	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	
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. (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 (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

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	Laboratory work
2.	Understanding	Laboratory work
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
10.	Verbal Communication Skills	Laboratory work
11.	Presentation Skills	Laboratory work
12.	Behavioral Skills	Laboratory work
13.	Information Management	Laboratory work
14.	Personal Management	Laboratory work
15.	Leadership Skills	Laboratory work

9. Course Resources

a. Essential Reading

1. Nikhil Buduma (2017), Fundamentals of Deep Learning-Designing Next Generation Machine Intelligence Algorithms, O'Reilly.
2. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, (2019), Deep Learning Using Python, Wiley.

b. Recommended Reading

1. Ian GoodFellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press.Aho, A. V., Hopcroft, J. E., and Ulman, J. D., 1974.

2. Michael Bowles, (2015), Machine Learning in Python, Wiley.

c. **Magazines and Journals**

1. Deep learning Weekly
2. Deep learning-Chatbots Magazine.

d. **Websites**

1. https://www.datacamp.com/community/tutorials/deep-learning-python
2. https://towardsdatascience.com/deep-learning-for-beginners-practicalguide-with-python-and-keras-d295bfca4487

e. **Other Electronic Resources**

1. https://www.tensorflow.org/resources/learn-ml

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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 experience of identifying an engineering problem, conceptualize 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.** Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature and requirement analysis
- **CO-2.** Define engineering design specifications based on the software requirements specification
- **CO-3.** Design, model, synthesize, analyze 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

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Unit 6: Product development planning, cost calculations

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

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 needs 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. Understanding 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.

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 (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		×	×
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.

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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. 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	CSC402A
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 experience of identifying an engineering problem, conceptualizing 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. Students 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.** Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature and requirement analysis
- **CO-2.** Define engineering design specifications based on the software requirements specification
- **CO-3.** Design, model, synthesize, analyze 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

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 is 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

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	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	X	×	×
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

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Course Specifications: Information Security and Protection

Course Title	Information Security and Protection
Course Code	CSC306A
Course Type	Professional Core Elective
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-1. Describe elements and components of information security and protection

CO-2. Describe security attacks and defense mechanisms

CO-3. Explain the requirements, principles and models of security policies

CO-4. Analyze the security properties of a given model

CO-5. Analyze a given scenario, application or system and recommend appropriate security policies and mechanisms

CO-6. 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

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
CO-5		X	X

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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
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. Whitman, M. E., and Mattord, H. J., 2017, Principles of Information Security, 6th edn., Cengage Learning.
2. 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

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3. International Journal of Information Security
4. IET Information Security

d. Websites

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: Internet of Things

Course Title	Internet of Things
Course Code	ISE404A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

Internet of Things (IoT) is being used wide range of applications, varying from agriculture, healthcare, retail and automotive to name a few. With its growing popularity, it becomes essential to study and understand the supporting technologies and protocols for IoT. Students will learn the role of IoT in present day communication and networks, IoT architecture and reference model, and supporting protocols. They will learn to configure IoT models for industry specific applications, integrate with cloud and analyze the obtained data.

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 the need and importance of IoT in present day communication networks
CO-2. Explain the architectural overview and reference architecture of IoT
CO-3. Describe popular IoT protocols and standards for different IoT applications
CO-4. Recommend appropriate IoT devices and protocols for given applications
CO-5. Integrate sensors, actuators, gateways, displays and cloud for IoT applications
CO-6. Develop IoT applications for industry specific requirements and analyze the obtained data

4. Course Contents

Unit 1 (Introduction): Need for IoT, IoT application scenarios - automotive, healthcare, retail, manufacturing, agriculture industry, Overview of the IoT architecture, protocol reference model, components of IoT - sensors, actuators, gateway modules, Machine - to - Machine (M2M) communication. The IoT communication protocol stack, role of data link, network and session layers in IoT, protocols for data link layer.

Unit 2 (IoT Protocols): Data Link Protocols - IEEE 802.15.4e, IEEE 802.11 ah, WirelessHART, Bluetooth, Zigbee, LoRaWAN. Network Layer Routing Protocols - RPL, CORPL, CARP. Network Layer Encapsulation Protocols - 6LoWPAN, 6Lo, IPv6 over Bluetooth Low Energy. Session Layer Protocols - MQTT, SMQTT, AMQP, CoAP. Management protocols - Interconnection of heterogeneous datalink, smart transducer interface. Security in IoT. IoT challenges.

