



RAMAIAH
Institute of Technology

CURRICULUM
Academic Year 2026 – 2027

V & VI SEMESTER
B.E.
Computer Science and Engineering
(AI&ML)
Batch - 2024

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
(Approved by AICTE, New Delhi & Govt. of Karnataka)
Accredited by NBA & NAAC with A Grade

About the Institute

In 1962, Dr. M. S. Ramaiah, a visionary philanthropist, established the Gokula Education Foundation with a noble mission to uplift society through education. The same year marked a pivotal moment in technical education in India with the founding of the M S Ramaiah Institute of Technology (MSRIT).

MSRIT offers an impressive array of 18 undergraduate and 15 postgraduate programs, all approved by the All India Council for Technical Education (AICTE). The National Board of Accreditation (NBA) has accredited all eligible programs at the undergraduate (UG) and postgraduate (PG) levels. In March 2021, MSRIT earned an 'A+' grade from the National Assessment and Accreditation Council (NAAC), underscoring its unwavering commitment to academic excellence. Since 2007, the institute has proudly held Autonomous Status for its UG and PG programs, a prestigious recognition granted by the University Grants Commission (UGC) and Visvesvaraya Technological University (VTU). According to the Ministry of Education, Government of India's NIRF Ranking Framework, MSRIT ranks 75th among 1,584 leading engineering institutions and 31st among 131 architecture schools in India for 2025, highlighting its remarkable impact and leadership in education.

The institute participated in the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. To foster a research culture, the institute has established several specialized centres, including the Centre for Imaging Technologies, the Centre for Advanced Materials Technology, the Centre for Antennas and Radio Frequency Systems (CARFS), the Centre for Cyber Physical Systems, the Schneider Centre of Excellence, the Centre for Bio and Energy Materials Innovation, JSW Centre of Excellence in Power Systems and more. MSRIT boasts a faculty of 380 highly qualified members, 70% of whom hold doctoral degrees, and over 300 scholars currently pursuing Ph.D. degrees.

The Entrepreneurship Development Cell (EDC) and "Ramaiah Evolute" have been established on campus to support startup incubation. MSRIT features a dedicated Placement and Training department, a strong mentoring and proctorial system, a fully equipped sports department, and a spacious, air-conditioned library with a wide range of books and subscriptions to both international and national journals. The Digital Library provides access to online e-journals from renowned publishers, including Elsevier ScienceDirect, IEEE, Taylor & Francis, and SpringerLink. Additionally, the Institute is a member of DELNET, CMTI, and the VTU E-Library Consortium.

The institute features a state-of-the-art auditorium, a well-equipped recording studio, and multiple advanced conference halls with videoconferencing capabilities. Additionally, MSRIT provides excellent hostel accommodations for both boys and girls, ensuring a comfortable living environment. MSRIT alumni have achieved remarkable success, holding prominent positions in India and internationally. They maintain strong connections with the institute through an engaged and active Alumni Association.

Founded on Dr. Ramaiah's unwavering commitment to knowledge and innovation, this remarkable institution continues to inspire generations of students and shape the future of engineering and technology in the country.

About the Department

The Department offers Bachelor of Engineering (B. E) in Computer Science and Engineering (Artificial Intelligence and Machine Learning). The department is started in the year 2021 with an intake of 60 each. Currently intake for B.E. in Computer Science and Engineering (Artificial Intelligence and Machine Learning) is 129. In 2024, M.Tech. in Artificial Intelligence started with an intake of 18 under the department of Computer Science and Engineering (Artificial Intelligence and Machine Learning). The department has experienced faculty members with the doctoral degree. The faculty members of the department are actively involved in the research activities and publishing their research findings in reputed International Journals/Conferences/Book Chapters. The faculty members have authored books with premiere publishing agencies like Springer, Taylor & Francis.

The Department has state-of-the-art laboratories and classroom facilities. The department regularly conducts Bootcamps, Technical Seminars, Workshops, Faculty Development Programs and Hackathons. The department encourages the students to participate in cocurricular and extracurricular activities. The department has established strong collaborations with Industries and premier peer Institutes to design the curriculum to meet the global standards in the domains of Cyber Security. The department is partnering with Ramaiah Medical and Dental College to work on projects which has societal impact. The department is having collaborations with Industries like SAP Labs, Unisys, IBM, HPE, Samsung, Microsoft, GE Healthcare, Adobe, Thomson Reuters, Yubi, JP Morgan, Intellytix etc. to support Internships, Projects, Curriculum upgradation, Guest Lectures, and Industry Visits.

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VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To provide quality education, inculcate professionalism, and enhance problem solving and coding, innovative design skills in Computer Science and Engineering especially in the domain of AI & ML and Cyber Security with a focus to produce professionally competent and socially sensitive engineers capable of working in a global environment.

MISSION OF THE DEPARTMENT

To pursue excellence in Academics, Research and Innovation by:

1. Enabling creative and dynamic learning environments to impart quality technical education through continuously improving curriculum and pedagogy techniques.
2. Collaborating with the industry, academia and society for strengthening design thinking, research, innovation, and entrepreneurship ecosystem.
3. Encouraging extra and co-curricular activities to nurture the leadership qualities with a sense of commitment and accountability and inculcate values and ethics.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

A B.E in Computer Science & Engineering (Artificial Intelligence and Machine Learning) graduate of Ramaiah Institute of Technology:

PEO1: Excel in professional career by acquiring knowledge in basic sciences and Computer Science and Engineering, Artificial Intelligence & Machine Learning and Data science principles and contribute to the profession as an excellent employee, or as an entrepreneur.

PEO2: Capable of pursuing higher education and research.

PEO3: Adapt to technological advancements in multidisciplinary environments by engaging in lifelong learning with leadership qualities, professional ethics and soft skills.

PROGRAM OUTCOMES (POs):

The Outcomes of the Bachelor of Engineering in Computer Science & Engineering (Artificial Intelligence and Machine Learning) Programme are as follows:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: 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.

PO4: Conduct investigations of complex problems: 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.

PO5: Modern tool usage: 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.

PO6: The engineer and society: 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.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: 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.

PO11: Project management and finance: 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.

PO12: Life-long learning: 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.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Ability to understand and identify problems/opportunities where CSE, AI and ML concepts can be applied and to identify the right AI and ML techniques in such contexts.

PSO2: Ability to perform the data engineering, designing, developing and testing the AI and ML solutions that include both hardware and software.

PSO3: Ability to be aware of technical solutions that are following ethical aspects aligning with social responsibilities both at designing and developmental phases of applications.

Semester wise Credit Breakdown for B.E Degree Curriculum

Batch 2024-2028

Semester Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Science Course (BSC)	08	08	03	03	---	---	---	---	22
Engineering Science Courses(ESC/ PLC/ETC)	09	08	---	---	---	---	---	---	17
Humanities, Social Sciences and Management (HSMC)	02	02	---	---	03	03	---	---	10
Ability Enhancement Course (AEC)	01	02	01	01	01	---	---	---	06
Skill Development Course (SDC)	---	---	---	---	---	01	02	---	03
Universal Human Values (UHV)	---	---	02	---	---	---	---	---	02
Professional Courses Core (PCC)	---	---	11	12	12	06	04	---	45
Integrated Professional Core Course (IPCC)	---	---	04	04	03	---	04	---	15
Professional Electives Courses - (PEC)	---	---	---	---	03	06	03	---	12
Open Elective Courses (OEC)	---	---	---	---	---	03	03	---	06
Internship (INT)	---	---	---	---	---	---	---	05	05
Mini Project/ Project Work(PW)	---	---	---	---	---	04	---	13	17
Non Credit Mandatory Courses (NCMC)	---	---	---	Yes	Yes	Yes	---	---	---
Total Credits	20	20	21	20	22	23	16	18	160

SCHEME OF TEACHING V SEMESTER

B.E. in Computer Science and Engineering (AI & ML) Scheme of Teaching Batch - 2024 V Semester												
Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week			
					L	T	P	Total	L	T	P	S
1	CI51	Big Data Systems	CSE(AI ML)	PCC	3	0	0	3	3	0	0	3
2	CI52	Foundations of Artificial Intelligence and Computational Agents	CSE(AI ML)	IPCC	2	0	1	3	2	0	2	2
3	CI53	Machine Learning	CSE(AI ML)	PCC	3	1	0	4	3	2	0	3
4	CI54	Software Engineering with MLOPs	CSE(AI ML)	PCC	3	0	0	3	3	0	0	3
5	CIE55x	Program Elective Course – 1	CSE(AI ML)	PEC	3	0	0	3	3	0	0	3
6	CIL56	Big Data Systems Laboratory	CSE(AI ML)	PCC	0	0	1	1	0	0	2	0
7	CIL57	Machine Learning Laboratory	CSE(AI ML)	PCC	0	0	1	1	0	0	2	0
8	AL58	Research Methodology & Intellectual Property Rights	CSE(AI ML)	HSMC	3	0	0	3	3	0	0	3
9	CIAEC59	Ability Enhancement Course – V DevOps	Any Dept.	AEC	1	0	0	1	1	0	0	1
Total					18	1	3	22	18	2	6	18
10	HS510	Environmental Studies *	Humanities	NCMC	0	0	0	0				

PROGRAM ELECTIVE – 1										
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week			
			L	T	P	Total	L	T	P	S
1.	CIE551	Edge Computing	3	0	0	3	3	0	0	3
2.	CIE552	Information Retrieval	3	0	0	3	3	0	0	3
3.	CIE553	Advanced Algorithms	3	0	0	3	3	0	0	3
4.	CIE554	Full Stack Development	3	0	0	3	3	0	0	3
5.	CIE555	Optimization Techniques	3	0	0	3	3	0	0	3

* Environmental Studies is under the category of NCMC, 1-hour teaching per week has to be allocated in the time

Nomenclature: **IC:** Integrated Course (Practical Integrated with Theory Course), **PCC:** Professional Core Course, **PEC:** Professional Elective Course, **AEC:** Ability Enhancement Course, **NCMC:** Non-credit Mandatory Course

Credit Definition:

1. **1 credit = 1 hour/week of lecture (L)**
2. **1 credit = 2 hours/week of tutorial (T)**
3. **1 credit = 2 hours/week of practical(P)**
4. **Self-Learning Hours (S)**

Note: XXE55x, where x=1,2,3,4,5

PCC(IC) is an Integrated course, combining theory with practical components.

- Theory sessions shall be conducted for 3 hours per week, while the practical sessions shall be conducted for 2 hours per week.
- Theory components shall be evaluated through both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The practical component shall be assessed only through CIE (No SEE).
- The CIE shall consist of two internal test of 30 marks each. Each test will have three questions and student shall answer any two full questions. Each question shall have all CO's addressed for that test. An average of two test shall be taken to award 30 marks.
- The CIE for the practical component shall be evaluated for 20 marks. Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 15 marks. Another 05 marks from a lab test and viva.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of 10 questions with internal choice and student shall answer any five full questions.
- However, questions from the practical component of the Integrated course (IC) can be included in the SEE question paper.

PCC & PEC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

NOTE: Professional Elective Courses shall have minimum students' strength for offering open electives as 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

AEC is a 1-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- The SEE will comprise of Part-A with MCQs (10 marks) and Part-B (5x8=40 marks) with descriptive questions.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.
- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.
3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

The Non-Credit Mandatory Course, Environmental Studies: The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured '**F**' grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

SCHEME OF TEACHING VI SEMESTER

B.E. in Computer Science and Engineering (AI & ML)												
Scheme of Teaching Batch – 2024												
VI Semester												
Sl.No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours / week			
					L	T	P	Total	L	T	P	S
1	AL61	Management & Entrepreneurship	CSE(AIML)	HSMC	3	0	0	3	3	0	0	3
2	CI62	Deep Learning and Computer Vision	CSE(AIML)	PCC	3	1	0	4	3	2	0	3
3	CIE63x	Program Elective Course – 2	CSE(AIML)	PEC	3	0	0	3	3	0	0	3
4	CIE64x	Program Elective Course – 3	CSE(AIML)	PEC	3	0	0	3	3	0	0	3
5	CIL65	Deep Learning Laboratory	CSE(AIML)	PCC	0	0	1	1	0	0	2	0
6	CIL66	Data Engineering Laboratory	CSE(AIML)	PCC	0	0	1	1	0	0	2	0
7	CIOE0x*	Institutional Open Elective - 1	Any Dept.	IOE	3	0	0	3	3	0	0	3
8	CIP67	Mini Project	CSE(AIML)	PW	0	0	4	4	0	0	4	0
9	CI68	Technical Skill Enhancement Course	CSE(AIML)	INT	0	1	0	1	0	2	0	0
Total					15	2	6	23	15	4	8	15
10	PE69	Physical Education		NCC	All students have to register compulsorily for any one of the courses with the concerned coordinator (Yoga Teacher/ Physical Education Director/ NSS Coordinator) in the beginning of the III semester. Attending the registered course from III to VI semesters. Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree.							
	YO69	Yoga										
	NS69	NSS										

PROGRAM ELECTIVE – 2										
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week			
			L	T	P	Total	L	T	P	S
1.	CIE631	Principles of Cryptography	3	0	0	3	3	0	0	3
2.	CIE632	Data Storage Techniques	3	0	0	3	3	0	0	3
3.	CIE633	Cloud computing	3	0	0	3	3	0	0	3
4.	CIE634	Augmented and Virtual Reality	3	0	0	3	3	0	0	3
5.	CIE635	Quantum Computing	3	0	0	3	3	0	0	3

PROGRAM ELECTIVE – 3										
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week			
			L	T	P	Total	L	T	P	S
1.	CIE641	Natural Language Processing	3	0	0	3	3	0	0	3
2.	CIE642	Data Management for Machine Learning	3	0	0	3	3	0	0	3
3.	CIE643	Bio Informatics	3	0	0	3	3	0	0	3
4.	CIE644	Pattern recognition	3	0	0	3	3	0	0	3
5.	CIE645	Federated Learning	3	0	0	3	3	0	0	3

OPEN ELECTIVE – 1 for other Departments										
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week			
			L	T	P	Total	L	T	P	S
1.	CIOE01	Web App Development	3	0	0	3	3	0	0	3
2.	CIOE02	Python Programming	3	0	0	3	3	0	0	3
3.	CIOE08	Data Base Management Systems	3	0	0	3	3	0	0	3
4.	CIOE09	Introduction to Digital Forensics	3	0	0	3	3	0	0	3
5.	CIOE05	Introduction to Artificial Intelligence	3	0	0	3	3	0	0	3

Nomenclature- **PCC:** Professional Core Course, **PEC:** Professional Elective Courses, **OEC:** Open Elective Course, **PW:** Mini Project, **SDC:** Skill Development Course, **NCMC:** Non-credit Mandatory Course, **INT:** Internship

Credit Definition:

5. **1 credit = 1 hour/week of lecture (L)**
6. **1 credit = 2 hours/week of tutorial (T)**
7. **1 credit = 2 hours/week of practical(P)**
8. **Self-Learning Hours (S)**

Note: XXE63x, where x=1,2,3,4,5

PCC & PEC & HSMC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE shall be evaluated for 100 marks, which shall be scaled down to 50 marks.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

NOTE: Professional Elective Courses shall have minimum students' strength for offering open electives as 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.
- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent department. However, they can take an elective offered by other departments, provided they satisfy the prerequisite condition, if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

1. The candidate has studied the same course during the previous semesters of the program.
2. The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
3. A similar course, under any category, is prescribed in the higher semesters of the program.
4. The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session as per the rubrics defined by the department.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session as per the rubrics defined by the parent department.

