RAMAIAH
Institute of Technology

CURRICULUM

Outcome Based Education

Academic year 2023 – 2024

Computer Science and Engineering
(ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

V & VI SEMESTER B.E.

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Dr. M. S. Ramaiah, a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 17 UG programs and 11 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^+' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 67% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 107 & world ranking 600 for the year 2022.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology is recognized by Atal Ranking of Institutions on Innovation Achievements (ARIIA), MoE, Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, Ramaiah Institute of Technology has achieved 78th rank among 1314 top Engineering Institutions & 23rd Rank among 105 School of Architecture in India for the year 2023.

About the Department

Year of Establishment	2021
Names of the Programme offered	UG: B.E. in Computer Science and Engineering (Artificial Intelligence and Machine Learning)

The Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning) has eminent professor and faculty with the doctorate degree. The faculty has been publishing research papers in refereed journals and in conference proceedings. The department has the state-of-the-art laboratories and class rooms. The department conducts technical seminars, workshops and hackathons regularly for students. The department encourages the students to conduct and participate in extra- curricular/sports activities. The department conducts courses with more of hands- on sessions and encourages students to take up MOOC based online courses in NPTEL, IIT Bombay, Coursera and Udemy.

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 2021-25

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	08	08	03	03	--	--	--	--	22
Engineering Sciences (ESC)	09	11	--	--	--	--	--	--	20
Humanities, Social Sciences and Management (HSMC)	02	--	01	01	03	03	--	--	10
Ability Enhancement Course (AEC)	01	01	01	01	01	--	03	--	08
Universal Human Values (UHV)	--	--	02	--	--	--	--	--	02
Professional Core Courses (PCC)	--	--	11	12	11	05	04	--	43
Integrated Professional Core Course (IPCC)	--	--	03	03	03	--	04	--	13
Professional Elective Courses (PEC)	--	--	--	--	03	06	03	--	12
Institutional Open Elective Courses (IOE)	--	--	--	--	--	03	03	--	06
Internship (INT)	--	--	--	02	--	02	--	05	09
Mini Project / Project Work (PW)	--	--	--	--	--	03	03	09	15
Non Credit Mandatory Courses (NCMC)	--	--	Yes	--	Yes	--	--	--	--
Total Credits	20	20	21	22	21	22	20	14	160

SCHEME OF TEACHING V SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	CI51	Big Data Analytics	CSE(AIML)	PCC	3	0	0	3	3
2	CI52	Introduction to Machine Learning	CSE(AIML)	IPCC	2	0	1	3	4
3	CI53	Automata Theory and Compiler Design	CSE(AIML)	PCC	2	1	0	3	4
4	CI54	Software Engineering	CSE(AIML)	PCC	3	0	0	3	3
5	CIE55x	Program Elective Course – 1	CSE(AIML)	PEC	3	0	0	3	3
6	CIL56	Application Development using Java Laboratory	CSE(AIML)	PCC	0	0	1	1	2
7	CIL57	Data Analytics Laboratory	CSE(AIML)	PCC	0	0	1	1	2
8	AL58	Research Methodology & Intellectual Property Rights	CSE(AIML)	HSMC	3	0	0	3	3
9	AEC510	**Ability Enhancement Course – V**	Any Dept.	AEC	1	0	0	1	1
				Total	17	1	3	**21**	**25**
10	HS59	Environmental Studies *	Humanities	NCMC	0	0	0	0	1

PROGRAM ELECTIVE – 1							
SL. NO.	COURSE CODE	COURSE NAME	Credits				Total contact hours /week
			L	T	P	Total	
1.	CIE551	Advanced Artificial Intelligence	3	0	0	3	3
2.	CIE552	Advanced Computer Networks	3	0	0	3	3
3.	CIE553	Advanced Algorithms	3	0	0	3	3
4.	CIE554	Computer Graphics	3	0	0	3	3
5.	CIE555	Introduction to Image Processing	3	0	0	3	3

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

Nomenclature: IPCC: Integrated Professional Core Course**, PCC:** Professional Core Course**, HSMC:** Humanity and Social Science & Management Courses**, PEC:** Professional Elective Courses**, AEC–**Ability Enhancement Courses, **NCMC**: Non-credit Mandatory Course
L –Lecture, T – Tutorial, P- Practical/ Drawing
Note: CIE55x, where x=1,2,3,4,5
Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with practical of the same course. Credit for IPCC is 03 and its Teaching–Learning hours (L: T: P) can be considered as (2: 0: 1). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated only by CIE (no SEE). However, questions from the practical part of IPCC can be included in the SEE question paper.
Professional Elective Courses: A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five courses. The minimum student's strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.
Innovation/ Societal/ Entrepreneurship based Internship: At the End of fourth Semester four - weeks Summer Internship Shall Be Carried Out – Based On industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. Credited in fifth Semester. All the students admitted shall have to undergo mandatory internship of 04 weeks during the vacation of IV semester. A Viva-Voce examination shall be conducted during VI semester and the prescribed credit shall be included in VI semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements.
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 8^{th} 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; 8^{th} 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 8^{th} semester grade card.
The 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 fulfil 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

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	AL61	Management & Entrepreneurship	CSE(AIML)	HSMC	3	0	0	3	3
2	CI62	Introduction to Deep Learning	CSE(AIML)	PCC	3	0	0	3	3
3	CIE63x	Program Elective Course – 2	CSE(AIML)	PEC	3	0	0	3	3
4	CIE64x	Program Elective Course – 3	CSE(AIML)	PEC	3	0	0	3	3
5	CIL65	Deep Learning Laboratory	CSE(AIML)	PCC	0	0	1	1	2
6	CIL66	Big Data Analytics Laboratory	CSE(AIML)	PCC	0	0	1	1	2
7	CIOE0x*	Institutional Open Elective - 1	Any Dept.	IOE	3	0	0	3	3
8	CIP67	Mini Project	CSE(AIML)	PW	0	0	3	3	-
9	INT68	Innovation/Societal/ Entrepreneurship based Internship	CSE(AIML)	INT	0	0	2	2	-
Total					**15**	**0**	**7**	**22**	**19**

PROGRAM ELECTIVE – 2							
SL.NO	COURSE CODE	COURSE NAME	Credits				Total contact hours /week
			L	T	P	Total	
1	CIE631	Natural Language Processing	3	0	0	3	3
2	CIE632	Principles of Cryptography	3	0	0	3	3
3	CIE633	NoSQL Databases	3	0	0	3	3
4	CIE634	Virtual Reality	3	0	0	3	3
5	CIE635	Bio Informatics	3	0	0	3	3

PROGRAM ELECTIVE – 3							
SL.NO	**COURSE CODE**	**COURSE NAME**	**Credits**				**Total contact hours /week**
			L	**T**	**P**	**Total**	
1	CIE641	Cloud Computing	3	0	0	3	3
2	CIE642	Cyber Security	3	0	0	3	3
3	CIE643	Speech Processing	3	0	0	3	3
4	CIE644	Distributed Systems	3	0	0	3	3
5	CIE645	Augmented Reality	3	0	0	3	3

OPEN ELECTIVE – 1 for other Departments							
SL.NO	**COURSE CODE**	**COURSE NAME**	**Credits**				**Total contact hours /week**
			L	**T**	**P**	**Total**	
1	CIOE01	Web App Development	3	0	0	3	3
2	CIOE02	Python Programming	3	0	0	3	3
3	CIOE03	Data Base Management Systems	3	0	0	3	3
4	CIOE04	Programming in JAVA	3	0	0	3	3
5	CIOE05	Introduction to Artificial Intelligence	3	0	0	3	3

Nomenclature, PCC: Professional Core Course**, PEC:** Professional Elective Courses, **IOE:** Institutional Open Elective, **PW:** Mini Project, **INT –** Internship

L –Lecture, T – Tutorial, P- Practical/ Drawing

Note: CIE63x , where x=1,2,3,4,5
CIE64x , where x=1,2,3,4,5
CIOE0x*, where x=1,2,..,… continued from previous

L –Lecture, T – Tutorial, P- Practical/ Drawing/ Project work

Professional Elective Courses: A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five courses. The minimum student's strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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 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.

Research/Industrial Internship - At the end of sixth / seventh semester (in two cycles to accommodate all the students of the) Research/Industrial Internship shall be carried out – Based on Industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. All the students admitted shall have to undergo mandatory internship of 24 weeks during the vacation of VI/VII semesters. A Viva-Voce examination shall be conducted during VII semester and the prescribed credit shall be included in VII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements.

Research internship Students have to take up research internship at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organization / Institutes. Research internship is basically intended to give you the flavor of current research going on in a particular topic/s. The internships serve this purpose. They help students get familiarized with the field, the skill needed the effort amount and kind of effort required for carrying out research in that field.

Industry internships: Is an extended period of work experience undertaken by /Institute students looking to supplement their degree with professional development. The students are allowed to prepare themselves for the workplace and develop practical skills as well as academic ones. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with "unexpected contingencies" helps students recognize, appreciate, and adapt to organization realities by tempering knowledge with practical constraints.

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 8^{th} 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; 8^{th} 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 8^{th} semester grade card.

BIG DATA ANALYTICS	
Course Code: CI51	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Mrs. Akshatha G C	

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: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs92

Unit II

Hadoop / Spark /HDFS Overview, Introduction to Scala: Hadoop Over view: 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 Spark Overview: Spark Ecosystems, Advantages of Spark.