Unit 3 (IoT and Cloud): Sensor - Cloud, fog computing, smart cities, smart homes, connected vehicles, smart grid and industrial IoT. Industrial IoT case study: agriculture, healthcare, retail, manufacturing and automotive.

Unit 4: Integration of sensors and actuators with Arduino / Raspberry Pi, integration with cloud, data handling and analytics

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
CO-1	3	3	2	2									3	2	1	
CO-2	3	3	2			2	2						3	2	1	
CO-3	3	3	2	3	2	1							3	2	1	
CO-4				3	2	1				2						
CO-5				3	2	1				2						
CO-6		3		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		50
Demonstrations		10
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	10	
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		**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
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	Classroom Lectures and Demonstrations
2.	Understanding	Classroom Lectures, Tutorials and Demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom Lectures, Tutorials and Assignment
5.	Problem Solving Skills	Tutorials and Assignment

6.	Practical Skills	Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Tests, Examination and Assignment
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Interaction with peers, instructors and tutors
13.	Information Management	Assignment, Examination
14.	Personal Management	Interaction and requirements of discipline
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. N Abhishek S. Nagarajan, Shriram K Vasudevan and RMD Sundaram, 2019. Internet of Things. Wiley Publications, ISBN: 978 - 8126578375.
3. Arsheep Bahga and Vijay Madisetti, 2015. Internet of Things - A Hands-on Approach. Orient Blackswan Private Limited, ISBN: 978 - 8173719547.
4. Tara Salman and Raj Jain, 2015. Networking protocols and standards for internet of things. Internet of Things and Data Analytics Handbook.

b. Recommended Reading

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
3. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.

c. Magazines and Journals

1. https://theiotmagazine.com
2. https://iot.ieee.org
3. www.ieee-iotj.org
4. https://www.sciencedirect.com/journal/internet-of-things

d. Websites

1. www.sciencedirect.org
2. www.ieee.org

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Course Specifications: AI and Healthcare

Course Title	Artificial Intelligence and Healthcare
Course Code	AIE403A
Course Type	Professional Core Elective
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 deep learning 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. Describe the role and assess the benefits and risks of Artificial Intelligence in Healthcare
CO-2. Describe data mining in clinical data analysis
CO-3. Discuss the role of deep learning and machihe learning for diverse types of healthcare data
CO-4. Discuss and apply pattern recognition in medical image analysis for disease diagnosis
CO-5. Apply Natural Language Processing methods to extract information from Electronic Health Records

4. Course Contents

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;

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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, pathology etc. for disease diagnosis;

Unit 3 Use of text mining or NLP on speech therapy, Psychotherapy and on Electronic Health records 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	

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
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: Quantum Computing

Course Title	Quantum Computing
Course Code	MCC309A
Course Type	Professional Core Elective
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 Computing Architectures: Architectural elements, programming and scheduling. Quantum Programming Environment: Quantum Programming Languages, Quantum Programming Paradigms.

Approved by the Academic Council at its 26th meeting held on 14th July 2022

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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	

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:

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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.	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: Computational Intelligence

Course Title	Computational Intelligence
Course Code	CSE408A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The objective of this course is to provide theoretical and practical knowledge of Computational Intelligence (CI) for building intelligent systems. The course lays major emphasis on the computational modelling of natural intelligent systems. Theory, mathematical formalism, implementation and applications of the paradigms of CI, namely, fuzzy logic, evolutionary computation, swarm intelligence and artificial immune systems will be covered. In addition, the course includes hybrid intelligent systems that seek to resolve real-world and complex problems within the CI development framework.

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 the terms and concepts related to fuzzy systems, evolutionary computation, swarm intelligence and artificial immune systems
CO-2. Analyze whether a specific engineering problem can be solved using a CI approach
CO-3. Compare and contrast different CI techniques used to achieve particular functionalities
CO-4. Recommend the most suitable CI technique to address a specific engineering problem
CO-5. Specify, implement, customize and evaluate typical CI algorithms to solve a practical problem
CO-6. Develop variants and hybrids of the typical CI algorithms

4. Course Contents

Unit 1 (Fundamental Principles of CI): Pitfalls of traditional artificial intelligence, Definitions and nomenclature, Fundamental elements of CI, A brief review of CI paradigms, Synergism in CI.