SEE component for Mini-Project: SEE will be conducted by the two examiners appointed by the Institute. SEE marks awarded for the mini project shall be based on the evaluation of project work report, project presentation skill and question and answer session.

Technical Skill Enhancement Course: is a 1-credit tutorial course with 2 contact hours per week. This course is designed to improve the practical and technical skills of students, focusing on developing industry-relevant and job-oriented skills, and enhance employability of the students. The course teacher shall be an industry expert who provides hands-on experience with relevant tools and technologies currently existing in the industry. The students shall attend classes for

the course during the semester and complete all formalities of attendance and CIE. The course shall be evaluated by the industry expert through Continuous Internal Evaluation (CIE) for 100 marks.

Non-Credit Mandatory Course: The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured 'F' grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years' degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fail to earn the prescribed activity points; 8th semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

Note: Internship: All the students shall have to undergo mandatory internship of 6 – 8 weeks during the intervening vacation of the IV & V semesters, intervening vacation of VI & VII semesters, VII semester. A Viva-voce based CIE examination shall be conducted during the VIII semester as per the rubrics defined by the department and the prescribed credits shall be included in VIII semester grade card.

BIG DATA SYSTEMS	
Course Code: CI51	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L +45S
Course Coordinator: Mr. Subash N	

Course Contents:

Unit-I

Introduction to Big Data: Types of Digital Data, Introduction to Big Data: Characteristics, Evolution, Definition, Challenges, What is Big Data, Other Characteristics, Why Big data, Significance of Big Data, Traditional BI versus Big Data, Data warehouse environment versus Hadoop Environment, Trends in Big data, Big Data Analytics: Introduction to Big Data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies for Big data, Data Science, Data Scientist, Terminologies Used.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Links: <https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop>

Unit-II

Hadoop / Spark /HDFS Overview: Hadoop Overview: Features, Key advantages, Versions, Distributions, Overview of Hadoop Ecosystem, Why Hadoop, why not RDBMS, HDFS: Hadoop Distributed File System (HDFS), HDFS Daemons, File Read, File Write, Replica Placement Strategy, HDFS commands, Special features of HDFS and its limitations, MapReduce, YARN.

- Pedagogy: Tool-Based Demonstration
- Links: <https://hadoop.apache.org/>
<https://nptel.ac.in/courses/106104189>

Unit-III

Spark Core: Spark Overview: Spark Ecosystems, Advantages of Spark, Spark Standalone application, Running on Cluster, Programming with RDD's: Basics, RDD operations, Lineage Graphs, Lazy evaluation, Persistence, Immutability, Fault Tolerance, Performance (Pipelining, Shuffle). Pair RDD's: Transformations and Actions, Partitioning, Accumulators, Broadcast Variables.

- Pedagogy: Case Study, Demo and Student Presentation
- Links: <https://hadoop.apache.org/>
<https://nptel.ac.in/courses/106104189>

Unit-IV

Spark SQL: Rows, Data frames, Tables and SQL operations on Tables. Spark Session, Creating Data Frame, Parquet files, working with Hive.

Spark Streaming: Introduction to Stream Processing, Architecture of Spark Streaming, Caching and Persistence, Check pointing, Fault tolerance, Structured Streaming-Output Modes, Output sinks, Failure recovery and check pointing.

- Pedagogy: Coding and Lab Hands-on Exercises
- Links: <https://hadoop.apache.org/>
<https://nptel.ac.in/courses/106104189>

Unit-V

Machine Learning with Spark: Introduction to spark ML Lib, need for pipeline API, working of pipeline API, Scala syntax for building pipeline, Predictions on test documents, Feature engineering, Feature extraction algorithms, Feature transformation algorithms, Feature

selection algorithms, classification and regression, clustering, Collaborative filtering, ML-tuning - model selection and hyper parameter tuning.

- Pedagogy: Coding and Lab Hands-on Exercises
- Links: <https://hadoop.apache.org/>
<https://nptel.ac.in/courses/106104189>

Text Books:

1. Seema Acharya and Subhashini C, Big Data and Analytics, Wiley India, 2019 (Chapter 1,2,3,5,9)
2. Muhammad Asif Abbasi, Learning Apache Spark 2, Packt Publishing, 2017 (Chapter 1,2,3,4,5)

Reference Books:

1. Cay S. Horstmann, Scala for the Impatient 2nd Edition (Chapter 1to 6, 12 to 14)
2. Andy Konwinski, Holden Karau, Matei Zaharia, Patrick Wendell, Learning Spark a Lightning-Fast Big Data Analysis, O'Reilly, 2015 (Chapter 1, 2, 3, 4, 6, 7, 8, 9, 10)
3. Tom White, Hadoop: The Definitive Guide, O'Reilly, 2015

Course Outcomes (COs):

At the end of the course, student will be able to:

1. Understand the Big Data concepts and differentiate Big Data environments from traditional BI systems. (PO-1,2,3, PSO-1,2)
2. Demonstrate Hadoop ecosystem tools including HDFS, MapReduce, and YARN for large-scale data processing. (PO-1,2,3,5,10 PSO-1,2)
3. Explain the various components of Spark architecture and their key features. (PO-1,2,3, PSO-1,2)
4. Implement RDD operations, data processing with Spark SQL and Spark Streaming for batch and real-time analytics. (PO-1,2,3,5,10, PSO-1,2)
5. Apply Spark MLlib for machine learning tasks. (PO-1,2,3,5, 10, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Tool based Problem solving Assignments	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE AND COMPUTATIONAL AGENTS	
Course Code: CI52	Credits: 2:0:1:2
Pre – requisites: Nil	Contact Hours: 30L+15P+30S
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction to AI: Introduction to AI, Foundations of AI, Weak AI and Strong AI. Weak AI: Can Machines Act Intelligently? Strong AI: Can Machines Really Think?

Intelligent Agents: Agents and Environments, Good Behavior—Concept of rationality, Nature of Environments, Structure of Agents. Problem-Solving Agents, Uninformed Search Strategies: Breadth First Search, Depth-First Search, Depth-limited search, Iterative deepening depth-first search. Applications of Uninformed Search Strategies

- Pedagogy: Chalk and Talk, PowerPoint Presentations, Agentic AI Tools
- Links: <https://nptel.ac.in/courses/112103280>
<https://www.deeplearning.ai/courses/agentic-ai>

Unit II

Informed Search and Exploration: Greedy Best-First Search, A Star Algorithm, Heuristic Functions, Hill Climbing Algorithm, AND-OR Graphs and AO* Algorithm, Adversarial Search-Minimax and Alpha-Beta Pruning

- Pedagogy: Chalk and Talk, PowerPoint Presentations, AI Tool Enabled Learning
- Links: <https://nptel.ac.in/courses/112103280>
<https://www.deeplearning.ai/courses/agentic-ai>

Unit III

Knowledge Representation and Reasoning in AI: Knowledge Representation, Knowledge based agents, Wumpus World, Logic-Based Representation- Propositional Logic, Reasoning Patterns in Propositional Logic, Effective propositional inference, First order Logic.

Pedagogy: Chalk and Talk, PowerPoint Presentations, AI Tool Enabled Learning

Links: <https://nptel.ac.in/courses/112103280>
<https://www.deeplearning.ai/courses/agentic-ai>

Unit IV

Agentic AI Architectures and Patterns: Structured Reasoning and Action, Letting Your AI Agents Think Out Loud, Generating a Tree of Possibilities. How to Make Your Agent Take Action and Reflect, AI Agent, Designing Human-in-the-Loop Workflows, Advanced Agent Paradigms: Supervisor and Hierarchical Agents, Building a Hierarchical Research Team, Developing a Swarm of Agents.

- Pedagogy: Chalk and Talk, PowerPoint Presentations, Agentic AI Tools
- Links: <https://www.deeplearning.ai/courses/agentic-ai>

Unit V

Probabilistic Reasoning and Statistical Learning: Representing Knowledge in an Uncertain Domain, Bayesian networks, Semantics of Bayesian networks, Exact inference in Bayesian Networks, Maximum-likelihood parameter learning.

- Pedagogy: Chalk and Talk, PowerPoint Presentations, AI Tool Enabled Learning
- Links: <https://nptel.ac.in/courses/112103280>
<https://www.deeplearning.ai/courses/agentic-ai>

Text Books:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Fourth Edition, Reprint 2024, Prentice Hall Publications.
2. AI Agents: The Definitive Guide, Nicole Koenigstein, O'Reilly Media, Inc. Sept. 2026

References:

1. David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, 3rd Edition, Cambridge University Press, 2023.
2. Elaine Rich, Kevin K and S B Nair, Artificial Intelligence, 3rd Edition, McGraw Hill Education, 2017.
3. George F Luger, AI-Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson Publications.
4. Stuart Russell, Human Compatible-AI and the problem of control, Viking Publishers, 2019.

Course Outcomes (COs):

At the end of the course student will be able to:

1. Understand fundamental concepts of intelligent agents and uninformed search strategies to solve basic AI problems. (PO-1,2,3,4,5, PSO-1,2)
2. Analyze and implement informed search algorithms and adversarial search techniques for optimal decision-making. (PO-1,2,3,4,5, PSO-1,2)
3. Demonstrate reasoning using propositional and first-order logic for effective knowledge representation. (PO-1,2,3,4,5, PSO-1,2)
4. Analyze Agentic AI Architectures and Patterns for structured reasoning and action. (PO-2,6,7,8, PSO-2,3)
5. Apply probabilistic reasoning and learning techniques to represent and infer knowledge under uncertainty. (PO-1,2,3,4,5, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Lab Test	10	CO1, CO2, CO3
Active Learning: Agentic AI – Tool Implementation	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Machine Learning	
Course Code: CI53	Credits: 3:1:0:3
Prerequisite: Nil	Contact Hours: 45L+15T+15S
Course Coordinator: Dr. A N Ramya Shree	

Course Contents

Unit I

Machine Learning Preliminaries: Introduction, three different types of machine learning, bias vs. variance trade-off, overfitting vs. underfitting, training and test sets, and k-fold cross-validation. Feature Engineering: Variance Threshold, Pearson Correlation (Heatmap), Greedy Feature Selection, Univariate Feature Selection, Recursive Feature Elimination, Feature Extraction and Dimensionality Reduction using Principal Component Analysis (PCA).

- Pedagogy: Lecture PPTs, Chalk and Talk ,Demonstration
- Link: <https://github.com/rasbt/machine-learning-book/tree/main/ch04>

Unit II

Supervised Learning: Concept Learning: Concept learning task, concept learning as search, Find-S algorithm, Candidate Elimination Algorithm, Univariate and Multivariate Regression, Polynomial Regression, L1 and L2 Regularization, Logistic Regression , Decision Tree Learning using ID3 Algorithm, Naive Bayes Classification, K-nearest Neighbor (KNN) Classification, and Classification with SVM.

- Pedagogy: Core concepts and theoretical concepts , PPT and Demonstration
- Link: <https://www.mheducation.co.in/machine-learning-9789364446037-india>

Unit III

Unsupervised Learning: Measures of similarity and distance, grouping objects by similarity using K-means clustering, the elbow method for optimal cluster selection, hierarchical clustering and dendrograms, density-based clustering using DBSCAN, Expectation-Maximization (EM) algorithm for Gaussian Mixture Models (GMMs).

- Pedagogy: Core concepts and theoretical concepts , PPT and Demonstration
- Link: <https://github.com/rasbt/machine-learning-book/tree/main/ch10>

Unit IV

Reinforcement Learning: Introduction, Elements of Reinforcement Learning, Extended Example: Tic-Tac-Toe, Learning Task, Passive reinforcement learning, Active reinforcement learning, Q Learning, Generalization in reinforcement learning, Policy search, Limitations and Scope.

- Pedagogy: Core concepts and theoretical concepts , PPT and Demonstration
- Link: <https://github.com/rasbt/machine-learning-book/tree/main/ch19>

Unit V

Ensemble Learning, Model Evaluation, and Model Selection: Ensemble learning concepts, simple majority vote classifier, bagging, AdaBoost, gradient boosting, and random forests. Model Evaluation: Evaluation metrics for classification, regression, and clustering. Model Selection and Overfitting Control: Hyperparameter tuning, cross-validation for model selection, and tackling overfitting through regularization.

- Pedagogy: Case Study, PPT, Demo and Presentation.

- Link: <https://github.com/rasbt/machine-learning-book/tree/main/ch07>

Text Books:

1. Machine Learning, Tom Mitchell, Tata Mc Graw Hill Publications 2017. Sebastian Raschka, Yuxi (Hayden) Liu and Vahid Mirjalili, Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python, Packt Publishing Limited, December 2022.