Scala: Scala Overview, Values and Variables, basic types, operators, control structures, functions, maps, tuples, Collections - Mappings, Iterators, comprehensions, classes, objects, pattern matching. Functions as a parameter.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs92

Unit III

Spark Core: 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: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs92

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: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs92

Unit V

Introduction to Hive: History of Hive and Recent Releases of Hive, Hive Features, Hive Integration and Workflow, Hive Data Units, Hive Architecture, Hive Data Types, Hive File Format, Hive Query Language, RC file implementation, SerDe Interface, User-Defined Function.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs92

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)
3. Cay S. Horstmann, Scala for the Impatient 2nd Edition (Chapter 1to 6, 12 to 14)
4. 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)
5. 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, big data analytics, big data processing requirements. (PO1, 2,3, PSO1)
2. Compare the Hadoop and SPARK framework for big data. (PO3,4, PSO1)
3. Illustrate the programming model in Scala using basic data types, functions, objects, classes. (PO1, 2,3, PSO1)
4. Apply the Knowledge of RDDs, Data frames to develop SPARK applications. (PO1, 2,3, PSO1)
5. Analyze the big data framework used in industry. (PO4,5, PSO1,2)

INTRODUCTION TO MACHINE LEARNING	
Course Code: CI52	**Credits: 2:0:1**
Prerequisite: Nil	**Contact Hours: 28L+14P**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

Unit I

Machine Learning Introduction: Three different types of machine learning, Artificial neurons (early history of machine learning): Perceptron learning algorithm in Python, Adaptive linear neurons: loss functions with gradient descent, Implementing Adaline in Python, feature scaling, stochastic gradient descent.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_cs87

Unit II

Machine Learning Preliminaries: Cross-validation (K-fold), Evaluation metrics-classification metric, regression metric for balanced and unbalanced data implementation with python, Categorical variables handling, L1 and L2 regularization. Feature selection: Variance Threshold, Pearson correlation (Heat map), greedy feature selection, recursive feature elimination, Univariate feature selection.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_cs87

Unit III

Regression and Classification (Supervised): Polynomial Regression, Logistic Regression, Adaline implementation for logistic regression, tackling overfitting via regularization, Classification with SVM, Nonlinear problems using a kernel SVM, Decision tree, Combining multiple decision trees via random forests, K-nearest neighbor (KNN).

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_cs87

Unit IV

Dimensionality Reduction: Principal Component Analysis (PCA), linear discriminant analysis LDA, t-SNE (non-linear dimensionality reduction). Ensemble Learning: simple majority vote classifier, Bagging- Bagging Classifier, Boosting- AdaBoost, Gradient boosting for regression and classification.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_cs87

Unit V

Unlabelled Data – Clustering Analysis: Grouping objects by similarity using k-means, elbow method to find the optimal number of clusters, organizing clusters as a hierarchical tree (dendrograms), Locating regions of high density via DBSCAN.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_cs87

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.

References:

1. Abhishek Thakur, Approaching (Almost) Any Machine Learning Problem, Kindle version, 2020.
2. M. Pradhan and U. Dinesh Kumar, Machine Learning using Python, Wiley, 2023.

Course Outcomes (COs):

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

1. Gain a comprehensive knowledge of machine learning's core principles, encompassing types and historical context. (PO- 1, 2,6,9,10,12) (PSO- 3)
2. Acquire hands-on proficiency by implementing key machine learning algorithms and techniques using Python for real-world applications. (PO- 1, 2,3,6,9,10,12) (PSO- 3)
3. Evaluate models effectively using cross-validation, classification, and regression metrics, and apply strategies to mitigate overfitting through regularization. (PO- 1, 2,3,6,9,10,12(PSO- 3)
4. Explore advanced topics such as ensemble learning, dimensionality reduction, and clustering, expanding your toolkit for complex data analysis. (PO- 1, 2,3,6,9,10,12) (PSO- 3)
5. Develop real time applications data analysis using appropriate machine learning algorithms, interpret model outcomes, and make informed decisions. (PO- 1, 2,3,6,9,10,12) (PSO-3)

AUTOMATA THEORY AND COMPILER DESIGN	
Course Code: CI53	**Credits: 2:1:0**
Prerequisite: Nil	**Contact Hours: 28L+14T**
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction to Finite Automata: Central Concepts of Automata theory, Deterministic Finite Automata (DFA), Non- Deterministic Finite Automata (NFA), NFA to DFA Conversion, Minimization of DFA.

Introduction to Compiler Design: Language Processors, Phases of Compilers, Compiler Construction Tools.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106104148
  https://nptel.ac.in/courses/106108113

Unit II

Regular Expressions and Languages: Regular Expressions: The Operators of Regular Expressions, Building Regular Expressions, Precedence of Regular expression-operators, Finite Automata and Regular Expressions: From DFA's to regular Expressions.

Pushdown Automata: Definition of the Pushdown Automata: Informal Introduction, Formal Definition of Pushdown Automata, A Graphical Notation of PDA's. Deterministic Pushdown Automata: Definition of Deterministic PDA.

Lexical Analysis Phase of compiler Design: The Role of Lexical Analyzer, Input Buffering, Specifications of Tokens, Recognition of Tokens.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106104148
  https://nptel.ac.in/courses/106108113

Unit III

Context Free Grammars: Formal Definition of a Context Free Grammar, Derivations, Parse Trees, Ambiguity, Writing a Grammar: Elimination of Ambiguity, Elimination of Left Recursion, Left Factoring.

Syntax Analysis: The role of the Parser, Top-down Parsing, First and Follow, LL (1) Grammars, Nonrecursive Predictive Parsing, Error Recovery in Predictive Parsing. Bottom-up Parsing, Introduction to LR Parsing: Simple LR parser. More Powerful LR Parsers: Canonical LR (1) items, Constructing LR (1) set of items, Canonical LR(1) parse tables, Constructing LALR parsing tables.

- Pedagogy: Chalk and Talk, PowerPoint Presentations, Active Learning
- Links: https://nptel.ac.in/courses/106108113

Unit IV

Introduction to Turing Machine: Problems that Computers Cannot Solve, The Turing machine: Notation for the Turing Machine, Descriptions for Turing Machines.

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation order for SDDs, Applications of Syntax-Directed translation, Syntax-Directed Translation Schemes.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106104148
  https://nptel.ac.in/courses/106108113

Unit V

Intermediate Code Generation: Variants of syntax trees, Three-address code, Types and declarations, Translation of expressions, Type checking: Rules of Type Checking, Type Conversions, Control flow: Boolean Expressions, Short-Circuit Code, Flow of Control statements, Control Flow Translation of Boolean Expressions, Avoiding Redundant Gotos, Back patching: One pass Code generation Using backpatching, Backpatching for Boolean Expressions.

Code Generation: Issues in the Design of a Code Generator, Target Language, A Simple Code Generator.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106108113

Text Books:

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Third Edition, Pearson Education India, 2011.
2. Alfred V.Aho, Monica S.Lam, Ravi Sethi, Jeffrey D. Ullman, " Compilers Principles, Techniques and Tools", Second Edition, Pearson Education India, 2013.

References:

1. Elain Rich, "Automata, Computability and complexity", 1st Edition, Pearson Education,2018.
2. K.L.P Mishra, N Chandrashekaran, 3rd Edition , 'Theory of Computer Science", PHI, 2012.
3. Peter Linz, "An introduction to Formal Languages and Automata ", 3rd Edition, Narosa Publishers,1998.
4. K Muneeswaran," Compiler Design", Oxford University Press 2013.

Course Outcomes (COs):

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

1. Understand the core concepts in automata theory and Theory of Computation. (PO 1, 2, PSO 1,2)
2. Design and develop lexical analyzers, parsers and code generators. (PO1,2, 3, 9, PSO 1,2)
3. Design Grammars and Automata (recognizers) for different language classes and become knowledgeable about restricted models of Computation (Regular, Context Free) and their relative powers. (PO 1, 2,3,4, PSO 1,3)
4. Gain the knowledge of the structure of a Compiler and Apply concepts automata theory and Theory of Computation to design Compilers. (PO 1,2,3,4,9, PSO 1, 2)
5. Design syntax directed computation models for problems in Automata theory and adaptation of such model in the field of compilers. (PO 2,3,4, PSO 2,3)

SOFTWARE ENGINEEING	
Course Code: CI54	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Ms. Pallavi T P	

Course Contents

Unit I

Introduction: Professional software development, Software engineering ethics, Case studies. **Software processes:** Software process models, Process activities, coping with change, The Rational Unified process. **Agile Software Development:** Agile methods, Plan-driven and agile development, Extreme programming, Agile project management, Scaling agile methods.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106105182

Unit II

Requirements engineering: Functional and Non-functional requirements, the software requirements document, Requirements specification, Requirements Engineering Processes, Requirements elicitation and analysis, Requirements validation, Requirements management.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106105182

Unit III

Architectural Design: Software Design and Implementation, Architectural design decisions, Architectural views, Architectural patterns, Application architectures. Design and implementation: Object-oriented design using the UML, Design patterns, Implementation issues, Open source development.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106105182

Unit IV

Software testing: Development testing, Test-driven development, Release testing, User testing. Software evolution: Evolution processes, Program evolution dynamics, Software maintenance, Legacy system management Software Project Estimation: Software Sizing, Problem-Based Estimation, An Example of LOC-Based Estimation, An Example of FP-Based Estimation, The COCOMO II Model.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106105182

Unit V

Software Management: Project management: Risk management, Managing people, Teamwork. Project planning: Software pricing, Plan-driven development, Project scheduling, Agile planning, Quality management: Software quality, Software measurement and metrics. Process improvement: The process improvement process, The CMMI process improvement framework.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/106105182

Textbooks:

1. Ian Sommerville, Software Engineering, 10th Edition, Pearson Education, July,2021
2. Roger S Pressman and Bruce R. Maxim, Software Engineering: A Practitioner's Approach, 8/e, New York: McGraw-Hill, March, 2019

References:

1. Emilia Mendes, Nile Mosley: Web Engineering, Springer,2006
2. David Gustafson: Software Engineering, Schaum's Outline Series, McGraw Hill,2002

Course Outcomes (COs):

1. Understand the concepts of software engineering and development processes. (PO 1,8,9,10,11,12 PSO-1)
2. Analyze the functional and non-functional requirements for the given problem. (PO 1,2,9,10,11,12 PSO 1)
3. Apply software architectural design for the given scenario. (PO 1,2, 3,9,10,11,12 PSO 1)
4. Understand Software testing and evolution processes. (PO 1, 9,10,11,12 PSO 1)
5. Analyze Software Project Management issues and process improvement. (PO 1,2,11 PSO 1)

ADVANCED ARTIFICIAL INTLLIGENCE	
Course Code: CIE551	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

Unit I

Intelligent Agents: Agents and Environments, Good Behavior: The Concept of 10 Rationality, The Nature of Environments, The Structure of Agents Problem Solving: Game Paying

Textbook 1: Chapter 2, Chapter 5 (2.1 to 2.4, 5.1 to 5.6)

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://nptel.ac.in/courses/112105249

Unit II

Uncertain knowledge and Reasoning: Quantifying **Uncertainty**, Acting under Uncertainty **Basic Probability Notation**, Inference **Using** Full Joint Distributions, Independence **Bayes 'Rule** and Its Use The Wumpus World Revisited.