Unit 2 (Evolutionary Computation): Genetic algorithms, genetic programming, evolutionary programming, evolution strategies, differential evolution, coevolution, recent trends, implementation considerations and applications

Unit 3 (Fuzzy Systems): Fuzzy sets and logic, fuzzification, fuzzy inferencing, fuzzy controllers and rough sets, recent trends, implementation considerations and applications

Unit 4 (Swarm Intelligence (SI)): Particle swarm optimization algorithm, bacterial foraging algorithm, artificial honeybee algorithm, ant colony optimization algorithm, recent trends in SI, variants and hybrids of SI algorithms, implementation considerations and applications

Unit 5 (Artificial Immune System (AIS)): Negative and clonal selection, multilayered AIS, danger theory, implementation considerations and applications

Unit 6 (Performance Issues of CI Algorithms): Suitability of CI algorithms for desired functionalities, hybrid intelligent systems, relative performance analysis of CI algorithms

Unit 7 (Tutorials): Implementation of CI algorithms to solve real-world optimization and control 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	PSO-4
CO-1	3	1		2		1		1					2	2		
CO-2	3	1		2		1		1					2	2		
CO-3	3	1		2		1		1					2	2		
CO-4	3	1		2		1		1					2	2		
CO-5	3	1		2		1		1					2	2		
CO-6	3	1		2		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		50
Demonstrations		10
1. Demonstration using Videos	04	
2. Demonstration using Physical Models / Systems	01	
3. Demonstration on a Computer	05	
Numeracy		00
1. Solving Numerical Problems	0	
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		
5. Group Discussions		
6. Discussing Possible Innovations		
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
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 and Demonstrations
2.	Understanding	Classroom Lectures, Tutorials, Assignment and Demonstrations
3.	Critical Skills	Assignment
4.	Analytical Skills	Classroom Lectures, Tutorials and Assignment
5.	Problem Solving Skills	Tutorials and Assignment
6.	Practical Skills	Assignment
7.	Group Work	Assignment
8.	Self-Learning	Assignment
9.	Written Communication Skills	Tests, Examination and Assignment
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Interaction with peers, instructors and tutors
13.	Information Management	Assignment and Examination
14.	Personal Management	Peer interaction
15.	Leadership Skills	--

9. Course Resources

a. **Essential Reading**

1. Course notes
2. Engelbrecht, A. P., 2007, Computational intelligence: An introduction, Chichester, England, John Wiley & Sons.
3. Eberhart, R. C., 2007, Computational Intelligence: Concepts to Implementations, San Francisco, CA, USA, Morgan Kaufmann Publishers Inc.
4. Konar, A., 2005, Computational Intelligence: Principles, Techniques and Applications, Secaucus, NJ, USA, Springer-Verlag New York, Inc.

b. **Recommended Reading**

1. Kennedy, J., and Eberhart, R. C., 2001, Swarm Intelligence, San Francisco, CA, USA, Morgan Kaufmann Publishers Inc.
2. De Jong, K. A., 2012, Evolutionary Computation: A Unified Approach, New York, USA, Bradford Books.
3. Ross, T. J., 2004, Fuzzy Logic with Engineering Applications, John Wiley & Sons.
4. de Castro L. R., and Timmis, J., 2002, Artificial Immune Systems: A New Computational Intelligence Paradigm, Secaucus, NJ, USA, Springer-Verlag New York, Inc.

c. **Magazines and Journals**

1. IEEE Computational Intelligence Magazine
http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10207
2. IEEE Transactions on Neural Networks and Learning Systems

http://cis.ieee.org/ieee-transactions-on-neural-networks-and-learning-systems.html

3. IEEE Transactions on Fuzzy Systems
   http://cis.ieee.org/ieee-transactions-on-fuzzy-systems.html
4. IEEE Transactions on Evolutionary Computation
   http://cis.ieee.org/ieee-transactions-on-evolutionary-computation.html

d. Websites

1. http://cis.ieee.org/
2. http://www.calvin.edu/~pribeiro/othrlnks/Fuzzy/home.htm
3. http://nptel.ac.in/courses/108104049/1
4. https://in.mathworks.com/help/fuzzy/getting-started-with-fuzzy-logic-toolbox.html

e. Other Electronic Resources

1. https://www.ewh.ieee.org/soc/es/May2001/14/Begin.htm
2. http://www.calvin.edu/~pribeiro/othrlnks/Fuzzy/home.htm
3. https://abc.erciyes.edu.tr/
4. http://www.techferry.com/articles/swarm-intelligence.html