References:

1. Richard S. Sutton & Andrew G. Barto, Reinforcement Learning: An Introduction, MIT Press.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, Inc., October 2022.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Understand machine learning concepts, bias-variance tradeoff, overfitting, cross-validation, and feature engineering techniques (PO-1, 2, 4, PSO-1,2).
2. Analyze regression, decision trees, SVM, and k-NN supervised learning algorithms for classification and prediction tasks. (PO-1,2,3,4,5, PSO-1,2)
3. Apply k-means, hierarchical clustering, DBSCAN, and EM algorithm unsupervised learning techniques for data clustering and pattern discovery. (PO-1, 2, 4, 5, PSO-1,2).
4. Demonstrate reinforcement learning models by exploring passive, active learning and Q-learning. (PO-1,2, 4,5, PSO-1,2)
5. Apply ensemble learning, model evaluation, and model selection techniques to develop robust and generalized machine learning models. (PO-1,2,3, 4, 5, PSO-1, 2, 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
The average of two internal tests shall be taken for 30 marks.		
Other components		
Certification Course	10	CO1, CO2, CO3, CO4, CO5
Case Study	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

SOFTWARE ENGINEERING WITH MLOPs	
Course Code: CI54	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Nayana G.Bhat & Dr. Sajini G.	

Course Contents

Unit I

Introduction to Software Engineering: Professional Software Development, Software Engineering Ethics. Software Processes: Software Process Models, Process Activities, Coping with Change, Process Improvement. **Agile Software Development:** Agile Methods, Agile Development Techniques, Agile Project Management, Scaling Agile Methods.

- Pedagogy: Chalk and Talk, PowerPoint Presentations, AI Tool Enabled Learning
- Links: [Software engineering for machine learning - Google Drive](#)

Unit II

Requirements Engineering: Functional and Non-Functional Requirements, Requirements Engineering Processes, Requirements Elicitation and Analysis, Software Requirements Document (SRS), Requirements Specification, Requirements Validation, Requirements Management.

- Pedagogy: Chalk and Talk, PowerPoint Presentations, AI Tool Enabled Learning
- Links: [ISO/IEC/IEEE 29148:2018 - Systems and software engineering — Life cycle processes — Requirements engineering](#)

Unit III

Systems Design: Introduction to Software Engineering for AI and Machine Learning Systems, Business and ML Objectives, Requirements for ML Systems, Iterative Development Process. Reliability, Scalability, Maintainability, Adaptability, Software Quality Challenges in ML Systems, Evaluating ML Models, Model deployment Testing Data and Models.

- Pedagogy: Tool-Based Demonstration
- Links: [Designing Machine Learning Systems \[Book\]](#)

Unit IV

Introduction to MLOps and DataOps : Defining MLOps and Its Challenges, MLOps to Mitigate Risk, Risk Assessment, Key ML ops Features, Developing, preparing for production, deployment , Monitoring. DataOps and MLOps. CaseStudy: MLOps for AWS, MLOps for GCP.

- Pedagogy: Case Study, Demo and Presentation
- Links: [What is MLOps? - Machine Learning Operations Explained - AWS](#)

Unit V

Software Testing: Development testing, Test-driven development, Software **Project management:** Risk management, **Project planning:** Plan-driven development, Project scheduling, agile planning, Estimation techniques. Testing Strategies for ML Systems.

- Pedagogy: Case Study, Demo and Presentation
- Links: [Software engineering for machine learning - Google Drive](#)

Text Books:

1. Software Engineering, 10th Edition, Ian Sommerville, Pearson Education, 2020.
2. Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications, Chip Huyen, O'Reilly Media, 2022.
3. Introducing MLOps: How to Scale Machine Learning in the Enterprise, Mark Treveil et al., 2020.

References Textbooks & Links:

1. Practical MLOps – Noah Gift & Alfredo Deza
2. Machine Learning Engineering – Andriy Burkov
3. <https://www.ibm.com/think/topics/data-architecture#2014952965>

Course Outcomes (COs):

At the end of the course student will be able to:

1. To apply core software engineering principles, process models, ethics, and agile methodologies to handle changing operational requirements. (PO-1,2,3,5,8,9,10,11 PSO-1,2,3)
2. To elicit, analyze, document, and validate functional and non-functional requirements to construct a complete Software Requirements Specification (SRS). (PO-1,2,3,4,5,8,9,10,11 PSO-1,2,3)
3. To design system architectures and iterative workflows for AI and Machine Learning applications while addressing quality challenges like reliability, scalability, and maintainability. (PO-1,2,3,4,5,8,9,10,11 PSO-1,2,3)
4. To analyze MLOps and DataOps pipelines, risk assessment strategies, and continuous monitoring tools using cloud environments like AWS and GCP. (PO-1,2,3,4,5,6,7,8,9,10,11 PSO-1,2,3)
5. To formulate software project plans, estimation models, risk management protocols, and specialized testing strategies for traditional and ML-driven systems. (PO-1,2,3,4,5,6,8,9,10,11 PSO-1,2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II (CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Certification	10	CO1, CO2, CO3
Tool Based Project	10	CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks +20 Marks scored in Certification and Tool based Project		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

Edge Computing	
Course Code: CIE551	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Ms. Kavya Natikar & Ms. Bhagyasree Hosmani	

Course Contents

UNIT I

Introduction to Edge Computing: Edge computing purpose and definition, key components of edge ecosystem, Edge computing devices, Edge vs Fog Computing vs Cloud computing, Working of edge computing. Edge computing use cases and examples: video surveillance, smart cities, autonomous vehicles.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: https://onlinecourses.nptel.ac.in/noc23_cs65/educba.com/edge-computing-architecture/

UNIT II

Edge Computing platforms and frameworks: Edge hardware architectures: processors, storage, and memory, hardware accelerators in edge computing: Use of Hardware accelerators like Intel Compute Stick/Google Coral with companion to Raspberry Pi or JetsonEdge platforms: Architectures, Virtualization, containersEdge computing popular frameworks: Microsoft Azure IoT Edge or Google cloud IoT Edge.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: https://onlinecourses.nptel.ac.in/noc23_cs65/educba.com/edge-computing-architecture/

UNIT III

Edge Networking:: Edge routing and networking: TCP/IP network functions at the edge, Edge-level network security, Software-defined networking.

Communication Models: Edge, Fog, M2M: Building M2M and WSN network (HTTP/MQTT) – Topologies and applications

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: https://onlinecourses.nptel.ac.in/noc23_cs65/educba.com/edge-computing-architecture/

UNIT IV

IoT and Edge Security: Introduction to IoT and Edge security: cybersecurity, physical and hardware security, Edge security best practices, Threats and vulnerabilities related to edge computing. **Case study:** Anomaly Detection in Edge Computing.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://blogs.nvidia.com/blog/2019/10/22/what-is-edge-computing/>

UNIT V

Edge Analytics: Basic data analytics in Edge IoT, Machine learning in Edge IoT, Edge AI. Edge Analytics applications and examples: Deep Learning at the Edge, Exploiting Edge Computing in Health Monitoring, Edge Computing Model for Evolving Smart Transportation, Deployment of deep model on edge devices using Edge Impulse platform.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://www.nvidia.com/en-in/edge-computing/>

Text Books:

1. Perry Lea , “IoT and Edge Computing for Architects”, Packt Publishing, ISBN: 9781839214806, March 2020.
2. Rajkumar Buyya, Satish Srirama, “Fog and Edge Computing: Principles and Paradigms”, Wiley publication, ISBN:9781119524984, January 2019.

Reference Books:

1. David Jensen, “Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, Springer India,ISBN-13 978-1484275504, January 2022.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases",CRC Press, ISBN 9781032509266, June 2022.

Course Outcomes (COs):

At the end of the course, students should be able to:

1. Identify the need for new computing paradigms and compare the edge computing with existing paradigms. (PO-1, PSO-2)
2. Analyze the need of hardware and software-based components in edge computing architectures and platforms. (PO-1,2,3 PSO-2)
3. Recognize Edge networking related requirements and components and Describe various communication models of edge computing. (PO-1,2,3 PSO-2)
4. Analyze data/application requirements related to security in edge computing. (PO-1, PSO-2)
5. Design edge analytics models using edge AI/ML methods (PO-1,2,3,4 PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II (CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

Information Retrieval	
Course Code: CIE552	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

UNIT I

Introduction: Overview, History of IR, Text Operations: Document pre-processing, Document Clustering, Text Compression, Indexing: Inverted files, Mathematics for IR: Set Theory, Mathematical Logic, Probability and Linear algebra, Classic IR Models: Boolean Model, Vector space model: tf-idf weighing, Probabilistic Model. Language models for IR: The language model and the query likelihood model.

- Pedagogy: Interactive Lecture, Power point Presentation, Tool-Based Demonstration
- Links: <https://nptel.ac.in/courses/106106852>

UNIT II

Evaluation Measures: Precision, Recall, Alternative Measures, Reference Collections: TREC, Relevance Feedback and Query Expansion, **Text Classification:** The text classification problem, Flat clustering: Clustering in information retrieval, Problem Statement, Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and Complete-link clustering.

- Pedagogy: Interactive Lecture, Power point Presentation, Tool-Based Demonstration
- Links: <https://nptel.ac.in/courses/106106852>

UNIT III

String Matching algorithms: Knuth Morris Pratt and Rabin Karp, Stemming algorithm: Porter, Map reduce algorithms: tf- idf calculation and indexing, Classification: Naive Bayes algorithm, Clustering: k-means algorithm. Machine learning Algorithms: Machine- learned scoring, Result ranking by machine learning.

- Pedagogy: Interactive Lecture, Power point Presentation, Tool-Based Demonstration
- Links: <https://nptel.ac.in/courses/106106852>

UNIT IV

Web search basics: web characteristics, Architecture of web search engine, Web Crawling and Indexing: Overview, Crawling, Distributing Indexes, Connectivity Servers. Link analysis: Web as a graph, Page Rank, Hubs and Authorities.

- Pedagogy: Interactive Lecture, Power point Presentation, Tool-Based Demonstration
- Links: <https://nptel.ac.in/courses/106106852>

UNIT V

XML Retrieval: Basic XML Concepts, Challenges in XML retrieval, a vector space model for XML retrieval, Introduction to Semantic Web: Purpose, Semantic Web Stack, RDF, RDFS, Ontology, Web ontology language (OWL) and ontology tools.

- Pedagogy: Interactive Lecture, Power point Presentation, Tool-Based Demonstration
- Links: <https://nptel.ac.in/courses/106106852>

Text Books:

1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto: Modern Information Retrieval, Pearson Education, 1999.
2. Introduction to Information Retrieval. C.D. Manning, P. Raghavan, H. Schütze. Cambridge UP, 2008.

Reference Books:

1. William B Frakes, Ricardo Baeza Yates: Information Retrieval Data Structures and Algorithms, PH PTR, 1992.
2. David A Grossman, Ophir Frieder: Information Retrieval Algorithms and Heuristics, 2e, Springer, 2004
3. Mathematics for Classical Information Retrieval: Roots and Applications: Dariush Alimohammadi,
4. [http://www.dcc.fc.up.pt/~zp/aulas/1213/pde/geral/bibliografia/MIT.Press.A. Semantic. Web.Primer.eBook-TLFeBOOK.pdf](http://www.dcc.fc.up.pt/~zp/aulas/1213/pde/geral/bibliografia/MIT.Press.A.Semantic.Web.Primer.eBook-TLFeBOOK.pdf)

Course Outcomes (COs):

At the end of the course, student should be able to

1. Describe text operations and various information retrieval models. (PO-1,2, PSO-2)
2. Evaluate an IR system using various evaluation measures. (PO-1,2,4, PSO- 2)
3. Apply various algorithms such as string matching, map reduce, classification and clustering. (PO-1,2,3,4,5, PSO-3)
4. Design web search engine, web crawling and link analysis techniques. (PO- 1,2, 3,4, PSO-3)
5. Explain XML Retrieval and various semantic web technologies. (PO-1, 3, 5, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+		
Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

ADVANCED ALGORITHMS	
Course Code: CIE553	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Sini Anna Alex	

Course contents

Unit I

Analysis Techniques: Growth of Functions, Asymptotic notations, Standard notations and common functions, Recurrences and Solution of Recurrence equations – The Substitution method, The recurrence – tree method, The master method.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: <https://nptel.ac.in/courses/106105164>

Unit II

Graph Algorithms: Bellman-Ford Algorithm, Single source shortest paths in a DAG, Johnson's Algorithm for sparse graphs. Trees: B-trees, Red- Black trees. Hashing: General Idea, Hash Function, Separate Chaining, Open addressing, Rehashing, Extendible hashing.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: <https://nptel.ac.in/courses/106105164>

Unit III

Number – Theoretic Algorithms: Elementary notations, GCD, Modular Arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element. Heaps: Heaps, Priority Queues, Binomial Heaps, Fibonacci Heaps.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: <https://nptel.ac.in/courses/106104019>

Unit IV

String Matching Algorithms: Naïve string matching, Rabin – Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm, BoyerMoore Algorithms.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: <https://nptel.ac.in/courses/106104019>

Unit V

Algorithmic Puzzles: Magic Square, n-queens problem, Glove Selection, Ferrying Soldiers, Jigsaw Puzzle Assembly, A Stack of Fake Coins, Maximum Sum Descent, Hats of Two Colors, Pluses and Minuses, searching for a Pattern, Locker Doors, Palindrome Counting.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: <https://nptel.ac.in/courses/106104019>

Text Books:

1. T H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3/e, PHI, 2011.
2. Mark Allen Weiss: Data Structures and Algorithm Analysis in C++, 3rd Edition, Pearson Education, 2011.
3. Anany Levitin and Maria Levitin: Algorithmic Puzzle, Oxford University Press, 2011.