Textbook 1: Chapter 13

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://nptel.ac.in/courses/112105249

Unit III

Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The 10 Semantics of **Bayesian Networks, Efficient Representation** of Conditional Distributions Exact **Inference** in **Bayesian Networks,** Approximate Inference **in Bayesian** Networks.

Textbook 1: Chapter 14.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://nptel.ac.in/courses/112105249

Unit IV

Perception: Image Formation, Early Image-Processing Operation, Object Recognition by Appearance, Reconstructing the 3D World. Object Recognition from Structural Information, Using Vision.

Textbook 1: Chapter 24

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://nptel.ac.in/courses/112105249

Unit V

Overview and language Modeling: Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. **Language Modeling:** Various Grammar- based Language Models-Statistical Language Model.

Textbook 2: Chapter 1, 2

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://nptel.ac.in/courses/112105249

Textbooks:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, India, 2016.
2. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems",. Harlow: Addison Wesley, 2002.

References:

1. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992.
2. Robin Murphy, Robin R. Murphy, Ronald C. Arkin, "Introduction to AI Robotics", MIT Press, 2000.
3. Francis. X. Govers, "Artificial Intelligence for Robotics", Packt Publishing, 2018.

Course Outcomes (COs):

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

1. Demonstrate the fundamentals of Intelligent Agents. (PO-1,2,3, PSO-1,2,3)
2. Illustrate the reasoning on Uncertain Knowledge. (PO-1,2,3, PSO-1,2,3)
3. Explore the explanation-based learning in solving AI problems. (PO-1,2,3,4,5, PSO-1,2,3)
4. Demonstrate the applications of Rough sets and Evolutionary Computing algorithms. (PO-1,2,3,4,5, PSO-1,2,3)
5. Design and perform an empirical evaluation of different algorithms on a problem formalization. (PO-1,2,3,4,5,9,10,11,12, PSO-1,2,3)

ADVANCED COMPUTER NETWORKS	
Course Code: CIE552	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Siddesh G M	

Course Contents

Unit I

Network layer: Logical addressing - IPV4 addresses, Address space, notations, classful and classless addressing with problem solving, NAT, IPV6 addresses; IPV6 addresses; **Network layer:** Internet protocol - IPV4 datagram, fragmentation, checksum and options; IPV6 packet format, advantages and extension headers; Transition from IPV4 to IPV6.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_cs19/

Unit II

Address mapping, Error reporting, & Multicasting - Address mapping, ARP, RARP, BOOTP and DHCP; ICMP, IGMP, **Network layer: Delivery, Forwarding, & Routing** – Direct Vs Indirect delivery, Forwarding Techniques, Forwarding Process, Routing Table, **Unicast routing protocols with problem solving** – Optimization, Intra and Inter domain routing, distance vector routing, link state rout routing.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_cs19/

Unit III

Multicast routing protocols – Introduction, applications, unicast routing vs multicast routing, source-based tree routing, group shared tree routing. Transport Layer - Process-to-Process delivery, User Datagram Protocol, Transmission Control Protocol.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_cs19/

Unit IV

Congestion control & QOS - Data traffic, Congestion, Congestion control, Two examples – congestion control in TCP and Frame Relay, Quality of Service, Techniques to improve QOS.

Application Layer: Domain Name System - Namespace, Domain name space, Distribution of Name space, DNS in internet, Resolution.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_cs19/

Unit V

Remote logging – TELNET; Electronic mail – Architecture, User Agent, Message Transfer Agent: SMTP; File transfer - File transfer protocol (FTP), Network Management: SNMP - Network management system; Simple Network Management Protocol – concept, management components.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_cs19/

Text Books:

1. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition, Tata McGraw-Hill, 2006.

References:

1. Alberto Leon-Garcia and Indra Widjaja, Communication Networks –Fundamental Concepts and Key architectures, Second Edition, Tata McGraw-Hill, 2004.
2. Wayne Tomasi, Introduction to Data Communications and Networking, Pearson Education, 2005.

Course Outcomes (COs):

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

1. Identify and solve the problems associated with transition from IPV4 to IPV6. (PO-1, 2, 3) (PSO-1, 2)
2. Use different protocols to achieve Address mapping, Error reporting & routing. (PO-1, 2, 3, 5) (PSO-2)
3. Paraphrase different transport layer protocols and analyze different techniques to improve QOS (PO-1, 2, 3) (PSO-2, 3)
4. Describe the working of various application layer services. (PO-2, 3) (PSO-2)
5. Analyze various network management protocols. (PO-1, 2, 3) (PSO-1, 2)

ADVANCED ALGORITHMS	
Course Code: CIE553	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
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. Devise 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-1,6,9,10-PSO-1,2)
4. Assess the string-matching algorithms such as Boyer-Moore and Knuth Morris-Pratt algorithm. (PO-1,2,3,6,9,10, 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)

COMPUTER GRAPHICS	
Course Code: CIE554	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Mrs. Akshatha G C	

Course Contents

Unit I

Introduction: Applications of computer graphics, A graphics system, Images: Physical and synthetic, Imaging Systems, the synthetic camera model, the programmer's interface, Graphics architectures, Programmable Pipelines Graphics Programming: Programming two- dimensional applications, OpenGL application programming interface, Primitives and attributes, color, viewing, control functions, the gasket program, polygons and recursions, the three-dimensional gasket, adding interactions, menus.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs90

Unit II

Geometric Objects and Transformations: Scalars, Points, and Vectors, Three- dimensional Primitives, Coordinate Systems and Frames, Modeling a Colored Cube, Affine Transformations, Rotation, Translation and Scaling,

Transformation in Homogeneous Coordinates, Concatenation of Transformations, OpenGL Transformation Matrices, Spinning of cube, Interfaces to three-dimensional applications.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs90

Unit III

Implementation: Basic Implementation Strategies, Four major tasks, Clipping, Line-segment clipping, Polygon clipping, Clipping of other primitives. Clipping in three dimensions, Rasterization: Bresenham's algorithm, Polygon Rasterization, Hidden-surface removal.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs90

Unit IV

Viewing: Classical and computer viewing, Viewing with a Computer, Positioning of the camera, Parallel Projections, Perspective projections, Projections in OpenGL, Hidden-surface removal, Parallel-projection matrices, Perspective-projection matrices, Interactive Mesh Displays, Projections and Shadows.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs90

Unit V

Lighting and Shading: Light and Matter, Light sources, The Phong reflection model, Polygon shading, Approximation of sphere by recursive subdivision, specifying lighting parameters, Implementing a lighting model.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc20_cs90

Text Book:

1. Edward Angel and Dave Shreiner: Interactive Computer Graphics - A Top- Down Approach with Shader-based OpenGL, 6th Edition, Pearson Education, 2011.

Reference Books:

1. Donald Hearn and Pauline Baker: Computer Graphics with OpenGL, 3rd Edition, Pearson Education, 2011.
2. F.S. Hill Jr.: Computer Graphics Using OpenGL, 3rd Edition, Pearson Education, 2009.
3. James D Foley, Andries Van Dam, Steven K Feiner, John F Hughes: Computer Graphics, 2nd Edition, Pearson Education, 2011

Course Outcomes (COs):

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

1. Understand the components of a graphics system with the building blocks & the overall architecture. (PO 1,3, PSO 1,2)
2. Derive the geometrical transformations used in interactive computer graphics in different coordinate systems and for viewing and projections. (PO 1,2,3, PSO 1,2)
3. Discuss the different algorithms for clipping and rasterization of lines and polygons, and for hidden surface removal. (PO 1,2,3, PSO 1,2)
4. Illustrate different lighting and shading models. (PO 1,2,3, PSO 1,2)
5. Implement 3D computer graphics applications in OpenGL using knowledge of display systems, image synthesis, and interactive control. (PO 1,2,3,4 PSO 1,2)

INTRODUCTION TO IMAGE PROCESSING	
Course Code: CIE555	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

Unit I

Introduction: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels- Neighbours and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_ee116

Unit II

Image Enhancement in The Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_ee116

Unit III

Image Enhancement In Frequency Domain: Introduction, Fourier Transform, Discrete Fourier Transform (DFT), properties of DFT , Discrete Cosine Transform (DCT), Image filtering in frequency domain.