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Course Specifications: Data Engineering

Course Title	Data Engineering
Course Code	AIE301A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The course objective is to understand data engineering in the aspect of data science that focuses on practical applications of data collection and analysis. The aim of the course is to train the students to learn the basics of reading and manipulating datasets using Python. Students are able to learn about several python libraries to perform Data Pre-processing, Data retrieval, Web Scraping and Visualization. Also introduce the field of data science specialization: Design Thinking and Predictive Analytics for data products, predictive modeling and deploying machine learning models. Students shall be taught appropriate data processing and big data processing techniques, frameworks and tools for Big data. Big data using a data processing workflow is covered. Design and synthesis of Big Data and complex data processing applications employing a wide variety of data models, representations, approaches, frameworks and libraries is covered. Students employ modern tools and platforms to develop big data processing for applications and scenarios.

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	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. To choose appropriate data processing techniques, frameworks and tools for a Big Data

CO-2. To develop models for structured data using Big Data models

CO-3. To design a Big Data processing application using modern data processing techniques, frameworks and tools

CO-4. To synthesize a data processing application for Big Data

CO-5. To analyze Big Data using a data processing workflow and evaluate alternative solutions to a Big Data processing problem

4. Course Contents

Unit 1 (Introduction Data Engineering): Introduction to Data Engineering: Characteristics, applications and challenges.

Unit 2 (Data Preprocessing): Data Cleaning, Handling Missing Data, Identifying Misclassifications, Graphical Methods for Identifying Outliers, Measures of Center and Spread, Data Transformation, Normalization, Standardization, Scaling , Transformations to Achieve Normality , Methods for Identifying Outliers , Data transformation, Removal of Duplicate data. Data Scraping, Web scraping and processing using Python Libraries and Toolkits.

Unit 3 (Big Data Processing): Introduction to distributed data processing, Architecture of Hadoop Distributed File System (HDFS), MapReduce framework. Design and implementation of Big Data processing pipelines and workflows.

Unit 4 (Introduction to Apache Spark): Resilient Distributed Datasets (RDDs), RDD Operations, RDD Persistence, Spark SQL, DataFrames and Datasets, Spark Streaming, Programming in Spark using RDDs.

Unit 5 (NoSQL Models): Distributed data stores, CAP Theorem, ACID properties, managing transactions and integrity. Introduction to NoSQL, Differences between the relational and NoSQL databases, Merits and demerits of NoSQL technology, Key values database, Characteristics of a columnar database, graph databases, design reliable, scalable and maintainable applications.

Unit 6 (Distributed column-oriented database (HBase)): Basic concepts, configuration and installation, working With HBase, HBase versus RDBMS, Schema Design. Integrate HBase with Hadoop's MapReduce framework, applications of HBase.

Demonstrations, case studies, laboratory and assignment activity: Data processing scripting and programming. Laboratory and Assignment activity: Design and synthesis of Big Data and complex data processing applications.

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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	2	2	2	3	3				1	1			3	3	1
CO-2	2	2	2	3	3				1	1			3	3	1
CO-3	2	2	2	3	3				1	1			3	3	1
CO-4	2	2	2	3	3				1	1			3	3	1
CO-5	2	2	2	3	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		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	
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
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	Classroom Lectures and Demonstrations
2.	Understanding	Classroom Lectures and tutorials
3.	Critical Skills	Demonstrations

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4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Tutorial, Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Test, Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Presentation , Assignment
14.	Personal Management	Interaction with peers, instructors and tutors
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Hadoop: The Definitive Guide by Tom White, Published by O'Reilly Media, Inc.,
3. Han, J., Kamber, M., and Pei, J., 2011, Data Mining: Concepts and Techniques, 3rd edn., Morgan Kaufmann.
4. Discovering Knowledge in Data: An Introduction to Data Mining, Second Edition Daniel T. Larose and Chantal D. Larose
5. Principles of Data Wrangling Practical Techniques for Data Preparation by Tye Rattenbury Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras, Published by O'Reilly Media
6. Radtka, Z., and Miner, D., 2016, Hadoop with Python, O'Reilly

b. Recommended Reading

1. Data Wrangling with Python by Jacqueline Kazil and Katharine Jarmul, Published by O'Reilly Media, Inc.,
2. McKinney, W., 2018, Python for Data Analysis, 2nd edn., O'Reilly.
3. Mining of Massive Datasets by Jure Leskovec, Jeffrey D. Ullman Stanford Univ. Anand Rajaraman Milliway Labs.