References:

1. Ellis Horowitz, Sartaj Sahni, S Rajasekharan: Fundamentals of Computer Algorithms, University Press, 2007.
2. Alfred V Aho, John E Hopcroft, J D Ullman: The Design and Analysis of Computer Algorithms, Pearson Education, 2011.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Describe recurrence relations and amortized cost of various operations. (PO1,2,4, PSO-1,2)
2. Illustrate graph algorithms such as Bellman-Ford, Shortest path, and bipartite matching, B-trees, Red-Black trees and hashing techniques. (PO1,2,3, PSO-1,2)
3. Understand the methods for solving modular linear equations, Chinese remainder theorem, RSA cryptosystem, Binomial and Fibonacci heaps. (PO-1,2,3,9,10,PSO-1,2)
4. Apply the string-matching algorithms such as Boyer-Moore and Knuth Morris-Pratt algorithm. (PO-1,2,3,9,10, PSO-1,2)
5. Analyze the mathematical models, objective functions and constraints to solve algorithmic puzzles. (PO-1,2,4,9,10,12, PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

FULL STACK DEVELOPMENT	
Course Code: CIE554	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Mr. Subash N/ Ms. Shrilaxmi G	

Course Contents:

Unit I

Introduction to Full Stack Development: Client-server Architecture Static vs Dynamic websites Roles and responsibilities How front-end and back-end communicate. Cascading Styles Sheet: Concept of CS, Creating Style Sheet, CSS Properties, CSS Styling, CSS Id and Class, Box Model, **Front-End Web Development:** JavaScript syntax, Types of Data and Variables and Operations, The Document Object, Using Events. JavaScript Advanced: Scopes and Closures, understand "this" and prototypes.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos
- Link: <https://www.coursera.org/learn/>

Unit II

ReactJS: Building blocks of React, Create-react-app - Create first React app using this CLI, JSX - Understand what it is and how it's required to create components, Simple functional components, CSS - Load CSS and use it via class Name, props - Passing props to components to make them reusable

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos
- Link: <https://www.coursera.org/learn/>

Unit III

Back-End Web Development: Node.js: Introduction - What is Node.js, Architecture, Feature of Node JS, Installation and setup - Creating webservers with HTTP (Request & Response), Understand dependence management: npm and package.json File system APIs. CRUD Operations using Node.js: Event Handling - GET & POST implementation.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos
- Link: <https://www.coursera.org/learn/>

Unit IV

Database Integration: Overview of NoSQL and SQL databases, document-oriented data model, key features of MongoDB, MongoDB Compass cloud setup, schema design and data modelling, core MongoDB CRUD operations using Node.js, Connecting MongoDB with Node.Js [File system + Express.js].

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos
- Link: <https://www.coursera.org/learn/>

Unit V

MERN Stack Deployment: Development and deployment of a full-featured MERN stack application including authentication, authorization and CRUD operations. Version Control Systems (VCSs) and Git: Distributed Git: Distributed Workflows, contributing to a Project. Static code quality analysis using SonarQube and real-time code feedback using SonarLint.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos
- Link: <https://www.coursera.org/learn/>

Text Books:

1. Steven A. Gabarro, “Web Application Design and Implementation: Apache 2, PHP5, MySQL, JavaScript, and Linux/UNIX”, Wiley- IEEE Computer Society Press 2007.
2. Krasimir Tsonev, “Node.js by Example”, Packt Publishing Limited, 2015
3. Ethan Brown, Web Development with Node and Express: Leveraging the JavaScript Stack Publisher: O'Reilly Media Latest Edition: 2nd Edition

References:

1. Web link for Node.js: <https://nodejs.org/en/>
2. Web link for MongoDB: <https://www.mongodb.com/>
3. Web link for React JS: <https://reactjs.org/>

Course Outcomes(COs)

At the end of the course, student will be able to:

1. Understand and apply fundamental concepts of JavaScript and web technologies to solve basic and intermediate problems in front-end web application development. (PO 1,2,5, PSO1)
2. Analyse client-side and server-side requirements and develop logical solutions using advanced JavaScript concepts such as asynchronous programming, scopes, closures, and event handling. (PO1,2,3, PSO1,2)
3. Design and develop scalable and reusable front-end applications using ReactJS, following component-based architecture and modern UI development practices. (PO3,5,9,10, PSO2)
4. Design and implement secure and efficient back-end services using Node.js and Express.js with RESTful APIs for real-world web applications. (PO3, 4,5,11, PSO2)
5. Implement a full-stack MERN application using Git-based version control, GitHub collaboration, code quality tools. (PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO11, PO12, PSO2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		

Other components		
Problem Statement Demonstration using AI tools	20	CO1, CO2, CO3 CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

OPTIMIZATION TECHNIQUES	
Course Code: CIE555	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Naveen N C	

Course Contents

Unit I

Problems to Be Solved: Optimisation, Modelling, Simulation, Search Problems, Optimisation Versus Constraint Satisfaction, The Famous NP Problems

Evolutionary Computing: The Origins: The Main Evolutionary Computing Metaphor, Brief History, The Inspiration from Biology, Darwinian Evolution, Genetics, Putting It Together, Evolutionary Computing: Why?

What Is an Evolutionary Algorithm?: What Is an Evolutionary Algorithm?, Components of Evolutionary Algorithms, Representation (Definition of Individuals), Evaluation Function (Fitness Function), Population, Parent Selection Mechanism.

- Pedagogy: Chalk and board, Problem based learning, Visual Aids
- Link: <https://nptel.ac.in/courses/106105173>

Unit II

Representation, Mutation, and Recombination: Roles of Variation Operators, Binary Representation, Mutation for Binary Representation, Recombination for Binary Representation, Integer Representation, Mutation for Integer Representations, Recombination for Integer Representation, Real-Valued or Floating-Point Representation.

- Pedagogy: Chalk and board, Problem based learning, Visual Aids
- Link: <https://nptel.ac.in/courses/111105038>

Unit III

Fitness, Selection, and Population Management: Population Management Models, Parent Selection, Survivor Selection, Age-Based Replacement, Fitness-Based Replacement, Selection Pressure, Multimodal Problems, Selection, and the Need for Diversity, Characterising Selection and Population Management Approaches for Preserving Diversity, Fitness Sharing. **Popular Evolutionary Algorithm Variants:** Genetic Algorithms, Evolution Strategies, Evolutionary Programming, Genetic Programming, Learning Classifier Systems, Differential Evolution, Particle Swarm Optimisation, Estimation of Distribution Algorithms

- Pedagogy: Chalk and board, Problem based learning, Visual Aids
- Link: <https://nptel.ac.in/courses/111105038>

Unit IV

Parameters and Parameter Tuning: Evolutionary Algorithm Parameters, EAs and EA Instances, Designing Evolutionary Algorithms, The Tuning Problem, Algorithm Quality: Performance and Robustness, Tuning Methods **Parameter Control:** Introduction, Examples of Changing Parameters, Changing the Mutation Step Size, Changing the Penalty Coefficients, Classification of Control Techniques.

- Pedagogy: Chalk and board, Problem based learning, Case Studies
- Link: <https://nptel.ac.in/courses/111105038>

Unit V

Working with Evolutionary Algorithms: What Do You Want an EA to Do? Performance Measures, Different Performance Measures, Peak Versus Average Performance, Test Problems for Experimental Comparisons, Using Predefined Problem Instances, Using Problem Instance Generators, Using Real-World Problems, Example Applications, Bad Practice, Better Practice

- Pedagogy: Chalk and board, Problem based learning, Flipped Class
- Link: <http://acl.digimat.in/nptel/courses/video/112103301/L13.html>

Textbooks:

1. A.E. Eiben, J.E. Smith, Introduction to Evolutionary Computing, Second Edition, Springer, 2015

References:

1. Andries P. Engelbrecht, Computational Intelligence: An Introduction . Second Edition, John Wiley & Sons Ltd, 2007
2. Xinjie Yu · Mitsuo Gen, Introduction Evolutionary Algorithms, Springer , 2010.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Understand different types of optimization problems, biological inspiration and working principles of evolutionary algorithms. (PO- 1,2,4, PSO-1,2)
2. Apply representations and variation operators for solving complex optimization problems. (PO- 1,2,3, PSO-1,2)
3. Evaluate parent and survivor selection methods, population models, and diversity preservation techniques. (PO-1,2,3,4, PSO-1,2)
4. Analyze parameter tuning, control methods to enhance the performance and robustness of evolutionary algorithms. (PO- 1,2,3,4, PSO-1,2)
5. Investigate evolutionary algorithms for applications and compare results using performance metrics. (PO-1,2,5, PSO-1,2).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case Study	10	CO1, CO2, CO3
Assignment-2	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

BIG DATA SYSTEMS LABORATORY	
Course Code: CIL56	Credits: 0:0:1
Pre – requisites: Nil	Contact Hours: 15P
Course Coordinator: Mrs. Akshatha G C	

Lab schedule:

Sl.No	Topics
1.	Demonstrate HDFS file management operations, configure file permissions, and analyze the block storage characteristics of files.
2.	Write a MapReduce program using Java to perform the Word Count operation on a given dataset and demonstrate the execution of the MapReduce programming model.
3.	Write a MapReduce program using Java, to analyze the given employee data and generate a statistics report with the total number of Female and Male Employees and their average salary.
4.	Write a spark program to analyze the given weather report data and to generate a report with cities having maximum temperature for a particular year
5.	Write a spark program to analyze the given Sales Records over a period of time and generate data about the country's total sales, and the total number of the products. Country's total sales and the frequency of the payment mode.
6.	Write spark code to demonstrate different transformation and action operations on pair RDD's
7.	Write Spark program demonstrating Accumulators to count invalid transaction records and Broadcast Variables to efficiently share a read-only product lookup table across executors in retail data processing.
8.	An organization uses Spark SQL to manage employee data. Write queries to create an employee database and perform CRUD operations on it.
9.	Write a Spark Streaming application for a sports analytics system that receives continuous real-time match commentary data through a TCP socket. Ingest the stream and perform real-time analysis of key terms such as player names, scores, and match events from the incoming data.
10.	Write PySpark Structured Streaming application to monitor streaming log data, identify log levels, and perform real-time log analysis.
11.	Write a Spark program to analyze customer data stored in raw text and categorical format. Load the dataset into a Data Frame, explore its structure, and perform data pre-processing and feature engineering by converting categorical and text data into numerical features for further analysis in a customer analytics application.
12.	Write a Spark Structured Streaming application for a banking system that detects fraudulent card transactions in real time. The system should read live transaction data, apply a pre-trained machine learning model and display results for immediate alerting and action.
13.	Write a Spark program to build a recommendation system using the ALS algorithm to generate movie recommendations and perform prediction on test data.

Text Books:

1. Seema Acharya and Subhashini C, Big Data and Analytics, Wiley India, 2019 (Chapter 1,2,3,5,9)
2. Muhammad Asif Abbasi, Learning Apache Spark 2, Packt Publishing, 2017 (Chapter 1,2,3,4,5)

Reference Books:

1. Cay S. Horstmann, Scala for the Impatient 2nd Edition (Chapter 1 to 6, 12 to 14)
2. Andy Konwinski, Holden Karau, Matei Zaharia, Patrick Wendell, Learning Spark a Lightning-Fast Big Data Analysis, O'Reilly, 2015 (Chapter 1, 2, 3, 4, 6, 7, 8, 9, 10)
3. Tom White, Hadoop: The Definitive Guide, O'Reilly, 2015

Course Outcomes (COs):

At the end of the course student will be able to

1. To Hadoop ecosystem concepts, including HDFS operations and MapReduce programming, for distributed storage and batch data processing. (PO1, PO2, PO3, PSO1)
2. To Develop scalable data processing solutions using Apache Spark, including RDD transformations, actions, Spark SQL, and data preprocessing techniques. (PO1, PO2, PO3, PO5, PSO1, PSO2)
3. To Design real-time analytics and machine learning applications using Spark Streaming and advanced algorithms such as recommendation systems and anomaly detection. (PO1, PO2, PO3, PO4, PO5, PSO1, PSO2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1
Lab Test-II	10	CO2, CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

Machine Learning Laboratory	
Course Code: CIL57	Credits: 0:0:1
Prerequisite: Nil	Contact Hours: 15P
Course Coordinator: Dr. A N Ramya Shree	

Course Contents

1. Develop a Python program to perform Exploratory Data Analysis (EDA) on the California Housing dataset by generating histograms for all numerical features to understand their distributions and box plots to visually detect and analyze the presence of outliers.
2. Develop a Python program to analyze the relationships between features in the Iris dataset. Compute and visualize the correlation matrix using a heatmap to identify patterns of strong correlation.
3. Develop a Python program to apply Principal Component Analysis (PCA) on the Iris dataset to reduce its dimensionality from 4 features to 2 principal components. Visualize the result using a scatter plot, with different colors for each Iris species.
4. For a given set of training data examples implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
5. Develop a Python program to demonstrate the working of linear regression. Use the Housing dataset to predict housing prices based on available features. Train the model, and evaluate its performance using the R^2 score and RMSE metrics.
6. Develop a Python program to demonstrate the working of polynomial regression. Apply polynomial transformation to capture the non-linear relationship between the input features and the target variable. Visualize the regression curve along with the actual data points to assess model fit.
7. Develop a program to implement logistic regression for binary classification on the Titanic Data Set. Split the dataset into training and testing sets. Evaluate the model using appropriate classification metrics.
8. Write a program to implement the k-Nearest Neighbor algorithm to classify the iris data set and display both correct and wrong predictions.
9. Develop a program to demonstrate the working of the decision tree algorithm. Use the Breast Cancer Data set for building the decision tree, and apply this knowledge to classify a new sample.
10. Implement the Expectation-Maximization (EM) algorithm to perform clustering on data with hidden variables.

11. Implement and compare Simple Majority Voting Classifier, Bagging Classifier, Boosting, and Random Forest ensemble learning techniques. Evaluate their performance on a classification dataset.
12. Implement policy search using a simple reinforcement learning environment to learn optimal decision-making.