Pedagogy: Chalk and Talk, PowerPoint Presentations

Link: https://onlinecourses.nptel.ac.in/noc22_ee116

Unit IV

Image Segmentation: Introduction, Detection of isolated points, line detection, Edge detection, Edge linking, Region based segmentation- Region growing, split and merge technique, local processing, regional processing, Hough transform, Segmentation using Threshold.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_ee116

Unit V

Image Compression: Introduction, coding Redundancy, Inter-pixel redundancy, image compression model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking, DCT implementation using FFT, Run length coding.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Link: https://onlinecourses.nptel.ac.in/noc22_ee116

Textbooks:

1. Rafael C G., Woods R E. and Eddins S L, Digital Image Processing, Prentice Hall, 3rd edition, 2008.

Reference Books:

1. Milan Sonka," Image Processing, analysis and Machine Vision", Thomson Press India Ltd, Fourth Edition.
2. Fundamentals of Digital Image Processing- Anil K. Jain, 2nd Edition, Prentice Hall of India.
3. S. Sridhar, Digital Image Processing, Oxford University Press, 2nd Ed, 2016.

Course Outcomes (COs):

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

1. Examine various types of images, intensity transformations and applying various filtering techniques. (PO1,3,4, PSO 1)
2. Understand image enhancement in frequency and spatial domain (PO 1,3,4,5, PSO 1)
3. Manipulate both binary and grayscale digital images using morphological filters and operators to achieve a desired result. (PO1,3,4, PSO 1)
4. Apply image processing algorithms in practical applications. (PO1,3,4, PSO 1)
5. Apply the image concepts such as edge detection, segmentation representation can be implemented and used. (PO1,3,4, PSO 1)

APPLICATION DEVELOPMENT USING JAVA LABORATORY	
Course Code: CIL56	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours: 14P**
Course Coordinator: Mrs. Akshatha G C	

LABORATORY OVERVIEW: A Java Programming lab manual is intended to provide a basic knowledge of java programming for students. To develop software development skills in java programming and Students will have the proficiency to develop projects in java programming.
The course helps the students to solve the inter disciplinary applications through java programming.

COURSE OBJECTIVES:

1. To teach fundamentals of object-oriented programming in Java. Understand various concepts of JAVA.
2. To familiarize Java environment to create, debug and run simple Java programs.
3. To demonstrate java compiler and eclipse platform and learn how to use Net Beans IDE to create Java Application.

Course Contents

1. Introduction to Java: Overview of Java Data types, Variables, arrays, Control statements
2. OOPs Concepts: Classes, Objects, Methods and Constructors.
3. Code reusability using Inheritance and Abstract classes.
4. Multi-threaded applications, Packages and interfaces.
5. Exception handling, collections frame work.
6. JavaFX Framework.
7. Data base connectivity using JDBC.
8. Web-based app development using Servlets, JSP, XML, 3-tier architecture.
9. Remote Method Invocation.

Text Books:

1. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, 2019.

Course Outcomes (COs):

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

1. Implement Object oriented features using Java. (PO 1,2,3,4,5, 8, 9,12, PSO 1,2 3)
2. Demonstrate data base connectivity using JDBC. (PO 1,2,3,4,5, 8, 9,12, PSO 1,2 3)
3. Develop web applications using servlets, JSP and RMI. (PO 1,2,3,4,5, 8, 9,12, PSO 1,2 3)

DATA ANALYTICS LABORATORY	
Course Code: CIL57	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours: 14P**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

- **Working in the Console** - Arithmetic Operators - Logical Operations - Using Functions - Getting Help in R and loading packages. Data structures, variables, and data types in R: numeric, arithmetic, assignment, Logical, relational operators, Vectors, Matrices and Arrays, lists, Special Values, Conditional Statements, Loops, Functions.
- **Overview on Data Frames** – Create it in scratch - Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Factors and Tables – factors and levels – Common functions used with factors – Working with tables - Math and Simulations in R - Reading a datafile directly into a dataframe - EDA using R - Reading different file formats.
- **Statistical analysis: Basic Statistics** – Linear Model – Generalized Linear models – Non-linear models - R functions for statistical analysis - Graphics: Creating Graphs – Customizing Graphs – Saving graphs to files – Creating three-dimensional plots – interfacing: Interfacing R to other languages – Parallel R – Time Series and Auto-correlation – Clustering
- **Data Visualization using R**: Introduction to GGPlot2 – Library - Factors – Aesthetics – Plotting with Layers – Overriding Aesthetics – Mapping vs Setting – Histograms – Density Charts – Statistical Transformation – Facets – Coordinates – Themes. Learning Techniques - Supervised Learning: Linear Regression; Logistic Regression.

Lab Exercises:

Lab Exercise 1: Basic Arithmetic Operations

You are working as a cashier at a grocery store. Your task is to create a program that simulates the checkout process for a customer's shopping cart. The program should calculate the total cost of the items, including tax, and provide a detailed receipt.

i. Define a list of products, each represented as a dictionary with keys: "name", "price", and "quantity".
ii. Allow the cashier to input the products in the customer's shopping cart, including the name, price, and quantity of each item.
iii. Calculate the subtotal (price * quantity) for each item and display a detailed receipt with product names, quantities, prices, and subtotals.
iv. Calculate the total cost of the items in the cart before tax.
v. Apply a tax rate (e.g., 8%) to the total cost to calculate the tax amount.
vi. Calculate the final total cost by adding the tax amount to the total cost before tax.

Lab Exercise 2: Loops Operations

You have been tasked with creating a program that calculates and assigns grades for students enrolled in multiple courses. The program will take input for the marks obtained by 10 students in 5 different courses, compute the total and average marks for each student, and assign corresponding grades based on their average performance.

Declare constants for the number of students (num_students) and the number of courses (num_courses).

Initialize an empty list to store student information.

For each student:

i. Input the student's name.
ii. Input marks for each of the 5 courses.
iii. Calculate the total marks and average marks.
iv. Determine the grade based on the average marks using a grading scale.
v. Display the student information, including their name, individual course marks, total marks, average marks, and the assigned grade.

Lab Exercise 3: Conditional statement, Loops and Functions:

You are developing a library management system that needs a fine calculation feature. Write a program that takes the number of days a book is overdue and calculates the fine amount based on the library's policy. The policy states that for the first 7 days, there is no fine. After 7 days, a fixed fine per day is charged. Additionally, there's a cap on the fine amount after 30 days.

Input the number of days the book is overdue.

i. Use conditional statements to calculate the fine amount based on the library's policy.
ii. Display the fine amount along with a message indicating whether the fine is within the cap or exceeded it.

Modify this code for 100 students and 5 courses.

Lab Exercise 4: Arrays and Functions:

You are developing an inventory management system for a small store. The system needs to handle inventory items and their quantities. Write a program that uses arrays to store inventory items and their quantities, and includes functions to add new items, update quantities, and display the inventory.

i. Define an array to store inventory items.
ii. Define an array to store corresponding quantities.
iii. Implement functions to:
    - Add a new item along with its quantity.
    - Update the quantity of an existing item.
    - Display the inventory items and quantities.
iv. Use the functions to manage the inventory and handle user interactions.

Lab Exercise 5: Dataframe

You are working as an educational analyst and need to analyze the performance of students in a school. You have data on student names, their scores in different subjects, and attendance. Write a program that uses data frames to manage and analyze student data, including calculating average scores, identifying students with low attendance, and generating a report.

Create a data frame to store student information with columns: "Name", "Math_Score", "Science_Score", "History_Score", "Attendance".
Implement functions to:

i. Calculate the average scores for each student.
ii. Identify students with attendance below a certain threshold.
iii. Generate a report with student names, average scores, and attendance status.
iv. Use the functions to analyze student performance and generate the report.

Lab Exercise 6: R functions for statistical analysis

You are a data analyst at a retail company that sells products online. The company is interested in predicting sales for the upcoming months to better manage inventory and plan marketing strategies. As part of your role, you need to develop a program that utilizes time series analysis to forecast sales based on a historical sales dataset.

Write an R program to forecast sales for the next three months using time series analysis techniques. The program should perform the following steps:

i. Load the required libraries, including the forecast package.
ii. Create a data frame with two columns: Month and Sales. The Month column should contain a sequence of dates from January 2023 to June 2023 (inclusive), and the Sales column should contain the corresponding sales amounts (12000, 15000, 18000, 16000, 20000, 22000).
iii. Convert the sales data into a time series object with a monthly frequency.
iv. Fit an ARIMA (AutoRegressive Integrated Moving Average) model to the sales time series using the auto.arima() function.
v. Forecast sales for the next three months using the fitted ARIMA model and the forecast() function.
vi. Display the forecasted sales results, including point forecasts and prediction intervals.

Lab Exercise 7: Customer Purchase Analysis for E-commerce Company (Enhanced)

You are a data analyst working for an e-commerce company that specializes in selling a variety of products online. The company aims to analyze customer purchase data comprehensively to gain insights into customer behaviour and spending patterns.

Your goal is to develop a R program that performs an in-depth analysis of customer purchase data. You will calculate various statistical measures and generate visualizations to understand the distribution of purchase amounts among customers.

Note: Load the necessary libraries, including the dplyr and ggplot2 packages.

Given the example customer purchase data provided below, create a data frame named purchase_data with two columns: CustomerID and PurchaseAmount.

Calculate and display the following statistical measures:

i. Mean (average) purchase amount
ii. Median purchase amount
iii. Standard deviation of purchase amounts
iv. 1st quartile (25th percentile) of purchase amounts
v. 3rd quartile (75th percentile) of purchase amounts

Create a histogram to visualize the distribution of purchase amounts using the ggplot2 package. Display the histogram with appropriate labels and titles.

Example Customer Purchase Data:

Customer ID	Purchase Amount
101	150
102	200
103	120
104	300
105	80

Lab Exercise 8: Matrix Manipulation in R

Write an R program that generates two matrices, matrix_A and matrix_B, and conducts operations including element-wise addition, scalar multiplication, matrix transpose, and multiplication.

Lab Exercise 9: Visualization

You are a data analyst tasked with analyzing and visualizing a dataset. The dataset contains information about student performance in a course. You need to create a program that generates various types of plots to help understand and present the data effectively.