c. Magazines and Journals

1. ACM Transactions on Information Systems
2. ACM Transactions on Knowledge Discovery from Data

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d. Websites

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1. https://www.coursera.org/
2. www.ieee.org
3. https://www.coursera.org/learn/hadoop/home/

e. Other Electronic Resources

1. NPTEL Course Materials www.ieee.org
2. NoSL systems: https://www.coursera.org/browse?query=NoSQL

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Course Specifications: Time Series Analysis

Course Title	Time Series Analysis
Course Code	AIE402A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course deals with the theory and practice of time series analysis and forecasting. Most of the real time applications generate time series data and the analysis of this data is highly significant. Forecasting time series data reveal future trends in the data and helps in anticipating future trend and subsequent decision making. Students will be taught to model and forecast time series data with examples and case studies using R.

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 time series data with an appropriate statistical framework and examples

CO-2. Perform appropriate preprocessing and carryout exploratory data analysis on time series data

CO-3. Apply appropriate filters, smoothing techniques on time series data and interpret the results

CO-4. Discuss appropriate statistical modelling techniques for forecasting time series data

CO-5. Apply and forecast time series data using stationary, non-stationary, multivariate time series models

CO-6. Use R to model, forecasts and interpret the results for time series data

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4. Course Contents

UNIT 1 (Time Series Data): Representation-graph and table form, time series data types and components, plots, trends and seasonal variation, Decomposition of time series data Correlations:

Expectation and the ensemble – expected value, ensemble and stationary, ergodic series, variance function, autocorrelation; the correlogram – examples

UNIT 2 (Forecasting Strategies): Leading Variables and associated variables-examples; Bass Model- model definition, interpretation, Example; Exponential Smoothing and Holt-Winters Method, Autoregressive model – definition, stationary and non-stationary AR processes, partial auto correlations, examples

UNIT 3 (Stationary Models): Moving Average Models- fitted MA models; Mixed Models-ARMA process- definition, examples and empirical analysis; ARIMA model –properties, forecasting using ARIMA model- examples

UNIT 4 (Regression): Linear models- definition, examples; fitted models- autocorrelation and the estimation of sample statistics; Generalized Least Squares- GLS to simulated example, confidence interval; Forecasting From regression- example.

UNIT 5 (Non-Stationary models): Seasonal ARIMA model – procedure and example; ARCH model –modeling volatility – fitting procedure and example; GARCH model- procedure and example. Introduction to Long Memory processes: Spectral Analysis; Multivariate Models; State Space 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	2	2	1	1	1	2	2						3	2	1
CO-2	2	2	1	1	1	2	2						3	2	1
CO-3	2	2	1	1	1	2	2						3	2	1
CO-4	2	2	1	1	1	2	2						3	2	1
CO-5	2	2	1	1	1	2	2						3	2	1
CO-6	2	2	1	1	1	2	2						3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		40
Demonstrations		
1. Demonstration using Videos	02	05
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	03	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		
1. Course Laboratory	00	00
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	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	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	--

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

9. Course Resources

a. Essential Reading

1. Class Notes
2. Cowpertwait, Paul S.P., Metcalfe(2009), Andrew V, Introductory Time Series with R, Springer
3. James D. Hamilton (1994), Time Series Analysis, Princeton University Press; 1st edition

b. Recommended Reading

1. Chris Chatfield (2013), The Analysis of Time Series: an Introduction, 6th Edition, Hoboken : Taylor and Francis, 2013
2. Douglas C. Montgomery, Cheryl L. Jennings and Murat Kulahci(2008) , Introduction to Time Series Analysis and Forecasting, Wiley

c. Magazines and Journals

1. Time Elsevier- International Journal of Forecasting
2. Wiley - Journal of Time Series Analysis journal

d. Websites

e. Other Electronic Resources

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Course Specifications: Graph Analytics for Big data

Course Title	AIE404A
Course Code	Graph Analytics for Big data
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course includes brief background on elementary graph algorithms, parallel computing and GPUs for big data analysis. Graph analytics plays an important role in big data analysis of various domains, such as social network and Web analysis, computational biology, machine learning, and computer networking. Students are trained in both the theory and practice of designing efficient graph algorithms for graphical data analysis in intensive data computation. After completing the course, students will be able to design and develop models to store, retrieve and analyse graph-structured big data. Efficiency and scalability shall be addressed.