Text books:

1. Sebastian Raschka, Yuxi (Hayden) Liu and Vahid Mirjalili, Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python, Packt Publishing Limited, December 2022.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, Inc., October 2022.
3. Richard S. Sutton & Andrew G. Barto, Reinforcement Learning: An Introduction, MIT Press.

Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Analyze real-world datasets using Exploratory Data Analysis (EDA) techniques, feature correlation, and PCA dimensionality reduction. (PO-1,2,3,4,5,8,10,12, PSO-1,2,3)
2. Evaluate candidate elimination, regression, classification, and clustering fundamental machine learning algorithms. (PO-1,2,3,4,5,10,12, PSO-1,2,3)
3. Apply ensemble and reinforcement learning techniques to solve complex decision-making problems. (PO-1,2,3,4,5,8,10,12, PSO-1,2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS	
Course Code: AL58	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L + 45S
Course Coordinator: Dr. Mohana Kumar S	

Contents

Unit I

Research Methodology Introduction: Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct. Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Conceptualizing Research, Critical and Creative Reading.

Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments, and Attributions.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit II

Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis, Experimental and Control Groups, Treatments.

Experimental Designs: Introduction to Randomised Block Design, Complete Randomised Design, Latin Square Design, and Factorial Design.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit III

Method of Data Collection: Primary and Secondary Data Collection.

Sampling Design: Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design.

Data Analysis: Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors, Level of Significance. Procedure for Hypothesis Testing: Mean, Variance, Proportions. Chi-square Test, Analysis of Variance (One Way ANOVA), and Covariance (ANOCOVA)

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit IV

Intellectual Property Rights: Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. TRIPS Agreement, Patent Cooperation Treaty (PCT).

Patents: Brief history of Patents-Indian and Global Scenario, Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. Non-patentable Inventions. Rights Conferred to a Patentee, Basmati Rice Patent Case.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit V

Design: What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design.

Trademarks: Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements, Types of Reliefs, Case Studies.

Copyrights: Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights, Case studies

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Textbooks:

1. C. R Kothari, Gourav Garg, Research Methodology – Methods and Techniques. New Age International Publishers.
2. Dr. B L Wadehra – Law relating to Intellectual property. Universal Law Publishing Co.
3. Dipankar Deb, Rajeeb Dey, Valentina E. Balas —Engineering Research Methodology, ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), <https://doi.org/10.1007/978-981-13-2947-0>.

References:

1. David V. Thiel —Research Methods for Engineers Cambridge University Press, 978-1-107-03488-4

Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Possess the knowledge of research and conduct a literature review. (PO-8, PO-10, PO-12)
2. Apply the knowledge of research design and design of experiments. (PO-4, PO-8, PO 10, PO-12)
3. Analyse data collection methods, analysis, and sampling design. (PO-4, PO-8, PO-10, PO-12)
4. Understand the global and Indian scenarios of patents and patent applications. (PO-8, PO-10, PO-12)
5. Acquire the requirements of registration and infringements related to trademarks, copyrights, and designs. (PO-8, PO-10, PO-12)

DevOps	
Course Code: CIAEC59	Credits: 1:0:0:1
Prerequisite: Nil	Contact Hours: 15L+15S
Course Coordinator: Mrs. Shobha.K	

Course contents

Unit 1

Introduction: DevOps Overview and Foundations- What is DevOps, Agile Infrastructure, DevOps Culture, DevOps Engineer, DevOps Lifecycle, DevOps Pipeline, Cloud Computing, Virtualization, Cloud Providers.

- Pedagogy: chalk and Talk, Tool-Based Demonstration, Coding and Lab Hands-on Exercises
- Links: <https://nptel.ac.in/courses/106105167>

Unit 2

Build Tools: Git- Git Basics, Repository, Branching / Merging, Git Workflow. **Maven,** - Maven, POM (Project Object Model, **Gradle** -Gradle, Groovy / Kotlin DSL, Build Lifecycle, Dependency Management, Build Automation.

- Pedagogy: chalk and Talk, Tool-Based Demonstration, Coding and Lab Hands-on Exercises
- Links: <https://www.coursera.org/learn/version-control-with-git>

Unit 3

Continuous Integration with Jenkins- Introduction to Jenkins, Continuous Integration (CI) with Jenkins Pipeline, Freestyle Job ,Source Code Management, Jenkins Plugins, Build Triggers, Post-build Actions, Slave Nodes.

- Pedagogy: chalk and Talk, Tool-Based Demonstration, Coding and Lab Hands-on Exercises
- Links: <https://www.edx.org/learn/continuous-integration/ibm-continuous-integration-and-delivery-ci-cd>

Unit 4

Configuration Management using Ansible- Why Configuration Management? Ansible Architecture & Requirements, YAML, Playbooks, Modules, Variables, Handlers, Roles and Reusability, Ansible Galaxy.

- Pedagogy: chalk and Talk, Tool-Based Demonstration, Coding and Lab Hands-on Exercises
- Links: <https://www.coursera.org/learn/ansible-for-the-absolute-beginners>

Unit 5

Kubernetes - Overview, Pods, Replica Sets, Deployments, Namespaces, Services and Networking, Persistent Volumes (PV) and Persistent Volume Claims (PVC), Labels, Selectors, Jobs, and Schedulers, Capstone: Deploy and Manage a Sample App on Kubernetes Cluster **Scaling:** Understanding Scaling, Teams & Tools in DevOps.

- Pedagogy: chalk and Talk, Tool-Based Demonstration, Coding and Lab Hands-on Exercises
- Links: <https://www.edx.org/learn/kubernetes/the-linux-foundation-introduction-to-kubernetes>

Textbooks:

1. Jennifer Davis and Katherine Daniels, “Effective DevOps”, 1st Edition, Shroff /O’Reilly Publications, 2021. (ISBN-13: 978-9352133765)
2. The DevOps Adoption Playbook: A Guide to Adopting DevOps in a Multi-Speed IT Enterprise 1st Edition, by Sanjeev Sharma.

Course Outcomes(CO) :

At the end of the course, the students should be able to:

1. Understand DevOps principles, culture, and cloud infrastructure (PO 1,2,3, PSO 1,2)
2. Demonstrate version control using Git, Maven, and Gradle for managing source code. (PO 1,2,3,5,9,10, PSO 1,2)
3. Implement continuous integration workflows using Jenkins, source control integration, and distributed builds.(PO 1,2,3,5,9,10, PSO 1,2)
4. Describe the infrastructure management using Ansible playbooks. (PO 1,2,3,5,9,10, PSO 1,2)
5. Explain the concepts of Kubernetes and deployment of applications. (PO 1,2,3,5,9,10, PSO 1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Project based learning	20	20
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study Implementation		
Semester End Examination (SEE)	50	CO1, CO2, CO3 CO4, CO5

MANAGEMENT & ENTREPRENEURSHIP	
Course Code: AL61	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. M Rajesh/Dr. Siddhartha Kar	

Course Contents

Unit I

Introduction to Management: Definition of Management, Its nature and purpose, Contributions of F.W. Taylor and Henry Fayol to management theory, Functions of managers.

Planning: Types of plans, Steps in planning, the planning process, Management By Objectives (MBO)

Organizing: The nature and purpose of organizing, Formal and informal organization. Organization levels and Span of management, Principle of span of management, the structure and process of organizing

- Pedagogy: Chalk board, power point presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_mg33/preview
<https://www.digimat.in/nptel/courses/video/110107150/L01.html>

Unit II

Staffing: Situational factors affecting staffing. **Leading:** Human factors in managing, definition of leadership, Ingredients of leadership

Controlling: Basic control process, Critical control points and standards, Control as a feedback system, Feed forward control, Requirements for effective controls.

- Pedagogy: Chalk board, power point presentations
- Links: <https://nptel.ac.in/courses/110107150>

Unit III

Introduction to Entrepreneurship: The Foundations of Entrepreneurship: What is an Entrepreneurship?, The benefits of Entrepreneurship, The potential drawbacks of Entrepreneurship; Inside the Entrepreneurial Mind: **From Ideas to Reality:** Creativity, Innovation and Entrepreneurship, Creative Thinking, Barriers to Creativity

- Pedagogy: Chalk board, power point presentations
- Links: <https://www.youtube.com/watch?v=HgjkRrvbhQ&list=PL7oBzLzHZ1wXW3mtolxV5nIGn48NLKwrb>

Unit IV

The Entrepreneurial Journey: Crafting a Business Plan: The benefits of creating a business plan, The elements of a business plan; Forms of Business Ownership and Buying an Existing Business: Sole proprietorships and partnership.

- Pedagogy: Chalk board, power point presentations
- Links: <https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M8EGZbmNUuUM7Vh2GkdbB1R>

Unit V

Launching the Business: Franchising and the Entrepreneur: Types of Franchising, The benefits of buying a Franchise; E-Commerce and the Entrepreneur: Factors to consider before launching into E-commerce, Ten Myths of E-Commerce.

- Pedagogy: Chalk board, power point presentations
- Links: https://www.youtube.com/watch?v=5RMqxtMwejM&list=PLyqSpQzTE6M9zMKj_PS m81k9U8NjaVJkR

Text Books:

1. Harold Koontz, H. Weihrich, and A.R. Aryasri, Principles of Management, Tata McGraw-Hill, New Delhi, 2004.
2. Essentials of Entrepreneurship and Small Business Management – Norman Scarborough & Jeffrey Cornwall (Pearson, 2016)

References:

1. Innovation & Entrepreneurship – Peter Drucker (Harper, 2006)
2. Entrepreneurship: The Art, Science, and Process for Success – Charles Bamford & Garry Bruton (McGraw-Hill, 2015)
3. Management and Entrepreneurship-NVR Naidu, T Krishna Rao, I.K. International Publishing House Pvt. Ltd.@ 2008
4. Poornima M Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 2006.

Course Outcomes (COs):

At the end of the course, student will be able to

1. Plan and organize for the manpower in the given type of organization (PO: 6,9,11)
2. Use staffing Leading and controlling function for the given organization. (PO: 6,8,9,10)
3. Understand the fundamentals of entrepreneurship with the goal of fulfilling the requirements of the industries and holding the responsibilities towards the society. (PO-6,7,8)
4. Design a basic business plan by considering case studies and show the involvement of ownership in Business. (PO-3,7,8,11)
5. Start a new small business with the help of E-Commerce and the current available technologies. (PO-5,11)

Deep Learning and Computer Vision	
Course Code: CI62	Credits: 3:1:0:3
Prerequisite: Nil	Contact Hours: 45L+15T+45S
Course Coordinator: Dr. A N Ramya Shree	

Course content

Unit I

Digital Image Processing: Components of an Image Processing System, Sampling and Quantization, Spatial and intensity resolution, neighbors and connectivity of pixels in image, applications of image processing, Spatial Domain: Basic Gray Level Transformations.

- Pedagogy: Chalk and board, Active Learning, Problem based learning
- Link: <https://github.com/JohnMachado11/Neural-Networks-from-Scratch-in-Python>.

Unit II

Affine transformations, Basics of Spatial Filtering, Smoothing, Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Introduction to Deep Learning: Significance of weights and bias, Working of a single neuron, Working of a layer, layer implementation with NumPy, Dense layer, Sigmoid, ReLu , Tanh, and Softmax Activation Functions

- Pedagogy: Chalk and board, Active Learning, Demonstration.
- Link: <https://github.com/JohnMachado11/Neural-Networks-from-Scratch-in-Python>.

Unit III

Loss Function: Categorical cross entropy loss, Binary cross - Entropy loss and accuracy calculation. Backpropagation Algorithm, Optimizers: Stochastic Gradient Descent (SGD), Learning Rate and LR Decay, SGD with Momentum, AdaGrad, RMSProp, Adam.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: <https://github.com/JohnMachado11/Neural-Networks-from-Scratch-in-Python>.

Unit IV

Convolutional Neural Networks: Key components of CNN, The Convolution Operation, ,Convolution with and without kernel flipping ,pooling, sparse interactions, parameter sharing, equivariant representations, convolution and pooling as an infinitely strong prior, LeNet, AlexNet, and ResNet CNN Architectures

- Pedagogy: Chalk and board, Problem based learning, Demonstration
- Link: <https://www.deeplearningbook.org/>

Unit V

Recurrent Neural Networks: Unfolding Computational Graphs, Teacher Training Force, Recurrent Neural Network, Backpropagation through Time (BPTT), Bidirectional RNNs, Deep Recurrent Networks, Long Short-Term Memory, and Gated Recurrent Neural Network.

- Pedagogy: Chalk and board, MOOC
- Link: <https://www.deeplearningbook.org/>

Text Books:

1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods ,3rd Edition,Pearson Publication 2013.
2. Harrison Kinsley & Daniel Kukiela, Neural Network from scratch in Python, Kinsley Enterprises Inc., MIT license, 2020.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

References:

1. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, 2009.
2. Nikhil Buduma, —Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly publications 2022.

Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Understand the components of a digital image processing system and gray-level transformations in the spatial domain.(PO: 1, 2, 3, 4, 5, 6,8,12; PSO: 1, 2)
2. Demonstrate the working of neural network learning models and their application to real-world problem-solving.(PO: 1, 2, 3, 4, 5, 6,8,12; PSO: 1, 2)
3. Analyze the impact of different loss functions and optimization techniques on the training performance of neural networks.(PO: 1, 2, 3, 4, 5, 6, 12; PSO: 1, 2, 3)
4. Design end-to-end convolutional neural network architectures for practical image classification tasks.(PO:1,2,3,4,5,6,8,12;PSO:1,2,3)
5. Demonstrate the functioning of recurrent neural networks for sequential data analysis.(PO: 1, 2, 3, 4, 5, 6, 12; PSO: 1, 2, 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	Marks	Course outcomes attained
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
The average of two internal tests shall be taken for 30 marks		
Other components		
Tutorial Assignment-1	10	CO1, CO2,CO3
Tutorial Assignment-2	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DEEP LEARNING LABORATORY	
Course Code: CIL65	Credits: 0:0:1
Prerequisite: Nil	Contact Hours: 15P
Course Coordinator: Dr. A N Ramya Shree	

Course Contents

1. Write a Python program to convert a given color image to grayscale and then to binary using thresholding. Display the original image, grayscale image, and binary image.
2. Write a Python program to rotate and translate a given image using affine transformation. Display the original image, rotated image, translated image, and combined rotated and translated image.
3. Write a Python program to apply various image smoothing techniques on a noisy image using Gaussian Blur and Median Filter and compare the effects.
4. Implement a simple feedforward neural network to demonstrate the impact of different learning rates and activation functions.
5. Build a simple Artificial Neural Network (ANN) with configurable activation and loss functions. Train the network using activation and loss functions.
6. Implement the categorical cross-entropy loss function with both forward and backward passes and verify loss computation.
7. Use the CIFAR dataset to build a deep neural network model and analyze the effect of batch normalization and dropout.
8. Implement a simple Convolutional Neural Network (CNN) and compare the performance of any two optimizers on the given image dataset.
9. Implement LeNet-5 architecture for image classification on MNIST dataset. Train the network and analyze classification performance on image data.
10. Implement the AlexNet architecture using a deep learning framework and apply it to the given image classification task.
11. Demonstrate the concept of language modeling using RNN, which involves training a model to predict the next word in a sequence of words.
12. Implement an LSTM-based text generation model and train the model to generate text sequences.