Write a program that performs data analysis and generates visualizations for a given dataset. The program should:

a. Load the necessary libraries (ggplot2).
b. Prepare example data with columns for student names, scores, and attendance percentages.
c. Perform the following tasks:
    i. Create a scatter plot to visualize the relationship between scores and attendance percentages.
    ii. Generate a bar plot to show the distribution of scores among different students.
    iii. Create a line plot to display the trend of scores over time (assuming different students' scores were collected at different time intervals).
    iv. Generate a histogram to visualize the distribution of scores.
d. Customize the appearance of each plot, such as color, labels, and titles.
e. Arrange the plots in a way that they are easy to compare and understand.
f. Provide appropriate titles for each plot and the axes.

Lab Exercise 10: Exploring Data Manipulation with dplyr Package

In this exercise, you will delve into data manipulation using the dplyr package in R. You will perform operations that empower you to filter, select, mutate, group, summarize, arrange, and join data frames. The dplyr package provides a streamlined approach to enhance your ability to manipulate and transform data efficiently, making it a vital tool for data analysis tasks.

i. Filter and Select:
   Apply the filter() function to extract rows that satisfy certain conditions from a given data frame. Additionally, employ the select() function to choose specific columns from the data frame.
ii. Mutate:
   Utilize the mutate() function to create new variables or modify existing ones within the data frame, thus enriching your dataset with calculated values.
iii. Group and Summarize:
   Harness the power of the group_by() function to group data based on specific variables. Then, employ the summarize() function to compute summary statistics within each group.

iv. Arrange:
Leverage the arrange() function to sort the data frame based on the values of selected variables, helping you gain insights from organized data.

v. Join:
Explore the join() function, which allows you to merge multiple data frames based on common variables, thereby combining information for a comprehensive analysis.

Lab Exercise 11: Data Analysis: Statement: Customer Purchase Analysis

You are a data analyst at an e-commerce company that sells a variety of products online. The company has provided you with a dataset containing information about customer purchases. Your task is to perform a comprehensive data analysis to gain insights into customer behavior and spending patterns.

Dataset Description:

The dataset customer_purchases.csv contains the following columns:

Customer ID: Unique identifier for each customer.

Purchase Amount: The amount spent by the customer on a purchase.

Problem Tasks:

You are required to perform the following tasks using R:

Task 1: Load the Dataset
Load the necessary libraries, including readr and dplyr.
Read the dataset customer_purchases.csv into a data frame named purchase_data.

Task 2: Data Summary
Calculate and display the total number of records in the dataset.
Calculate and display the total number of unique customers in the dataset.

Task 3: Calculate Statistical Measures
Calculate and display the mean (average) purchase amount.
Calculate and display the median purchase amount.
Calculate and display the standard deviation of purchase amounts.

Task 4: Customer Segmentation
Create a new column named Segment in the purchase_data data frame based on the following criteria:
"Low Spender" if the purchase amount is less than the median.
"High Spender" if the purchase amount is greater than or equal to the median.

Task 5: Visualize Data
Create a histogram to visualize the distribution of purchase amounts using the ggplot2 package. Customize the plot with appropriate labels and titles.

Lab Exercise 12: Data Analysis:

You are a data analyst tasked with performing an Exploratory Data Analysis (EDA) on the Indian Premier League (IPL) dataset. The IPL dataset contains information about various IPL matches, including match dates, teams, venues, outcomes, and performance metrics. Your objective is to gain insights into the dataset by conducting an in-depth analysis using R programming.

Dataset Description:

The dataset named "ipl_data.csv" includes the following columns:

Match_ID: Unique identifier for each match.

Date: Date of the match.

Team1: Name of the first team participating in the match.

Team2: Name of the second team participating in the match.

Venue: Stadium where the match was played.

Winner: Name of the winning team.

Total.Runs: Total runs scored in the match.

Total.Wickets: Total wickets taken in the match.

Other relevant columns (if any).

Problem Tasks:

Your task is to perform the following Exploratory Data Analysis (EDA) tasks using R:

Task 1: Data Overview and Structure
Display the structure of the dataset using str() function.\
Output summary statistics of numerical columns using summary().

Task 2: Basic Data Insights
Calculate and display the total number of matches in the dataset.
Determine the number of unique teams that have participated in IPL matches.
List the unique teams from both Team1 and Team2.

Task 3: Team Performance Analysis
Calculate the number of matches won by each team and display the results.
Compute the average total runs scored in the matches.
Calculate the average total wickets taken in the matches.\

Task 4: Venue Insights
Identify and display the most frequently used venue for matches.

Task 5: Visualization
Create a bar plot to visualize the number of matches won by each team.

Suggested Learning Resources

References:

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

Web References:

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

Course Outcomes (COs):

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

1. Apply R programming to test the hypothesis of the study, construct graphs and charts and understand different data sets. (PO-1, 3, 5, PSO-1, 2)
2. Analyze the data and know descriptive statistics by using R Programming. (PO-1,3,4,5, 10, PSO-1,2)
3. Predict the data and take decisions through R programming. (PO-1, 3, 4, 5 10,12, PSO-1,2,3)

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS	
Course Code: AL58	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Mohana Kumar S	

Course 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)

ABILITY ENHANCEMENT COURSE - V	
Course Code: AEC510	**Credits: 1:0:0**
Prerequisite: Nil	**Contact Hours: 14L**
Course Coordinator: Any Department	

Ability Enhancement Courses (AEC) are the generic skill courses which are basic and needed by all to pursue any career. These courses are designed to help students enhance their skills in communication, language, and personality development. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights and the law.

Every student shall register for AEC course under the supervision of his/her proctor. For III, IV & V semester, the student shall select the Ability Enhancement Course online such that the selected course does not overlap with any professional core/ elective course offered by the parent department of the student. After selection, the registration of the course has to be done by the student at his/her parent department.

ENVIRONMENTAL STUDIES	
Course Code: HS59	**Credits: 0:0:0 (NCMC)**
Prerequisite: Nil	**Contact Hours: 14L**
Course Coordinator: -	

Course Contents

Unit I

Environment, Ecology and Biodiversity

Definition, scope, and importance. Multidisciplinary nature of Environmental studies. Food chain and food web. Energy flow and material cycling in the ecosystem. Biodiversity and threats to biodiversity. Concept of sustainable development: Definition, objectives, and applications.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Models
- Link: https://youtu.be/I_bnGkviWOU
  https://youtu.be/Ar04qG1P8Es

Unit II

Natural resources

Forest resources: Ecological importance of forests. Water resources: Global water resources distribution. Mineral resources: Environmental effects of extracting and processing Mineral resources. Food resources: Effects of modern agriculture. Land resources: Soil erosion and Desertification.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/vsXv3anIBSU
  https://youtu.be/1rOVPqaUyv8

Unit III

Energy sources

Growing energy needs. Conventional and non-conventional / Renewable and Non-renewable energy sources. Bio Energy-Ethanol and Bio mass energy. Energy of the future – Hydrogen fuel cells and Nuclear energy. Environmental Impact Assessment (EIA): Definition, Objectives and benefits. Step by step procedure of conducting EIA.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Animations, Models
- Link: https://youtu.be/mh51mAUexK4
  https://youtu.be/XS-eXqppf_w

Unit IV

Environmental pollution

Definition, Causes, Effects and control measures of Water pollution, Air pollution and Soil/ land pollution. Management of Municipal Solid Waste and treatment methods of municipal solid waste.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/NRoFvz8Ugeo
  https://youtu.be/DAQapF-F4Vw

Unit V

Environmental protection

Global warming and Climate change, Acid rain, Ozone layer depletion. Salient features of Environmental Protection Act, Air & Water Acts. Functions of Central and State Pollution Control Boards.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Open source softwares
- Link: https://youtu.be/iV-BvYwl4Y8
  https://youtu.be/BYqLRGawoH0

Text Books:

1. Dr. S M Prakash – Environmental Studies, Elite Publishers, 2007.

Reference Books:

1. P. Venugopala Rao – Principles of Environmental Science & Engineering Prentice Hall of India, 1st edition, 2006.

Web links and video Lectures (e- Resources):

1. https://youtu.be/I_bnGkviWOU
2. https://youtu.be/vsXv3anIBSU
3. https://youtu.be/mh51mAUexK4
4. https://youtu.be/NRoFvz8Ugeo
5. https://youtu.be/iV-BvYwl4Y8

Course Outcomes (COs):

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

1. Describe the importance of environmental studies, sustainable development and biodiversity (PO-1, 7)
2. Explain the importance and conservation of impacts of natural resources (PO-1, 7)
3. Distinguish the energy sources and identify the alternative energy sources for sustainable development (PO-1, 7)
4. Identify the causes, effects and control measures of pollution in developmental activities (PO-1, 7)
5. Outline the current environmental issues and the role of the agencies for environmental protection (PO-1, 7)

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	CO4, CO5
Average of the two internal test shall be taken for 30 marks		
Other components		
Assignment – MCQ, Objectives	10	CO1, CO2
Assignment – Quiz, Group presentation	10	CO3, CO4
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

VI Semester

MANAGEMENT & ENTREPRENEURSHIP	
Course Code: AL61	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
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=Hgj_kRrvbhQ&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_PSm81k9U8NjaVJkR

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)

INTRODUCTION TO DEEP LEARNING	
Course Code: CI62	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

Unit I

Introduction to Deep Learning: Brief history of DL, Working of weights and bias, Working of single neuron, Working of a layer, layer implementation with numpy, Dense layer.

Activation Functions: Uses of activation function , Sigmoid, ReLu activation, Softmax Activation functions.

- Pedagogy: Chalk and board, Active Learning, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc20_cs62

Unit II

Loss Function: Categorial cross entropy loss, Binary cross-Entropy loss and Accuracy calculation.