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 fundamental mathematical models for graphical data analysis
- **CO-2.** Explain Graph Analytics Frameworks for big data
- **CO-3.** Discuss graphical data analysis algorithms for empirical data analysis
- **CO-4.** Apply statistical software for graphical big data analysis
- **CO-5.** Recommend graphical data analysis algorithms for modelling given Big Data
- **CO-6.** Implement graph algorithms using the techniques of high-performance computing

4. Course Contents

UNIT 1 (Introduction to Graph Analytics): Graph Preliminaries, Graph Storage Formats, Graph Partitioning Strategies, Heterogeneous Distributed Systems, Programming Libraries and APIs, Graph Analytics in Real-World Applications, Graph Analytics Challenges, Programming Abstractions for Graph Analytics

UNIT 2 (Graph Algorithms and Applications): Introduction, Fundamental Graph Algorithms, Other Algorithms, Applications of Graph Analytics in Different Domains

UNIT 3 (Efficient Parallel Implementation of Graph Algorithms): Introduction, Issues in Programming Parallel Graph Algorithms, Different Ways of Solving a Problem, A Note on Efficient Parallel Implementations of Graph Algorithms, Important Parallel Graph Algorithms, Graph Analytics on Distributed Systems

UNIT 4 (Graph Analytics Frameworks): Introduction, Frameworks—Merits and Demerits, Models for Graph Analytics, Frameworks for Single Machines, Frameworks for Distributed Systems

UNIT 5 (GPU Architecture and Programming Challenges): Introduction, Graphics Processing Unit, General Purpose Computing on GPU, Graph Analytics on GPU

UNIT 6 (Dynamic Graph Algorithms): Introduction, Dynamic Algorithms for Elementary Graph Problems, Dynamic Shortest Path Computation, Computational Geometry Algorithms. Challenges in Implementing Dynamic Algorithms

Case Study: Big Data Graphs in the Real World: Social Network Analysis, Biological network, Human information network analysis, smart city, Fraud Analysis

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												1	
CO-2	1	1	1	1	1								3	2	
CO-3	1	1	2		1									1	
CO-4	2	2			1								1	1	
CO-5	3	2	1		1	1	2						2		1
CO-6					1	1	1						1		

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	
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 and Demonstrations
2.	Understanding	Classroom Lectures and tutorials
3.	Critical Skills	Demonstrations
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Class Room Lectures, Assignments
6.	Practical Skills	Assignments, Laboratory Demonstrations
7.	Group Work	Tutorial, Assignments
8.	Self-Learning	Assignments
9.	Written Communication Skills	Test, Assignments, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--

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12.	Behavioral Skills	Class Room Interaction
13.	Information Management	Presentation , Assignment
14.	Personal Management	Interaction with peers, instructors and tutors
15.	Leadership Skills	--

9. **Course Resources**

a. **Essential Reading**

1. Class Notes
2. Unnikrishnan Cheramangalath, Rupesh Nasre, Y. N. Srikant, 2020. Distributed Graph Analytics Programming, Languages, and Their Compilation, Springer. https://doi.org/10.1007/978-3-030-41886-1
3. Brath, R. and Jonker, D., 2015. Graph analysis and visualization: discovering business opportunity in linked data. John Wiley & Sons.

b. **Recommended Reading**

1. Needham, M. and Hodler, A.E., 2019. Graph Algorithms: Practical Examples in Apache Spark and Neo4j. O'Reilly Media
2. Golumbic, M.C., 2004. Algorithmic graph theory and perfect graphs. Elsevier.
3. Eijkhout, V., 2013. Introduction to High Performance Scientific Computing. Lulu. com.
4. Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., 2009. Introduction to algorithms. MIT press.
5. Easley, D. and Kleinberg, J., 2012. Networks, crowds, and markets: Reasoning about a highly connected world.

c. **Magazines and Journals**

1. ACM Transactions on Algorithms
2. Journal of Algorithms

d. **Websites**

e. **Other Electronic Resources**

1. NPTEL Course Materials
2. https://www.coursera.org/learn/big-data-graphanalytics/home/welcome

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Course Specifications: Principles and Practices of Cryptography

Course Title	Principles and Practices of Cryptography
Course Code	CSE302A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

This course is intended to teach the principles and practices of cryptographic techniques. Security attacks affecting confidentiality and integrity, classification of the attacks and related security mechanisms are discussed. Stream and block ciphers, symmetric and asymmetric cryptography techniques are dealt in detail and illustrated using examples. Authentication techniques, e-mail and IP security are discussed in detail. Design of confidentiality and integrity primitives for web security and email security with authentication protocols are discussed. Students are trained to analyze attacks on confidentiality and integrity, and, implement the appropriate countermeasures for a given system.