Text Books:

1. Harrison Kinsley & Daniel Kukiela, Neural Network from scratch in Python, Kinsley Enterprises Inc, MIT license, 2020.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, —Deep Learning, MIT Press, November 2016.

Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Apply basic grayscale conversion, thresholding, affine transformations, and smoothing filters to perform image enhancement and transformation tasks. (PO: 1, 2, 3, 4, 5, 6, 8, 10 PSO: 1, 2, 3)
2. Design deep neural networks using various activation functions, loss functions, and optimization techniques to analyze and improve model performance on image datasets. (PO: 1, 2, 3, 5, 6, 8, 10; PSO: 1, 2, 3)
3. Demonstrate the use of Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) models for natural language processing tasks. (PO: 1, 2, 3, 4, 5, 10; PSO: 1, 2, 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO2, CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	50	CO1, CO2, CO3

Data Engineering Laboratory	
Course Code: CIL66	Credits: 0:0:1
Prerequisite: Nil	Contact Hours: 15P
Course Coordinator: Ms. Shrilaxmi G	

Course Content

1. Collect and ingest heterogeneous student academic data from CSV, Excel, JSON, and REST API sources using Python and Pandas. Integrate the datasets, store the processed data in a relational database, and formulate SQL queries to generate student performance reports.
2. Analyze healthcare patient dataset and assess its completeness, consistency, validity, and uniqueness. Identify and handle missing values, duplicate records, invalid values, and inconsistent formats, and generate a data-quality assessment report.
3. Develop an ETL pipeline for banking transaction data to extract, clean, transform, and load the data into a relational database. Formulate SQL queries to retrieve and analyse customer transaction information.
4. Integrate customer, purchase, customer-support, and marketing datasets using Python/Pandas and SQL. Develop a unified Customer 360 dataset and perform analytical queries to identify customer behaviour and marketing patterns.
5. Analyze sales, product, inventory, and regional datasets using SQL and Python/Pandas to identify significant business trends and performance indicators. Develop an interactive dashboard for data-driven decision-making.
6. Collect and analyze temperature, pressure, vibration, and humidity data from IoT-enabled manufacturing systems. Examine the statistical distributions using descriptive statistics and histograms, apply normalization/standardization techniques, and detect anomalous observations using IQR and Z-score methods.
7. Perform hypothesis testing and A/B testing on control and treatment datasets from an educational technology platform to determine whether a new learning interface produces a statistically significant improvement in student engagement and course completion rates.
8. Apply one-way ANOVA and Chi-Square tests to student academic data to determine significant differences in performance across teaching methods and associations between attendance and performance categories. Interpret the statistical results.
9. Perform feature engineering and data pre-processing on customer demographic, subscription, usage, and billing data for customer churn prediction. Handle missing and inconsistent data, encode categorical attributes, address class imbalance, and prepare training and testing datasets for machine learning.
10. Develop a real-time data processing pipeline for IoT-enabled traffic sensor data containing vehicle speed, traffic volume, location, and timestamp information. Process the streaming data to identify congestion patterns and abnormal traffic conditions and generate analytical summaries.

Text Books:

1. Joe Reis and Matt Housley, *Fundamentals of Data Engineering: Plan and Build Robust Data Systems*, O'Reilly Media, 2022.
2. Wes McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter*, 3rd Edition, O'Reilly Media, 2022.
3. Peter Bruce, Andrew Bruce, and Peter Gedeck, *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python*, 2nd Edition, O'Reilly Media, 2020.

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Collect, ingest, clean, transform, and integrate heterogeneous datasets using Python, Pandas, REST APIs, SQL, and relational database systems. PO (1, 2, 4, 5) PSO (1, 2)
2. Apply data-quality assessment, statistical analysis, hypothesis testing, visualization, and feature engineering techniques to derive meaningful insights and prepare data for analytical and machine learning applications. PO (1, 2, 3, 4, 5, 9, 10) PSO (1, 2)
3. Develop and demonstrate ETL, batch, and basic real-time data processing pipelines using databases and modern data engineering tools for real-world applications. PO (1, 2, 3, 4, 5, 9, 10, 12) PSO (1, 2)

Web References:

NPTEL course lecture links: https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs69

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation + Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)	100	CO1, CO2, CO3

PRINCIPLES OF CRYPTOGRAPHY	
Course Code: CIE631	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Ms. Pallavi TP	

Course content

Unit I

Introduction: Security Goals, Attacks, Services and Mechanism, Techniques. **Mathematics of Cryptography:** Integer Arithmetic, Modular Arithmetic, Matrices, Linear Congruence.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Link: <https://csrc.nist.gov/projects/cryptographic-standards-and-guidelines/example-values?>

Unit II

Traditional Symmetric-Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers. **Data Encryption Standard (DES):** Introduction, DES Structure, DES Analysis, Multiple DES, Security of DES.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Link: <https://csrc.nist.gov/projects/cryptographic-standards-and-guidelines/example-values?>

Unit III

Advanced Encryption Standard: Introduction, Transformations, Key Expansion, The AES Ciphers, Examples, Analysis of AES. **Asymmetric Key Cryptography:** Introduction, RSA Cryptosystem, Rabin Cryptosystem, Elgamal Cryptosystem.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Link: <https://csrc.nist.gov/pubs/fips/197/>

Unit IV

Message authentication: Message Authentication Requirements, Message Authentication Functions, requirement for Message Authentication Codes. **Digital signatures:** Digital Signatures, NIST Digital Signature Algorithm. **Public Key distribution:** Distribution of public keys, X.509 certificates.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Link: <https://csrc.nist.gov/projects/cryptographic-standards-and-guidelines/example-values?>

Unit V

User Authentication: Kerberos. **Transport Level security:** Web Security Considerations, Secure Sockets Layer, Transport level Security, HTTPS. **Electronic Mail security:** S/MIME, Pretty Good Privacy.

- Pedagogy: Lecture PPTs, Chalk and Talk
- Link: <https://csrc.nist.gov/pubs/sp/800/52/r2/>

Text Books:

5. Behrouz A. Forouzan, Debdeep Mukhopadhyay: Cryptography and Network Security, 2nd Edition, Special Indian Edition, Tata McGraw-Hill, 2011.
6. William Stallings, Cryptography and Network Security, Fifth Edition, Prentice Hall of India, 2009

References:

- Bernard Menezes: Cryptography, Network Security and Cyber Laws , Cengage Learning, First edition, 2018.
- Atul Kahate: Cryptography and Network Security”, 4th Edition, Tata McGraw Hill, 2019.
- William Stallings: Network Security Essentials: Applications and Standards by, 6th edition, Pearson Education, 2018.

Course Outcomes (COs):

At the end of the course, the students should be able to:

- Identify security goals, attacks, services and mechanism techniques. (PO-1,2,3, PSO-1,2).
- Apply Symmetric Cryptographic techniques depending on the need and security threat perception (PO- 1,2,3,5, PSO-1,2).
- Illustrate the Symmetric and Asymmetric algorithms. (PO-1,2,3,5, PSO-2).
- Describe the fundamentals of Key Management and Distribution (PO- 1,2,3, PSO-1,2).
- Discuss the need for authentication and protocols at the Transport and application layer. (PO- 1,2,3, PSO-1,2).

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Assignment 1	10	CO1, CO2, CO3
Assignment 2	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DATA STORAGE TECHNIQUES	
Course Code: CIE632	Credits: 3:0:0:3
Pre – requisites: Nil	Contact Hours: 45L+45S
Course Coordinator: Mrs.Akshatha G C	

Course Contents

Unit I

Introduction to Information Storage: Digital data and its types, Information storage, Key characteristics of data center and Evolution of computing platforms. Information Lifecycle Management.

Third Platform Technologies: Cloud computing and its essential characteristics, Cloud services and cloud deployment models, Big data analytics, Social networking and mobile computing, Characteristics of third platform infrastructure and Imperatives for third platform transformation.

Data Center Environment: Building blocks of a data center, Compute systems and compute virtualization and Software-defined data center.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106108058>

Unit II

Intelligent storage systems and RAID: Components of an intelligent storage system, Components, addressing, and performance of hard disk drives and solid-state drives, RAID, Types of intelligent storage systems, Scale-up and scale-out storage Architecture.

Block-Based Storage System, File-Based Storage System, Object-Based and Unified Storage.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106108058>

Unit III

Fibre Channel SAN: Software-defined networking, FC SAN components and architecture, FC SAN topologies, link aggregation, and zoning, Virtualization in FC SAN environment. Internet Protocol SAN: iSCSI protocol, network components, and connectivity, Link aggregation, switch aggregation, and VLAN, FCIP protocol, connectivity, and configuration. Fibre Channel over Ethernet SAN: Components of FCoE SAN, FCoE SAN connectivity, Converged Enhanced Ethernet, FCoE architecture.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106108058>

Unit IV

Backup archive and replication: Introduction to Business Continuity, Backup architecture, Backup targets and methods, Data deduplication, Cloud-based and mobile device backup,

Data archive, Uses of replication and its characteristics, Compute based, storage-based, and network-based replication, Data migration, Disaster Recovery as a Service (DRaaS).

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106108058>

Unit V

Secure storage Infrastructure: Information security goals, Storage security domains, Threats to a storage infrastructure, Security controls to protect a storage infrastructure, Governance, risk, and compliance, Storage infrastructure management functions, Storage infrastructure management processes.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://nptel.ac.in/courses/106108058>

Text Books:

1. EMC Corporation, Information Storage and Management, Wiley, India

Reference Books:

1. Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel and Libor Miklas, Introduction to Storage Area Networks, Ninth Edition, IBM - Redbooks, December 2017
2. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Hausteine, Storage Networks Explained, Second Edition, Wiley, 2009

COURSE OUTCOMES:

1. To Explain the fundamentals of information storage management and distinguish various models of cloud infrastructure services and deployment. (PO1,2,3,5 PSO-2)
2. To Apply advanced intelligent storage system concepts and RAID techniques to address storage management requirements. (PO-1,2,3,4,5 PSO-2).
3. To Design storage networking architectures, including SAN and associated storage subsystems, using virtualization technologies. (PO1,2,3,4,5 PSO-2).
4. To Describe disaster recovery and remote replication technologies for effective information storage management. (PO1,2,3,5,6 PSO-2)
5. To Analyze security requirements and recommend appropriate security measures for information storage management. (PO1,2,3,5,6 PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case study based assignments	10	CO1, CO2, CO3
	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

CLOUD COMPUTING	
Course Code: CIE633	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L + 45S
Course Coordinator: Dr. Siddesh G M	

Course Contents

Unit I

Introduction: Network centric computing and network centric content, Peer-to-peer systems, Cloud Computing, Cloud Computing delivery models & Services, Ethical issues, Cloud vulnerabilities, Challenges. Cloud Infrastructure: Amazon, Google, Azure & online services, open source private clouds. Storage diversity and vendor lock-in, intercloud, Energy use & ecological impact of data centers, service level and compliance level agreement, Responsibility sharing, user experience, Software licensing.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs14

Unit II

Cloud Computing: Applications & Paradigms, Challenges, existing and new application opportunities, Architectural styles of cloud applications, Workflows: Coordination of multiple activities, Coordination based on a state machine model – the ZooKeeper, The MapReduce programming model, A case study: the GrepTheWeb application, Clouds for science and engineering, High performance computing on a cloud, cloud computing for biological research, Social computing, digital content, and cloud computing.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs14

Unit III

Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual machines, Performance and security isolation, Full virtualization and paravirtualization, Hardware support for virtualization, **Case study:** Xen -a VMM based on paravirtualization, Optimization of network virtualization in Xen 2.0, vBlades - paravirtualization targeting a x86-64 Itanium processor, A performance comparison of virtual machines, The darker side of virtualization, Software fault isolation.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs14

Unit IV

Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Applications of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based web services, Resource bundling, combinatorial auctions for cloud resources, Scheduling algorithms for 60 computing clouds, fair queuing, Start time fair queuing, Cloud scheduling.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs14

Unit V

Storage systems: Storage models, file systems, databases, DFS, General parallel File system, GFS, Apache Hadoop, Locks & Chubby, TPS & NOSQL databases, Bigdata, Mega store.
Cloud security: Risks, Security, privacy and privacy impacts assessments, Trust, VM Security, Security of virtualization, Security risks in shared images.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs14

Text Books:

1. Dan Marinescu, Cloud Computing: Theory and Practice, 1st edition, MK Publishers, 2013

References:

1. Kai Hwang, Jack Dongarra, Geoffrey Fox, Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, 1st edition, MK Publishers, 2012.
2. Anthony T. Velte, Toby J. Velete, Robert Elsenpeter, Cloud Computing: A Practical Approach, Tata McGraw Hill, 2010.