Backpropagation and other Differentiation Algorithms, optimizers: Stochastic Gradient Descent (SGD), Learning Rate and LR decay, SGD with momentum, AdaGrad, RMSProp, Adam.

- Pedagogy: Chalk and board, Active Learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc20_cs62

Unit III

Convolutional Networks: The Convolution Operation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features- LeNet, AlexNet.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc20_cs62

Unit IV

Recurrent and Recursive Neural Networks: Unfolding Computational Graphs, Recurrent Neural Network, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, The Long Short- Term Memory and Other Gated RNNs.

- Pedagogy: Chalk and board, Problem based learning, Demonstration
- Link: https://onlinecourses.nptel.ac.in/noc20_cs62

Unit V

Transformers and Vision transformers: Self Attention and Multi-Head attention mechanism, positional encoding, residual connection, Encoder and Decoder.

Applications: applications of only Encoder, Decoder and Encoder-Decoder type models.

- Pedagogy: Chalk and board, MOOC
- Links: https://jalammar.github.io/illustrated-transformer/
  https://onlinecourses.nptel.ac.in/noc20_cs62

Text Books:

1. Harrison Kinsley & Daniel Kukiela, Neural Network from scratch in Python, Kinsley Enterprises Inc, MIT license,2020. (Module 1&Module-2)
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, November 2016. (Module-3 &Module-4)
3. Denis Rothman, "Transformers for Natural Language Processing", Packt, Second Edition, March 2022. (Module-5)

References:

1. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, 2009.
2. N.D.Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science", January2016.
3. Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", 0'Reilly publications.

Course Outcomes (COs):

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

1. Explain the concepts and applications of neural networks and deep learning. (PO-1,2,3,4,5,6,12, PSO 1,2,3)
2. Explain how various types of learning work and how they can be used. (PO-1,2,3,4,5,6,12, PSO 1,2,3)
3. Apply deep feed forward networks and convolutional to solve practical problems. (PO-1,2,3,4,5,6,12, PSO 1,2,3)
4. Demonstrate how recurrent and recursive nets function and how practical problems can be mapped to them. (PO-1,2,3,4,5,6,12, PSO 1,2,3)
5. Design end-to-end deep learning architectures involving various types of feedforward networks, auto encoders and generative adversarial networks for practical applications. (PO-1,2,3,4,5,6,12, PSO 1,2,3).

DEEP LEARNING LABORATORY	
Course Code: CIL65	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours: 14P**
Course Coordinator: Dr. Thippeswamy M N	

Course Objectives

1. Implement the various deep learning algorithms in Python.
2. Learn to work with different deep learning frameworks like Keras, Tensor flow, PyTorch, Caffe etc.

Course Contents

1. Basic image processing operations: Histogram equalization, thresholding, edge detection, data augmentation, morphological operations
2. Implement SVM/Softmax classifier for CIFAR-10 dataset: (i) using KNN
3. Study the effect of batch normalization and dropout in neural network classifier
4. Familiarization of image labelling tools for object detection, segmentation
5. Image segmentation using Mask RCNN, UNet, SegNet
6. Object detection with single-stage and two-stage detectors (Yolo, SSD, FRCNN, etc.)
7. Image Captioning with Vanilla RNNs
8. Image Captioning with LSTMs
9. Network Visualization: Saliency maps, Class Visualization
10. Generative Adversarial Networks
11. Chatbot using bi-directional LSTMs

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.
3. Denis Rothman, "Transformers for Natural Language Processing", Packt, Second Edition, March 2022.

Course Outcomes (COs):

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

1. Build deep learning models using regularization and convolutional operations. (PO-1,2,3,5,9,10,11,12) (PSO 1-3)
2. Analyze sequential data to build image segmentation and captioning. (PO-1,2,3,5,9,10,11,12) (PSO-1, 3)
3. Develop and analyze the applications using Network Visualization and bi-directional LSTMs (PO-1,2,3,5,9,10,11,12) (PSO-1,3)

BIG DATA ANALYTICS LABORATORY	
Course Code: CIL66	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours: 14P**
Course Coordinator: Mrs. Akshatha G C	

Course Contents

List of problems for which student should develop program and execute in the Laboratory

1. Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Install Hadoop single node cluster and run simple applications like wordcount.
4. Implement of Matrix Multiplication with Hadoop Map Reduce
5. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
6. Implementation of K-means clustering using Map Reduce
7. Installation of Hive along with practice examples.
8. Installation of HBase, Installing thrift along with Practice examples
9. Patrice importing and exporting data from various data bases.
10. Run apache spark basic applications.
11. Data analytics using Apache Spark.

Text Books:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.

Course Outcomes (COs):

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

1. Build applications using Hadoop node cluster and Apache Spark (PO-1,2,3,5,9,10,11,12) (PSO 1-3)
2. Analyze data using Apache Spark and installation of Hadoop, Hive and Hbase. (PO-1,2,3,5,9,10,11,12) (PSO-1, 3)
3. Develop and analyze the applications using Hadoop Map Reduce, Apache Spark, importing and exporting of data. (PO-1,2,3,5,9,10,11,12) (PSO-1,3)

NATURAL LANGUAGE PROCESSING	
Course Code: CIL66	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction: Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithms; Language, Thought, and Understanding; The State of the Art and The Near- Term Future; Regular Expressions and Automata; Morphology and Finite-State Transducers: Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc23_cs45/

Unit II

N-grams: Counting Words in Corpora, Smoothing, N-grams for Spelling and Pronunciation, Entropy; **Word Classes and Part-of-Speech Tagging:** Part-of- Speech Tagging, Rule-based Part-of-speech Tagging, Stochastic Part-of-speech Tagging, Transformation-Based Tagging; Context-Free Grammars for English: Constituency, Context-Free Rules and Trees, Sentence- Level Constructions, The Noun Phrase.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc23_cs45/

Unit III

Context-Free Grammars for English: Constituency, Context-Free Rules and Trees, Sentence Level Constructions. **Parsing with Context-Free Grammars:** The Earley Algorithm. **Features and Unification:** Feature Structures, Unification of Feature Structures, Features Structures in the Grammar, Implementing Unification, Parsing with Unification Constraints.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc23_cs45/

Unit IV

Lexicalized and Probabilistic Parsing: Probabilistic Context-Free Grammars, Problems with PCFGs. **Representing Meaning:** First Order Predicate Calculus, Some Linguistically Relevant Concepts, Related Representational Approaches, Alternative Approaches to Meaning.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc23_cs45/

Unit V

Semantic Analysis: Syntax-Driven Semantic Analysis; **Lexical Semantics:** Relations Among Lexemes and Their Senses, **WordNet:** A Database of Lexical Relations. Discourse: Reference Resolution, Text Coherence, Discourse Structure.

- Pedagogy: Chalk and board, Problem based learning, Demonstration.
- Link: https://onlinecourses.nptel.ac.in/noc23_cs45/

Text Book:

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

Course Outcomes (COs):

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

1. Interpret how speech and language technology relies on formal models to capture knowledge, and language processing deals with subparts of words. (PO- 1,5,11, PSO-2)
2. Illustrate the way *N*-gram tool is used for spelling and pronunciation processing, and part-of-speech tagging mechanism using various categories. (PO-2,3, 11, PSO-2)
3. Describe feature structures and unification operation which is used to combine them, and probabilistic parsing to capture more syntactic information. (PO-2,11, PSO-2)
4. Apply probabilistic context free grammar and first order predicate calculus to represent meaning. (PO- 1, 2, 3, 5, 9, 10,11,12) (PSO-3)
5. Understand the issues that NLP systems face during semantic analysis, lexical semantics & discourse. (PO-1,11, PSO-2).

PRINCIPLES OF CRYPTOGRAPHY	
Course Code: CIE632	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Mohana Kumar S	

Course Contents

Unit I

Introduction: Security Goals, Cryptographic Attacks, Services and Mechanism, Techniques. Symmetric ciphers, Introduction, Substitution Ciphers, Transposition Ciphers, Mathematics of Cryptography: Integer Arithmetic, Modular Arithmetic, Matrices. Linear Congruence.

- Pedagogy: Chalk and board, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs43

Unit II

Traditional Symmetric-Key Ciphers: Block Ciphers and Data Encryption Standard (DES): Introduction, DES Structure, DES Analysis, Security of DES. Advanced Encryption Standard: Introduction, Transformations, Key Expansion, The AES Ciphers. Examples, Analysis of AES. Block Ciphers and Operation.

- Pedagogy: Chalk and board, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs43

Unit III

Decipherment using Modern Symmetric-Key Ciphers: Use of Modern Block Ciphers, Use of Stream Ciphers, Other Issues. Asymmetric Key Cryptography: Introduction, RSA Cryptosystem. Rabin Cryptosystem, Elgamal Cryptosystem.

- Pedagogy: Chalk and board, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs43

Unit IV

Message authentication: Authentication Requirements, Authentication Functions, Message Authentication Codes. Digital signatures: Digital Signatures, Digital Signature Algorithm. Key management and distribution: Distribution of public keys, X.509 certificates. Kerberos.

- Pedagogy: Chalk and board, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs43

Unit V

System security: Intruders: Intruders, Intrusion detection. Malicious Software: Types of Malicious Software, Viruses. Firewalls: The need for Firewalls, Firewall Characteristics. Types of Firewalls.