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 techniques used for confidentiality and integrity in computing systems
CO-2. Discuss the importance, working and application of techniques to ensure confidentiality and integrity
CO-3. Compare and choose appropriate cryptographic techniques for a given scenario.
CO-4. Identify confidentiality and integrity issues in code review and suggest appropriate countermeasures
CO-5 Design secure applications using appropriate cryptographic techniques
C0-6 Develop security subsystems using appropriate cryptographic techniques

4. Course Contents

Unit 1 (Introduction): History of information security. Encoding, substitution and transposition. Overview of cryptography, security attacks, services and mechanisms, model for cyber security. Classical encryption techniques, stream and block ciphers, substitution techniques, transposition techniques, cryptanalysis and types of attacks. Steganography.

Unit 2 (Combinational Digital Circuits): Introduction to combinational circuits, realization of logic expressions using AOI, NOR, and NAND gates. Adders, Subtractors, Multiplexers, De-multiplexers, Encoders, Decoders, Priority encoders, Arithmetic circuits, such as multipliers, Ripple adders, Code-convertors

Unit 3 (Mathematics for Cryptography): Divisibility and The Division Algorithm, Euclidian Algorithm, Modular Arithmetic , Groups, Rings and Fields, Finite Field, The Polynomial Arithmetic, Congruence, Random number generator, Introduction to probabilistic analysis

Unit 4 (Block ciphers, symmetric and asymmetric encryption):
Block cipher principles-Fiestel structure, block cipher modes of operation, Data Encryption Standard, Advanced Encryption Standard (AES), Triple DES, Blowfish, RC5 algorithm. Public key cryptography: Principles of public key cryptosystems, RSA algorithm, Key management, Diffie-Hellman Key exchange, Oakley key exchange. Advanced topics: Quantum cryptography, Elliptic curve cryptography

Unit 5(Message authentication):
Authentication requirement, Authentication function, Hash function, Security of hash function, MAC, MD5,SHA, HMAC, Digital signatures and DSS, DSA. Advantages of digital signatures

Unit 6(Security practices):
User Authentication, Kerberos, X.509 Authentication services. Open authentication systems, Device authentication and Password management. Secure application development: Security in transit and Security in store.

Unit 6(E-mail security):
Pretty Good Privacy (PGP), SMTP and S/MIME. E-mail-attacks and possible security services, establishing keys privacy-authentication of the Source-Message Integrity-Non-repudiation

Unit 7 (IP & Web Security):
IP Security architecture, Authentication header, encapsulating payload, security associations, IPV6 and IPSec, Web Security: Secure Socket Layer (SSL), Transport Layer Security (TLS), Basic Protocols, Secure Electronic Transactions (SET)

Tutorial:
Exercise on transposition and substitution ciphers, Implementation of DES, AES, RSA and Diffie-Hellman algorithms, Application of creating login with encrypted password, application of MAC and SHA algorithm, development of simple digital signature using DSS, examples of encryption and decryption on a given information

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
CO-1	3	2	2	3	3	2	1	2	2	2	1	2	3	3	2	
CO-2	3	2	2	3	3	2	1	2	2	2	1	2	3	3	2	
CO-3	3	2	2	3	3	2	1	2	2	2	1	2	3	3	2	
CO-4	3	2	2	3	3	2	1	2	2	2	1	2	3	3	2	

CO-5	3	2	2	3	3	2	1	2	2	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 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	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	02	
5. Group Discussions	03	
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)

Subcomponent ►			Component 2: SEE (50% Weightage)
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
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	Tutorials and Assignment
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	Group discussions
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Stallings W., 2013, Cryptography and Network Security: Principles and Practice, 6th edn., Pearson Education.
2. Singh, S., 1999, The Code Book: The Evolution of Secrecy from Mary, Queen of Scots, to Quantum Cryptography, Doubleday.
3. Das, A. and Madhavan, C. E. V., 2009, Public-Key Cryptography: Theory and Practice, India, Pearson Education.