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Apply the concepts of cloud delivery models and services. (PO 1,2,3,5,7,9,10,12 PSO 2,3)
2. Build various cloud-based applications. (PO 1,2,3,5,7,9,10,12 PSO-2,3)
3. Illustrate different cloud resource virtualization strategies with case studies. (PO 1,7 PSO 2,3) 4. Describe cloud resource management and scheduling policies (PO 1 ,7 PSO 2,3)
5. Create cloud instances by applying storage models and security aspects. (PO 1,2,3,5,7,9,10,12 PSO 2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II (CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO2, CO3, CO4
Assignment	10	CO1, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

AUGUMENTED AND VIRTUAL REALITY	
Course Code: CIE634	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Nithya N	

Course Contents

Unit I

Introduction to Virtual Reality(VR): Basic Definitions and Terminology VR, History, Types of Virtual Reality, Virtual Reality Development, Types of VR Systems And Hardware, Components of VR Systems, VR Software And Tools, Virtual Reality Interfaces and Systems, Tracking Systems, Critical Aspects of Visually Coupled Systems, Comparing Immersive and Non-Immersive Virtual Reality User Interfaces.

Textbook 1: Chapter 1, 2.

- Pedagogy: Interactive Lecture on Chalk and Talk
- Links: <https://nptel.ac.in/courses/106106138>

Unit II

Geometry of Virtual Worlds: Geometric Models, Changing Position and Orientation, Tracking: Tracking 2D Orientation, Tracking 3D Orientation, Interaction: Locomotion, Locomotion implementation, Manipulation. Physics of Sound.

Textbook 2: Chapter 3, 9, 10, 11

- Pedagogy: PPT for Core concepts.
- Links: <https://nptel.ac.in/courses/106106138>

Unit III

Design of VR Projects: Exploring the Current State of Virtual Reality: Focusing on Features, Considering Controllers, Recognizing the Current Issues with VR, Planning Your Virtual Reality Project, Exploring Design Principles in Virtual Reality, Exploring Virtual Reality Use Cases.

Textbook 3: Chapter 2,7,10

- Pedagogy: Virtual tool based Demonstration.
- Links: <https://www.simlab-soft.com/technologies/simlab-showroom.aspx>

Unit IV

Tracking & Fundamentals of Augmented Reality (AR): Stereoscopic Vision And The Stereoscopic Displays, Head And Eye Tracking, Hand And Gesture Tracking, Introduction To AR: Basic Definitions, Components of AR, AR Devices, Augmented Reality Vs. Virtual Reality and Its Difference, Application of AR, Advantages of Augmented Reality, Disadvantage of Augmented Reality, And Binaural Audio for Virtual And Augmented Reality, Haptic Technology: Feedback.

Textbook 2: Chapter 4, 6, Textbook 3: Chapter 3.

- Pedagogy: Project based learning.
- Links: <https://www.simlab-soft.com/technologies/simlab-showroom.aspx>

Unit V

Design of AR Projects: Exploring the Current State of AR, Focusing on Features, Considering Controllers, Recognizing the Current Issues with AR, Planning Your AR Project, Exploring Design Principles in AR, Exploring AR Use Cases.

Textbook 3: Chapter 8, 11.

- Pedagogy: Project based learning
- Link: <https://docs.unity3d.com/6000.5/Documentation/Manual/AROverview.html>

Textbooks:

1. Alvin Albuerro De Luna, Introduction to Virtual Reality, Arcler Press, 2022.
2. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
3. Paul Mealy, Virtual & Augmented Reality, For Dummies, John Wiley & Sons, Inc, 2018.
4. Virtual Reality Technology, Second Edition, Gregory C. Burdea & Philippe Coiffet, John Wiley & Sons, Inc, 2017.
5. K.S. Hale and K. M. Stanney, Handbook on Virtual Environments, 2nd Edition, CRC Press, 2015.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Describe the concept of virtual reality and Interfaces. (PO- 1,2,3 ,PSO- 1, 2)
2. Understand Geometry of virtual environment and modeling objects. (PO- 1,2,3,,PSO- 1, 2)
3. Understand design principles of VR and Issues. (PO- 2,3,4, PSO- 2,3).
4. Describe the concept of augmented reality and Applications. (PO- 1,2,3,4 ,PSO- 1,2)
5. Develop Augmented Reality products. (PO- 1,2,3,4,5, PSO- 1,2,3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case Study	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Quantum Computing	
Course Code: CIE635	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Anjaneyulu Pasala/ Ms. Veena S	

Course Contents

UNIT I

Fundamentals of Quantum Computing: Overview of Quantum vs. Classical Computing, Basic Concepts in Quantum Mechanics: Superposition, Entanglement, Measurement, Qubits and the Bloch Sphere. Introduction to Quantum Gates: Pauli Gates, Hadamard Gate, Phase Shift, and CNOT, Quantum Circuit Design and Simulation.

- Pedagogy: Interactive Lectures and Classroom Discussions
- Link: <https://quantum.cloud.ibm.com/docs/en/guides>

UNIT II

Quantum Algorithms: Key Quantum Algorithms and Their Relevance: Deutsch-Jozsa Algorithm for Testing Quantum Speedup, Grover's Algorithm for Quantum Search, Shor's Algorithm for Factoring and Cryptography. Quantum Fourier Transform (QFT), Simon's algorithm.

- Pedagogy: Concepts based learning through PPTs and tool based demonstration
- Link: <https://quantum.cloud.ibm.com/composer>

UNIT III

Quantum Error Correction and Cryptography: Types of quantum errors and noise, Shor and Steane error-correcting codes, BB84 protocol and quantum key distribution, Security advantages of quantum cryptography.

- Pedagogy: Simulation ,Case Study, Demo and Student Presentation
- Link: <https://quantum.cloud.ibm.com/docs/en/guides/simulate-with-qiskit-aer>

UNIT IV

Quantum Information Theory and Applications: Von Neumann entropy, Fidelity and quantum mutual information, Quantum teleportation and dense coding, Real-world applications.

- Pedagogy: Simulation ,Case Study, Demo and Student Presentation
- Link: <https://quantum.cloud.ibm.com/docs/en/guides/simulate-with-qiskit-aer>

UNIT V

Programming a quantum computer: The IBM Qiskit/Qniverse/Cirq, Coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis.

- Pedagogy: Simulation ,Case Study, Demo and Student Presentation
- Link: https://www.nist.gov/pqcrypto?utm_source=chatgpt.com

Text Books:

1. Quantum Computation and Quantum Information, M. A. Nielsen & I. Chuang, Cambridge University Press (2013).
2. Quantum Computing: A beginners Introduction, Parag K. Lala, McGraw Hill; First Edition, 2020.

References:

1. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Cambridge, 2020.
2. Phillip Kaye, Raymond Laflamme et. al., An introduction to Quantum Computing, Oxford University press, 2007.
3. David McMahon-Quantum Computing Explained-Wiley-Interscience , IEEE Computer Society (2008).
4. Quantum Computing, A Gentle Introduction , Eleanor G. Rieffel and Wolfgang H. Polak MIT press(2014)

Course Outcome:

At the end of the course student will be able to:

1. Construct and analyze quantum circuits using basic and composite quantum gates. (PO-1,2,3,6,7; PSO:1,2)
2. Analyze Entanglement and Quantum Algorithms (PO-1,2, PSO-1,2)
3. Evaluate Quantum Error Correction and Cryptography Techniques (PO-3,4,5,PSO- 2,3)
4. Explore Quantum Information Theory and Applications (PO-5,9,10, PSO-1,2,3)
5. Design, implement, and analyze basic quantum programs using IBM Quantum Experience (IBMQiskit) or Qniverse and quantum simulators, including measurement and quantum state analysis.(PO-1,2,4,5-PSO-1,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	Marks	Course Outcomes (COs) addressed
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE shall be taken for 30 marks		
Other Components		
Case study	10	CO1, CO2, CO3
Assignment	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Case Study +Marks scored in Assignment		
Semester End Examination (SEE)	100	CO1, CO2, CO3 CO4, CO5

NATURAL LANGUAGE PROCESSING	
Course Code: CIE641	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L +45S
Course Coordinator: Dr. Naveen N C	

Course content

Unit I

Introduction: What is Natural Language Processing? Origins of NLP, Language and Knowledge, The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications, **Language Modelling:** Statistical Language Model - N-gram model (unigram, bigram), Regular Expressions and Automata; Morphological Parsing, POS Tagging

- Pedagogy: Chalk and board, Problem based learning, Interactive Demo
- Link: <https://nptel.ac.in/courses/106101007>

Unit II

Syntactic Analysis: Context-Free Grammar, Constituency, Top-down and Bottom-up Parsing, CYK Parsing.

Semantic Analysis: Meaning representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation

- Pedagogy: Chalk and board, Problem based learning, Interactive Demo
- Link: <https://nptel.ac.in/courses/106101007>

Unit III

Features and Unification: Feature Structures, Unification of Feature Structures, Features Structures in the Grammar, Implementing Unification, Parsing with Unification Constraints.

Lexicalized and Probabilistic Parsing: Probabilistic Context-Free Grammars, Problems with PCFGs.

- Pedagogy: Chalk and board, Problem based learning, Interactive Demo
- Link: <https://nptel.ac.in/courses/106101007>

Unit IV

Discourse Processing: Cohesion, Reference Resolution, Discourse Coherence and Structure

Natural Language Generation: Architectures, Generation tasks, Applications

- Pedagogy: Chalk and board, Problem based learning, Interactive Demo
- Link: <https://nptel.ac.in/courses/106101007>

Unit V

Machine Translation: Problems, Characteristics, Direct Machine Translation (DMT), Rule-Based MT (RBMT), Corpus-Based MT (CBMT), Translation involving Indian languages

- Pedagogy: Chalk and board, Problem based learning, Tools and Demo
- Link: <https://nptel.ac.in/courses/106101007>

Text Books:

1. Tanveer Siddiqui, U.S. Tiwari, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.

Daniel Jurafsky and James H Martin, —Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Prentice Hall, 2nd Edition, 2008.

Reference Book:

1. Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta & Harshit Surana ,1st Edition, 2020, O'Reilly, ISBN: 978-1-492-05405-4
2. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, O'Reilly Media, June 2009, ISBN :9780596516499

Course Outcomes (COs):

At the end of the course, the students should be able to:

2. Understand the concepts of Natural Language Processing, statistical language modeling techniques for text analysis. (PO- 1,2,5, PSO-1,2)
3. Analyze and construct syntactic structures using context-free grammars. (PO-1,2,3, PSO-1,2)
4. Describe feature structure, unification mechanisms and probabilistic parsing techniques. (PO-1,2,3,5, PSO-1,2)
5. Discuss discourse-level phenomena and design of Natural Language Generation systems. (PO-1,2,3,PSO-1,2)
6. Understand the challenges in machine translation with emphasis on Indian languages (PO- 1,2,3, PSO-1,2).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	Marks	Course outcomes attained
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
The average of two internal tests shall be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2
Case Study	10	CO2,CO3, CO4,CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Data Management for Machine Learning	
Course Code: CIE642	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Siddesh G M/ Mr. Subash N	

Course Contents Unit I

Introduction to Data Engineering: What Is Data Engineering? Data Engineering Defined the Data Engineering Lifecycle Evolution of the Data Engineer Data Engineering and Data as Liability the Data Sensitivity of ML Pipelines Phases of Data Creation Ingestion Processing Storage Management Analysis and Visualization Data Reliability Durability Consistency Version Control Performance Availability, Data Integrity, Security, Privacy, Policy and Compliance

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation.
- Links:<https://www.coursera.org/learn/introduction-to-data-engineering?specialization=ibm-data-engineer>

Unit II

Introduction to Queries and Data Modelling: What Is a Query? The Life of a Query the Query Optimizer Improving Query Performance Queries on Streaming Data What Is a Data Model? Conceptual, Logical, and Physical Data Models Normalization.

- Pedagogy: Chalk and board, Power point presentations.
- Links:<https://www.coursera.org/learn/introduction-to-data-engineering?specialization=ibm-data-engineer>

Unit III

Data Management Principle: Science Data Engineering Skills and Activities Principles of Good Data Architecture Major Architecture Concepts Examples and Types of Data Architecture Roles Involved in Designing Data Architecture.

- Pedagogy: Chalk and board, Power point presentations.
- Links:<https://www.coursera.org/learn/introduction-to-data-engineering?specialization=ibm-data-engineer>

Unit IV

Modern Data Architecture Approaches: Modern Data Stack, Lambda Architecture, Kappa Architecture, The Dataflow Model and Unified Batch and Streaming, Architecture for IoT, Data Mesh, Other Data Architecture Examples, **Data Storage:** Data Storage Systems, Data Organization and Optimization, Modern Storage Architectures, Data Catalogue, Data Sharing, Schema and Metadata.