- Pedagogy: Chalk and board, Problem based learning.
- Link: https://onlinecourses.nptel.ac.in/noc21_cs43

Text Books:

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

References:

1. Josef Pieprzyk, Thomas Hardjono, Jennifer Serberry Fundamentals of Computer Security, Springer.

Course Outcomes (COs):

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

1. Describe security goals attacks services and mechanism techniques. (PO 1,2 PSO 1,2)
2. Identify the type of encryption method DES and AES depending on the need and security threat perception. (PO 1,2,3,4 PSO 1,2)
3. Compare the need of Symmetric-key and Asymmetric-key Ciphers. (PO 1,2,3,4 PSO 1,2)
4. Summarize the fundamentals of Key Management and Identity need for Digital Signatures and its utility. (PO 1,2,3,4 PSO 1,2)
5. Describe the need for firewalls and network security. (PO 1,2 PSO 1,2)

NO SQL DATABASES	
Course Code: CIE633	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

An Overview of NoSQL: The Value of Relational Databases: Getting Persistent Data, Concurrency, Integration, Impedence Mismatch, ACID Properties, Distribution Models: Sharding and Master-Slave Replication, Consistency: Update Consistency, Read Consistency, Relaxing Consistency: The CAP Theorem, Quorums.

- Text Book 1: Chapter 1, 4, 5
- Pedagogy: Chalk and board, Problem based learning.

Unit II

MongoDB: The Document Data Model, Documents and Collections, MongoDB Use Cases, Embedded Data Modelsm, Normalized Data, Replication via Replica Sets, MongoDB Design, MongoDB and the CAP Theorem, The MongoDB Data Manipulation Language, Transactions, Atomicity, and Documents, Batch Processing and Aggregation, Indexing, Auto-Sharding, Shard Keys, and Horizontal Scalability, Writing to Shards, MongoDB as a File System

- Text Book 3: Chapter 5
- Pedagogy: Chalk and board, Problem based learning.

Unit III

The Column-Family Data Model: Introductio to Cassandra, CAP theorem,Data distribution concepts, The Cassandra Query Language, Cassandra configurations, Relational Data Model, Cassandra Data Modeling, CQL Types, CQL Commands ,Cassandra storage architecture: Data Centers and Racks

- Text Book 2
- Pedagogy: Chalk and board, Problem based learning.

Unit IV

Document Databases, What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure Document Databases, What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure

Document Databases, What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.

- Text Book 1: Chapter 9
- Pedagogy: Chalk and board, Problem based learning.

Unit V

Graph Databases Neo4j, What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

- Text Book 1: Chapter 11
- Pedagogy: Chalk and board, Problem based learning.

Textbooks:

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley, 2012.
2. Cassandra: The Definitive Guide, 3rd Edition by Jeff Carpenter, Eben Hewitt, 2019.
3. Seven Databases in Seven Weeks: A Guide to Modern Databases and the Nosql Movement, Eric Redmond, Jim R. Wilson, O′Reilly; 1st edition, 2012

References:

1. Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN-13: 978-9332557338)
2. Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022)
3. Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", 2nd Edition, O'Reilly Publications, 2013. (ISBN-13: 978-9351102694)

Course Outcomes (COs):

1. Demonstrate competency in describing how NoSQL databases differ from relational databases from a theoretical perspective(PO1,3,4, PSO 1,2,3).
2. Demonstrate an understanding of the detailed architecture, define objects, load data, query data Batch Processing and Aggregation and Sharding. (PO1,3,4, PSO 1,2,3)
3. Explain the detailed architecture, define objects, load data, query data and performance of Graph NoSQL databases and Key-Value Pair NoSQL databases. (PO1,3,4, PSO 1,2,3)
4. Explain Document Databases ,Real-Time Analytics and E-Commerce Applications (PO1,3,4, PSO 1,2,3)
5. Analyze Hadoop related to Cassandra and Neo4j for big data Analytics. (PO1,3,4,5, PSO 1,2,3)

VIRTUAL REALITY	
Course Code: CIE634	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Tojo Mathew	

Course Contents

Unit I

Introduction: Definition of VR, modern experiences, historical perspective. Hardware, sensors, displays, software, virtual world generator, game engines, human senses, perceptual psychology, psychophysics. Geometric Modeling, transforming rigid bodies, yaw, pitch, roll, axis-angle representation, quaternions, 3D rotation inverses and conversions, homogeneous transforms, transforms to displays, look-at and eye transforms, canonical view and perspective transforms, viewport transforms.

- Textbook 1: Chapter 1,2,3
- Pedagogy: Chalk and board, Power point presentations.

Unit II

Light propagation, lenses and images, diopters, spherical aberrations, optical distortion; more lens aberrations; spectral properties; the eye as an optical system; cameras; visual displays. Parts of the human eye, photoreceptors and densities, scotopic and photopic vision, display resolution requirements, eye movements, neural vision structures, sufficient display resolution, other implications of physiology on VR. Depth perception, motion perception, vection, stroboscopic apparent motion, color perception, combining information from multiple cues and senses, implications of perception on VR.

- Textbook 1: Chapter 4,5,6
- Pedagogy: Chalk and board, Power point presentations.

Unit III

Graphical rendering, ray tracing, shading, BRDFs, rasterization, barycentric coordinates, VR rendering problems, anti-aliasing, distortion shading, image warping (time warp), panoramic rendering. Velocities, acceleration, vestibular system, virtual world physics, simulation, collision detection, avatar motion, vection.

- Textbook 1: Chapter 7,8
- Pedagogy: Chalk and board, Power point presentations.

Unit IV

Tracking systems, estimating rotation, IMU integration, drift errors, tilt and yaw correction, estimating position, camera-feature detection model, perspective n-point problem, sensor fusion, lighthouse approach, attached bodies, eye tracking, inverse kinematics, map building, SLAM. Remapping, locomotion, manipulation, social interaction, specialized interaction mechanisms.

- Textbook 1: Chapter 9,10
- Pedagogy: Chalk and board, Power point presentations.

Unit V

Sound propagation, ear physiology, auditory perception, auditory localization; Fourier analysis; acoustic modeling, HRTFs, rendering, auralization. Perceptual training, recommendations for developers, best practices, VR sickness, experimental methods that involve human subjects Touch, haptics, taste, smell, robotic interfaces, telepresence, brain-machine interfaces.

- Textbook 1: Chapter 11,12,13
- Pedagogy: Chalk and board, Power point presentations.

Text Books:

1. Steven M. LaValle. 'virtual reality' Steven M. LaValle. Cambridge University Press 2016

Course Outcomes (COs):

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

1. Describe fundamentals of virtual reality systems. (PO 1,2,3 PSO 1,2)
2. Understand the concepts of shading, image warping and interaction mechanisms. (PO 1,2,3 PSO 1,2)
3. Summarize the hardware and software of the VR. (PO 1,2,3 PSO 1,2)
4. Analyze the applications of VR. (PO 1,2,3 PSO 1,2)
5. Apply the experimental methods involving Fourier analysis and interfaces. (PO 1,2,3 PSO 1,2)

BIO INFORMATICS	
Course Code: CIE635	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Thippeswamy M N	

Course Contents

Unit I

The genetic material, gene structure and information content, protein structure and function, chemical bonds, molecular biology tools.

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

Unit II

Dot plots, simple alignments, gaps, scoring matrices, the Needleman and Wunsch algorithm, semiglobal alignments, the Smith and Waterman algorithm, database searches – BLAST and FASTA.

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

Unit III

Patterns of substitutions within genes, estimating substitution numbers, molecular clocks Molecular phylogenetics, phylogenetic trees, distance matrix methods, maximum likelihood Approaches.

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

Unit IV

Parsimony, Inferred Ancestral Sequences, strategies for fast searches – branch and bound and heuristic searches, consensus trees, tree confidence, molecular phylogenies Genomics – 1: Prokaryotic genomes, prokaryotic gene structure, GC content and prokaryotic genomes, prokaryotic gene density, eukaryotic genomes.

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

Unit V

Genomics – 2: Eukaryotic gene structure Open reading frames, GC contents in eukaryotic genomes, gene expression, transposition, repetitive elements Amino acids, polypeptide composition, secondary structure, tertiary and quaternary structures, algorithms for modelling protein folding.

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

Textbooks:

1. Dan E. Krane, Michael L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2008.

References:

1. T K Attwood, D J Parry Smith, Introduction to Bioinformatics, Pearson Education,2004
2. 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 all the available molecular biology tools. (PO 1,2,3,5,12 PSO 3)
2. Solve sequence alignment problems with/without gap penalty. (PO 1, 2, 3, 4, 5 PSO 1, 2)
3. Explain the pattern of substitution within genes. (PO 1, 5, 10 PSO 3)
4. Distinguish between character based and distance-based phylogeny. (PO 1,2, 4 PSO 1, 2)
5. Identify different parts of prokaryotic and Eukaryotic Genes (PO 1, 2, 4, 5 PSO 1, 2)

CLOUD COMPUTING	
Course Code: CIE641	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
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

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)

CYBER SECURITY	
Course Code: CIE642	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Mohana Kumar S	

Course Contents

Unit I

Introduction to Cybercrime: Introduction, Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals? Classifications of Cybercrimes, Cybercrimes: An Indian Perspective, Hacking and the Indian Laws, A Global Perspective on Cybercrimes.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.swayam2.ac.in/cec21_ge10

Unit II

Cyber offenses: How Criminals Plan Them: Introduction, How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes. **Botnets:** The Fuel for Cybercrime, Attack Vector.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.swayam2.ac.in/cec21_ge10

Unit III

Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDOS Attacks, Attacks on Wireless networks.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.swayam2.ac.in/cec21_ge10

Unit IV

Phishing and Identity Theft: Introduction, Methods of Phishing, Phishing Techniques, Spear Phishing, Types of Phishing Scams, Phishing Toolkits and Spy Phishing, Phishing Countermeasures, Identity Theft (ID Theft)

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.swayam2.ac.in/cec21_ge10

Unit V

Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Digital Forensics Life cycle, Chain of Custody Concept, Network Forensics.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.swayam2.ac.in/cec21_ge10

Text Book:

1. Sunit Belapure, Nina Godbole, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley India Pvt Ltd, ISBN: 978-81- 265-21791, 2011, First Edition (Reprinted 2018).