b. Recommended Reading

1. Golreich O., 2004, Foundations of Cryptography, Cambridge University Press.
2. Menezes, A. J., Oorschot, P. C. V., and Vanstone, S. A., 2001, Handbook of Applied Cryptography, CRC Press.
3. Forouzan, B. A., 2017, Cryptography and Network Solutions, De Anza College, McGrawHill.
4. Whitman, M. E., and Mattord, H. J., 2011, Principles of Information Security, 4th edn., Cengage Learning.

c. Magazines and Journals

1. Journal of Cryptology
2. IEEE Transactions on Information Forensics and Security
3. International Journal of Information Security
4. IET Information Security
5. Cryptography — Open Access Journal
6. Info-Security Magazine
7. Cyber Defense magazine

d. Websites

1. The SANS Institute, www.sans.org
2. Information Systems Security Association, www.issa.org
3. Information Systems Audit and Control Association, www.isaca.org
4. The Cryptopals Crypto Challenges, https://cryptopals.com/

e. Other Electronic Resources

1. Lecture: YouTube: IIT Kharagpur: Dr. Indranil Sengupta, "Lecture Series on Internet Technologies"
2. Lecture: YouTube: Google TechTalks: Steve Weis, "Theory and Practice of Cryptography"
3. Lecture: YouTube: Computer History Museum: Whitfield Diffie, "Before, During, and After Public-Key Cryptography"
4. Online Book: Dr. Gary C. Kessler, An Overview of Cryptography: http://www.cs.princeton.edu/~chazelle/courses/BIB/overview-crypto.pdf

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Course Specifications: Blockchain Technologies

Course Title	Blockchain Technologies
Course Code	ISE405A
Course Type	Professional Core Elective
Department	Computer Science and Engineering
Faculty	Engineering and Technology

1. Course Summary

The aim of the course is to provide an intermediate level treatment of Blockchain technologies. This course introduces Blockchain fundamentals, Solidity and GoLang Programming, introduction to Ethereum and applications. Enterprise Blockchain applications and Hyperledger shall also be 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	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 about Blockchain technologies and evolution
CO-2. Explain smart contracts
CO-3. Discuss Components and Structure of Blockchain
CO-4. Compare and contrast decentralized and distributed systems
CO-5. Explain security principles behind blockchain
CO-6. Discuss achieving consensus in the design of blockchain applications

Course Contents

Unit 1 (Overview of Blockchain technologies): Overview of Blockchain Technologies; history, architecture and conceptualization

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Unit 2 (Basic Crypto Primitives): Bitcoin basics, currency, smart contracts; components and structure of Blockchain; Decentralized vs Distributed Systems

Unit 3 (Consensus in Bitcoin): Cryptography and mechanics behind blockchain; Achieving consensus

Unit 4 (Permissioned Blockchain): RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance

Unit 5 (Advanced Blockchain Concepts): Advanced Blockchain Concepts; Hyperledger and Enterprise Blockchains; Ethereum; Programming in Solidity; Decentralized applications; Mining and Scalability; Building a Wallet service; Building a Smart Contract Deployment Platform; Blockchain Security(Fabric SideDB)

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	PO11	PO12	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

3Strong 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		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	
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. (Information 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
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 Resource

a. Essential Reading

1. Class Notes

b. Recommended Reading

Bren Hiil, Samanyu Chopra, Paul Valencourt, Narayan Prusty, 2018, Blockchain Developer's Guide, O'Reilly.

c. Magazines and Journals

1. ACM Transactions on Security

d. Other Electronic Resources

1. NPTEL Course Materials

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Course Specifications: Advanced Mathematics

Course Title	Advanced Mathematics
Course Code	MTE302A
Course Type	Professional Core Elective
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

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 , generating function, 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	
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.			

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	SC2	SC3	SC4	
Subcomponent Type ▶	Term Test	Term Test	Assignment	Assignment	100 Marks
Maximum Marks ▶	25	25	25	25	
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	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

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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: 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

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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	
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. (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.			

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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. 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

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1. https://www.coursera.org/
2. http://nptel.ac.in/
3. https://ocw.mit.edu/index.htm

Course Specifications: Advanced Numerical Methods

Course Title	Advanced Numerical Methods
Course Code	MTE403A
Course Type	Professional Core Elective
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 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	
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
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

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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. 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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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

1. 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.

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 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

4. 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 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

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
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		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		**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
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. 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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