- Pedagogy: Chalk and board, Power point presentations
- Links:<https://www.coursera.org/learn/introduction-to-data-engineering?specialization=ibm-data-engineer>

Unit V

Model Evaluation, and Ethical ML Systems: Feature and Training Data, Feature Selection and Engineering, Human-Generated Labels, Annotation Workforces, Measuring Human Annotation Quality, Active Learning and AI-Assisted Labelling, Metadata and types, Data Privacy and Fairness, Evaluating Model Validity and Quality Fairness, Privacy, and Ethical ML Systems

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint Presentation
- Links: <https://www.coursera.org/learn/introduction-to-data-engineering?specialization=ibm-data-engineer>

Text Books:

1. Fundamentals of Data Engineering: Plan and Build Robust Data Systems by Reis and Housley
2. Reliable Machine Learning by Cathy Chen, Niall Richard Murphy, Kranti Parisa, D. Sculley, Todd Underwood

Course Outcomes (COs):

At the end of the course the student will be able to:

2. Understand core concepts of Data Engineering, including lifecycle, ingestion, processing, storage, and management. (PO- 1,2,5, PSO-1,2)
3. Analyze and apply querying and data modeling techniques for efficient data model design and query optimization. (PO-1,2,3, PSO-1,2)
4. Describe data management principles and data architecture design for scalable data systems. (PO-1,2,3,5, PSO-1,2)
5. Discuss modern data architectures and storage systems, including batch, streaming, and metadata management. (PO- 1,2,3, PSO-1,2)
6. Understand model evaluation and ethical issues in data-driven and ML systems. (PO-1,2,3, PSO-1,2).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case Study	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

BIOINFOMATICS	
Course Code: CIE643	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. Nayana G.Bhat	

Course content

Unit I

Introduction to Bioinformatics: Definition, scope, history, interdisciplinary nature, applications in medicine, agriculture, environment, industry. Molecular Biology Basics for Bioinformatics - Central Dogma of Molecular Biology (DNA, RNA, Protein), Structure and function of DNA, RNA, and Proteins, Genes, genomes, chromosomes, transcription, translation, gene regulation.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_bt06

Unit II

Biological Databases: Types of databases: Primary, Secondary, Composite, Specialized, Nucleotide Databases: NCBI GenBank, EMBL, DDBJ, Protein Databases: UniProt (Swiss-Prot, TrEMBL), PIR, PDB, Specialized Databases: OMIM, KEGG, GO, PFAM, PROSITE, Database retrieval and navigation (Entrez, SRS), Data formats: FASTA, GenBank, PDB, GFF, Sequence Alignment: Concept of homology, similarity, and identity, Pairwise sequence alignment: Global (Needleman-Wunsch algorithm) and Local (Smith-Waterman algorithm), Scoring matrices: PAM, BLOSUM, Gaps and gap penalties,

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_bt06

Unit III

Heuristic Database Searching: BLAST (Basic Local Alignment Search Tool): BLASTN, BLASTP, BLASTX, TBLASTN, TBLASTX, FASTA algorithm, Interpreting E-values, bit scores, and alignment statistics, Multiple Sequence Alignment (MSA): Need and importance of MSA, Progressive alignment methods (ClustalW, T-Coffee), Applications of MSA (conserved regions, phylogenetic analysis). Protein Structure Basics: Primary, Secondary, Tertiary, Quaternary structures, Protein Structure Prediction Methods: Homology modeling (comparative modeling), Fold recognition (threading), Ab-initio prediction, Secondary structure prediction (e.g., Chou-Fasman, GOR).

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_bt06

Unit IV

Protein Structure Visualization and Analysis: Tools for visualization (PyMOL, RasMol, Chimera), Ramachandran plots, Protein-protein interactions, protein-ligand interactions, Molecular Phylogenetics: Concept of evolution, phylogenetic trees, dendrograms, Types of trees: rooted, unrooted, bifurcating, multifurcating, Homology vs. Analogy, Tree Construction Methods: Distance-based methods: UPGMA, Neighbor-Joining, **Applications of Phylogenetics:** Tracing evolutionary history, disease outbreak analysis, species identification.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_bt06

Unit V

Genomics: Genome sequencing projects (Human Genome Project), Genome annotation: gene prediction, functional annotation, Comparative genomics, Transcriptomics: Gene expression analysis: Microarray data analysis (basic concepts), RNA-Seq data analysis (introduction, differential expression analysis), Proteomics: Introduction to mass spectrometry in proteomics, Protein identification and quantification, Systems Biology: Introduction to biological networks (protein-protein interaction networks, metabolic pathways), Pathway analysis (KEGG, Reactome).

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc21_bt06

Text Book:

- T K Attwood, D J Parry Smith, Introduction to Bioinformatics, Pearson Education, 2004.
- Dan E. Krane, Michael L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2008.

Reference Books:

9. Essential Bioinformatics by Jin Xiong, Texas A&M University, Cambridge University Press, 2006
10. Gary B. Fogel, David W. Corne, Evolutionary Computation in Bioinformatics, Morgan Kaufmann Publishers.

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain the central dogma of molecular biology and its implications for bioinformatics data types. (PO 1,2,3, PSO 1,2,3)
2. Analyze biological sequences and structures for the given biological databases. (PO 1,2,3,4,5,9, PSO 1,2,3)
3. Implement sequence alignment using algorithms to interpret the results for evolutionary and functional insights. (PO 1, 2,3,4,5,9, PSO 1,2,3)
4. Analyze protein structures, functional domains, and interactions using computational tools and visualization software. (PO 1, 2,3,4,5,6,8,9, PSO 1,2,3)
5. Analyze gene expression data to identify differentially expressed genes and pathways. (PO 1, 2,3,4,5,6,8,9, PSO 1,2,3)
6. **Course Assessment and Evaluation:**

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case Study	10	CO1, CO2, CO3
Assignment	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Pattern Recognition	
Course Code: CIE644	Credits:3:0:0:3
Prerequisites: Nil	ContactHours:45L+45S
Course Coordinator: Mr. Chetan Sharma	

Course Contents:

Unit I

Fundamental concepts and blocks of a typical pattern recognition system. Decision functions- role and types, pattern and weight space, properties and implementation of decision functions.

- Pedagogy: Interactive Lecture. Core concepts and theoretical concepts PPT.
- Link: <https://nptel.ac.in/courses/117105101>

Unit II

Feature identification, selection and extraction. Distance measures, clustering transformation and feature ordering, clustering in feature selection, feature selection through maximization and approximations.

- Pedagogy: Interactive Lecture, Core concepts and theoretical concepts PPT.
- Link: <https://nptel.ac.in/courses/117105101>

Unit III

Pattern classification by distance functions. Clusters and cluster seeking algorithms. Pattern classification by likelihood functions. Baye's classifier and performance measures.

- Pedagogy: Interactive Lecture, Core concepts and theoretical concepts PPT.
- Link: https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed142

Unit IV

Artificial neural network model, Neural network-based pattern associators, Feed forward networks and training by back-propagation- ART networks.

- Pedagogy: Interactive Lecture, Core concepts and theoretical concepts PPT.
- Link: https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed142

Unit V

Applications of statistical and neural network – based pattern classifiers in speech recognition, image recognition and target recognition.

- Pedagogy: Case Study, Demo and Presentation.
- Link: https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed142

Text Books:

1. J.I. Tou & R.C. Gonzalez, Pattern Recognition Principles, Addison-Wesley.
2. R. Schalkoff, Pattern Recognition - Statistical, Structural and Neural Approaches, John Wiley, 1992.

Reference Books:

1. P.A. Devijer & J. Kittler, Pattern Recognition - A Statistical Approach, Prentice-Hall.
2. Christopher. M. Bishop, 'Pattern recognition and machine learning, Springer, 2006.

Course Outcomes:

On the successful completion of this course students are able

1. Summarize the various techniques involved in pattern recognition
2. Categorize the various pattern recognition techniques into supervised and unsupervised.
3. Illustrate the artificial neural network based pattern recognition
4. Discuss the applications of pattern recognition in various applications
5. Understand statistical and neural network applications

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case Study	10	CO1, CO2, CO3
Assignment	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Federated Learning	
Course Code: CIE645	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: Dr. A N Ramya Shree	

Course Contents

Unit I

Fundamentals of Federated Learning: Introduction, Definition of Federated Learning, Categories of Federated Learning, Privacy-Preserving Machine Learning: PPML and Secure ML, Threat and Security Models, Secure Multi-Party Computation (MPC), Homomorphic Encryption.

- Pedagogy: Lectures PPTs, Core concepts and theoretical concepts , PPT and Demonstration.
- Links: <https://link.springer.com/book/10.1007/978-3-030-96896-0>

Unit-II

Distributed Machine Learning and Privacy: Introduction to DML, Scalability Motivated DML, Privacy-Motivated Differential Machine Learning, Differential Privacy, Privacy-Preserving Gradient Descent: Vanilla FL and Privacy-Preserving Methods

- Pedagogy: Lectures PPTs , Core concepts and theoretical concepts , PPT and Demonstration.
- Links:https://github.com/Gharibim/federated_learning_course/tree/main/Federated_Learning_with_Differential_Privacy

Unit III

Types of Federated Learning: Horizontal Federated Learning: Introduction, Architecture of HFL, Federated Averaging (FedAvg) Algorithm, Secured Federated Averaging Algorithm, Improvement of FedAvg Algorithm, and Challenges. **Vertical Federated Learning:** Introduction, Architecture of VFL, Secure Federated Linear Regression, Secure Federated Tree Boosting, and Challenges.

- Pedagogy: Lectures PPTs , Core concepts and theoretical concepts , PPT and Demonstration.
- Links: https://github.com/Gharibim/federated_learning_course/blob/main/Federated_Learning_techniques/FedAvg.ipynb

Unit IV

Federated learning for Transfer Learning and AI Applications: Federated Transfer Learning: Introduction and FTL Framework, Federated Learning for Computer Vision: Introduction, Federated Computer Vision and the workflow of federated object detection algorithm, Federated Learning for Natural Language Processing: Introduction, Federated NLP and Challenges, Federated Recommendation: Introduction, Federated Recommendation System and Challenges.

- Pedagogy: Lectures PPTs , Core concepts and theoretical concepts , PPT and Demonstration.
- Links: <https://link.springer.com/book/10.1007/978-3-030-96896-0>

Unit V

Federated Reinforcement Learning and Applications of FL: Introduction to Reinforcement Learning and Federated Reinforcement Learning, Horizontal Federated Reinforcement Learning, Vertical Federated Reinforcement Learning, Applications of FL in Finance, Healthcare, Education, Urban Computing and Smart Cities, Edge Computing and IOT, Blockchain, and 5G Networks.

- Pedagogy: Lectures PPTs , Core concepts and theoretical concepts , PPT and Demonstration.
- Links: <https://www.sciencedirect.com/book/edited-volume/9780443190377/federated-learning>

Text Books:

1. Qiang Yang , Yang Liu , Yong Cheng , Yan Kang ,Tianjian Chen and Han Yu, Federated Learning Springer Publications ,2022.
2. Heiko Ludwig and Nathalie Baracaldo, Federated Learning: A Comprehensive Overview of Methods and Applications,2022.

References:

1. Yaochu Jin , Hangyu Zhu , Jinjin Xu, Yang Chen , Federated Learning: Fundamentals and Advances- Machine Learning: Foundations, Methodologies, and Applications, Springer Publications,2023.
2. Lam M. Nguyen, Trong Nghia Hoang, Pin-Yu Chen, Federated Learning Theory and Practice, Elsevier and Academic Press,2024

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Discuss the fundamentals, categories, privacy-preserving techniques, threat models, Secure Multi-Party Computation, and Homomorphic Encryption in Federated Learning. (PO: 1, 2, 5, 6, 8, 12, PSO: 1,2, 3).
2. Apply distributed machine learning and privacy-preserving techniques, including Differential Privacy and privacy-preserving gradient descent, for secure collaborative learning. (PO: 1,2, 5, 6, 8, 12, PSO: 1, 2, 3)
3. Implement Horizontal and Vertical Federated Learning algorithms, including FedAvg, Secure Federated Averaging, Secure Federated Linear Regression, and Secure Federated Tree Boosting (PO: 1, 2, 3, 4, 5, 8, 12, PSO: 1, 2, 3)
4. Apply Federated Learning and Federated Transfer Learning techniques to computer vision, natural language processing, object detection, and recommendation systems. (PO: 1, 2, 3, 4, 5, 6, 8, ,12, PSO: 1, 2, 3)
5. Analyze Federated Reinforcement Learning approaches and the applications of Federated Learning in finance, healthcare, education, smart cities, Edge/IoT, blockchain, and 5G networks. (PO: 1, 2, 3, 4, 5, 6, 8,12, PSO: PSO: 1, 2, 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation: 50 Marks		
Assessment Tool	Marks	Course outcomes addressed
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Case Study	10	CO1, CO2, CO3
Assignment	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

INSTITUTIONAL OPEN ELECTIVE – 1	
Course Code: CIOE0x*	Credits: 3:0:0:3
Prerequisite: Nil	Contact Hours: 45L+45S
Course Coordinator: -	

Institutional Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent department. However, they can take an elective offered by other departments, provided they satisfy the prerequisite condition, if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

1. The candidate has studied the same course during the previous semesters of the program.
2. The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
3. A similar course, under any category, is prescribed in the higher semesters of the program.
4. The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

MINI PROJECT	
Course Code: CIP67	Credits: 0:0:4
Prerequisite: Nil	Contact Hours: -
Course Coordinator: Internal Guide	

Course Contents

Guidelines:

In order to address challenges within the realm of cutting-edge technologies, students are required to collaborate in groups of three or four. Each group focuses on solving a problem within a specific domain. To provide guidance and oversight of project advancement, an Internal Guide is assigned to each batch. These guides possess expertise in the relevant domain. Should the need arise, the Internal Guide is capable of organizing clarification sessions to address any uncertainties raised by the students working on the project. These interactions are duly documented for future reference.

Relevance of Project: Students are expected to articulate the significance of their project within the current IT landscape and broader society.

Literature Survey: Students must conduct a thorough review of research articles and existing projects to pinpoint gaps within the identified problem statement.

Design: Students are required to formulate a comprehensive design document encompassing class, use case, component diagrams, state models, sequence models, activity diagrams, and interaction models.

Implementation: Students should execute the designed model using appropriate techniques.

Presentation: Regularly, students are to present their progress to the evaluation committee. The committee evaluates based on the quality of the presentation, depth of content coverage, adeptness in addressing raised questions, and the evident division of teamwork. Scores are determined within this criterion for individual students.

Report and Publication: Each group must compose a project report and submit it to the department. Reports are expected to adhere to the standardized format set by the department. Each group must publish a paper in Scopus indexed conferences / journals as part of mini project.

Course Outcomes (COs):

At the end of the course Students will be able to:

1. Identify a problem, review research literature and analyse requirements (PO 1,12 PSO 1, 2, 3)
2. Schedule milestone and deliverables using appropriate project management techniques (PO 8,9,10,11 PSO 1,2, 3)
3. Design and implement the solution to selected problem using standard models and processes (PO 1,2,3,4,5,6,7,8,9, 10,11,12 PSO 1,2, 3)
4. Analyze the results and produce substantial written documentation (PO 1,2,4,8,9,10,11,12 PSO 1,2, 3)