References:

1. Thomas J. Mowbray, “Cybersecurity: Managing Systems, Conducting Testing, and Investigations”, John Wiley & Sons, ISBN: 978-1-118-69711-5, 2014.

Course Outcomes (COs):

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

1. Gain an in-depth grasp of cybercrime's origins, definitions, and its interplay with information security. (PO 1,2 PSO 1,2)
2. Explore the strategies used by cybercriminals, from social engineering to botnets and dissect attack vectors for digital systems compromise. (PO 1,2 PSO 1,2)
3. Assess the arsenal of cybercrime tools—proxy servers, phishing, malware, and DoS attacks—alongside their implications for digital security. (PO 1,2 PSO 1,2)
4. Investigate phishing, identity theft, and scams, while learning preventive measures and responses to counter these dangers effectively. (PO 1,2,3,4 PSO 1,2)
5. Delve into computer forensics' evolution, the significance of digital evidence and the investigative process, including chain of custody and network forensics. (PO 1,2,3,4 PSO 1,2)

SPEECH PROCESSING	
Course Code: CIE643	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc22_ee117

UNIT II

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc22_ee117

UNIT III

Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc22_ee117

UNIT IV

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc22_ee117

UNIT V

Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

- Pedagogy: Chalk and board, Power point presentations.
- Link: https://onlinecourses.nptel.ac.in/noc22_ee117

Text Books:

1. Lawrence Rabinerand Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003
2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education.

References:

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education.
3. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999.
4. Ben gold and Nelson Morgan, “Speech and audio signal processing”, processing and perception of speech and music, Wiley- India Edition, 2006 Edition. 5.Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press.

Course Outcomes (COs):

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

1. Understand the speech production and perception process. (PO 1,2 PSO 1,2)
2. Analyze speech signals in time and frequency domain. (PO 1,2 PSO 1,2)
3. Design and implement algorithms for processing speech signals. (PO 1,2,3,4 PSO 1,2)
4. Develop a simple speech recognition or TTS system. (PO 1,2,3,4 PSO 1,2)
5. Assess the Optimal State Sequence, Parameter Re-estimation and Implementation issues. (PO 1,2 PSO 1,2)

DISTRIBUTED SYSTEMS	
Course Code: CIE644	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sini Anna Alex	

Course Contents

Unit I

Introduction: Definition, Relation to computer system components, Motivation, Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges.

A model of distributed computations: A distributed program, A model of distributed executions, Models of communication networks, Global state of a distributed system, Cuts of a distributed computation, Past and future cones of an event.

Logical time: Introduction, A framework for a system of logical clocks, Scalar time, Vector time, efficient implementations of vector clocks, Jard–Jourdan's adaptive technique. Relation to parallel multiprocessor/multicomputer systems, Message-passing systems versus shared memory systems

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106106168

Unit II

Global state and snapshot recording algorithms: Introduction, System model and definitions, Snapshot algorithms for FIFO channels, Variations of the Chandy–Lamport algorithm, Snapshot algorithms for non-FIFO channels, Snapshots in a causal delivery system, Monitoring global state.

Terminology and basic algorithms: Topology abstraction and overlays, Classifications and basic concepts, Synchronizers, Maximal independent set (MIS), Leader election. Complexity measures and metrics, Program structure, Elementary graph algorithms.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106106168

Unit III

Message ordering and group communication: Message ordering paradigms, Asynchronous execution with synchronous communication, Synchronous program order on an asynchronous system, Group communication, Causal order (CO), Total order, Classification of application-level multicast algorithms.

Termination detection: Introduction, System model of a distributed computation, Termination detection using distributed snapshots, Termination detection by weight throwing, A spanning-tree based termination detection algorithm, Termination detection in a very general distributed computing model, Termination detection in the atomic computation model. A nomenclature for multicast, Propagation trees for multicast.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106106168

Unit IV

Distributed mutual exclusion algorithms: Introduction, Preliminaries, Lamport's algorithm, Ricart–Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm, Agarwal–El Abbadi quorum-based algorithm, Token-based algorithms, Raymond's tree-based algorithm.

Deadlock detection in distributed systems: Introduction, System model, Preliminaries, Mitchell and Merritt's algorithm for the single resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy–Misra–Haas algorithm for the OR model, Kshemkalyani–Singhal algorithm for the P-out-of- Q model. Models of deadlocks, Knapp's classification of distributed deadlock detection algorithms.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106106168

Unit V

Global predicate detection: Stable and unstable predicates, Modalities on predicates, Centralized algorithm for relational predicates, Conjunctive predicates, Distributed algorithms for conjunctive predicates.

Consensus and agreement algorithms: Problem definition, Overview of results, Agreement in a failure-free system (synchronous or asynchronous), Agreement in (message-passing) synchronous systems with failures, Agreement in asynchronous message-passing systems with failures.

Peer-to-peer computing and overlay graphs: Introduction, Data indexing and overlays, Unstructured overlays, Chord distributed hash table. Graph structures of complex networks, Scale-free networks.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.
- Links: https://nptel.ac.in/courses/106106168

Text Books:

1. Ajay D. Kshemkalyani, and Mukesh Singhal "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2008 (Reprint 2013).

References:

1. John F. Buford, Heather Yu, and Eng K. Lua, "P2P Networking and Applications", Morgan Kaufmann, 2009 Elsevier Inc.
2. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, "Distributed and Cloud Computing: From Parallel processing to the Internet of Things", Morgan Kaufmann, 2012 Elsevier Inc.

Course Outcomes (COs):

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

1. Identify the design issues and Challenges in building distributed systems, P2P overlays. (PO 1,2, 3, 4 PSO 1, 3)
2. Explore basic distributed graph algorithms, synchronizers, and recording global state of distributed computation. (PO 1,2, 3, 4, PSO 1,2)

3. Analyze ways to achieve various message ordering schemes for detecting termination of a distributed computation. (PO 1,2, 3, 4, PSO 1, 3)
4. Discuss distributed algorithms to implement Mutual Exclusion and Deadlock detection. (PO 1, 2, 3, 4, PSO 1, 2)
5. Understand consensus and agreement algorithms and predicates. (PO 1,2, 3 PSO 1, 2, 3)

AUGMENTED REALITY	
Course Code: CIE645	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Tojo Mathew	

Course Contents

Unit I

History of AR, Augmented reality characteristics, Difference between Augmented Reality and Virtual Reality, AR technological components, Technologies used in AR, Feature Extraction, Hardware components, AR devices, Importance of AR, Real world uses of AR, AR types, Software tools available for AR.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.

Unit II

Hardware technology, virtual scenes, 3D objects, AR components, Display, HMD, Eyeglasses Contact Lenses, significance of AR, AR powered devices, AR application development drawbacks, Compatibility, Performance, AR libraries, Motion tracking, Environmental understanding, Anchors.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.

Unit III

Technology use and integration in industrial settings, Assistive training to faculty members, Planning and administration for implementation, AR implications, Practical data, AR labs, Platforms to form AR content, Coordinated utilization of AR applications.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.

Unit IV

Micro learning techniques, Utilizing VR for learning, VR for Practical online assessment, VR info graphics, Virtual case considerations, Utilizing AR for learning, Accessible learning, sensible data, elevated learner engagement, VR technology, Components of VR, VR Hardware.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.

Unit V

Tools available for Augmented Reality and Recognition, Software Tools, Google Poly, Unity software approaches, recognition types, native software solutions – ARKit – ARCore – software development kit, Cloud services, AR business applications- weather prediction – market prediction – smart cities, AR application for Education, AR application for Healthcare sector.

- Pedagogy: Chalk and Talk, PowerPoint Presentations.

Text Books:

1. Kaliraj, P., Devi, T. (2021). Innovating with Augmented Reality: Applications in Education and Industry (P. Kaliraj, Ed.) (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, ebook ISBN 9781003175896 Auerbach Publications. https://doi.org/10.1201/9781003175896.

Course Outcomes (COs):

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

1. Understand the concepts of Computer Graphics with respect to AR requirements (PO 1,9,10,12 PSO 1)
2. Analyze the 3D viewing process & pipelines related to AR models. (PO 1,2,9,10,12 PSO 1)
3. Understand Computer Architecture and contextual knowledge of AR system (PO 1,9,10,12 PSO 1)
4. Illustrate the knowledge of Modeling and AR Programming for multidisciplinary areas. (PO 1,9,10,12 PSO 1)
5. Analyze the various animation techniques for designing the solutions of real-world problem. (PO 1,2,9,10,12 PSO 1)

INSTITUTIONAL OPEN ELECTIVE – 1	
Course Code: CIOE0x*	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42L**
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: 0:0:3**
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)

INNOVATION/SOCIETAL /ENTREPRENEURSHIP BASED INTERNSHIP	
Course Code: INT68	**Credits: 0:0:2**
Prerequisite: Nil	**Contact Hours: -**
Course Coordinator: Dr. Tojo Mathew	

Course Contents

Guidelines:

1. The student can do the Internship during the semester break between 4th -5th semesters
2. The student should take prior permission from the department committee before carrying out the internship.
3. The duration of the Internship is one month.
4. The report of the Internship needs to be submitted to the department in the 5th semester.
5. The department will constitute a committee for the evaluation of Internship of student in the 5th semester.

Course Outcomes (COs):

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

1. Schedule milestones of deliverables and formulate the requirements of the proposed work. (PO 2,9,11,12 PSO 1)
2. Apply the engineering knowledge to develop Solution in an industry environment (PO 1,2,3,4,5,6,7,9,12 PSO 1,2,3)
3. Develop the inter-personal skills required to work in a professional team. (PO 8,9, 10, 11,12 PSO 2)
4. Engage in independent study of technology required for development of software. (PO 9,12 PSO 2, 3)
5. Demonstrate and document the project and appraise its effectiveness (PO 8,9,10,12 PSO 3)