VIT | Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Computer Engineering

Final Year Scheme & Syllabus

(As per AICTE guidelines, with effect from the Academic Year 2025-26)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. The autonomous curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. The number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by the third year of the engineering programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begin from third year of programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learners capable of working in an industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness-Body, Mind & Spirit, Indian Traditional Knowledge System under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on Honours/ Minor degree that involves field/ domain study. Learners can avail themselves of this degree by completing requirement of additional 18 credits.

Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies
Department of Computer Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Final Year B. Tech. Computer Engineering **Semester: VII**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
CE17	Programming with R	Practical	1	25	-	25	50
CEXX	Professional Elective-4	As per list below	3	As per list below			
CEXX	Professional Elective-5	As per list below	3	As per list below			
CEXX	Professional Elective-6	As per list below	3	As per list below			
OEXX*	Any two from the offered Open Elective courses	Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
CE47	Project-1 (Synopsis)	Theory	3	50	-	50	100
		Total	**19**				
Course credits completed during the previous inter-semester break will appear in this semester's marksheet							
CE46	Industry Internship	Practical	5	75	-	75	150

*Selection is based on subset of OE courses offered by the Institute for the semester.
ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

List of Open Elective Courses (OEXX)

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OE21	Cyber Law	Theory	3	20	30	50	100
OE22	Project Management	Theory	3	20	30	50	100
OE23	Product Lifecycle Management	Theory	3	20	30	50	100
OE24	Sustainability Management	Theory	3	20	30	50	100
OE25	Operation Research	Theory	3	20	30	50	100
OE26	IPR and Patenting	Theory	3	20	30	50	100
OE27	Research Methodology	Theory	3	20	30	50	100

OE28	Renewable Energy Management	Theory	3	20	30	50	100
OE29	Energy Audit and Management	Theory	3	20	30	50	100
OE30	Bioinformatics	Theory	3	20	30	50	100
OE31	Nanotechnology	Theory	3	20	30	50	100

Professional Elective-4 Courses (CEXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	CE25T	Natural language processing	Theory	2	15	20	40	075
	CE25P	Natural language processing Lab	Practical	1	25	-	25	050
Data Science (DS)	CE27T	Text, Web & Social Media Analytics	Theory	2	15	20	40	075
	CE27P	Text, Web & Social Media Analytics Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	CE37T	IoT & Edge Computing	Theory	2	15	20	40	075
	CE37P	IoT & Edge Computing Lab	Practical	1	25	-	25	050
Computer Security (CSec)	CE32T	Web Application Security	Theory	2	15	20	40	075
	CE32P	Web Application Security Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-5 Courses (CEXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	CE29T	Advance Machine Learning	Theory	2	15	20	40	075
	CE29P	Advance Machine Learning Lab	Practical	1	25	-	25	050

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Data Science (DS)	CE34T	Big Data Analytics	Theory	2	15	20	40	075
	CE34P	Big Data Analytics Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	CE39T	IoT Security & Trust	Theory	2	15	20	40	075
	CE39P	IoT Security & Trust Lab	Practical	1	25	-	25	050
Computer Security (CSec)	CE35T	Malware Analysis	Theory	2	15	20	40	075
	CE35P	Malware Analysis Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-6 Courses (CEXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	CE33T	Deep Learning	Theory	2	15	20	40	075
	CE33P	Deep Learning Lab	Practical	1	25	-	25	050
Data Science (DS)	CE38T	Recommendation System	Theory	2	15	20	40	075
	CE38P	Recommendation System Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	CE40T	Industrial IoT	Theory	2	15	20	40	075
	CE40P	Industrial IoT Lab	Practical	1	25	-	25	050
Computer Security (CSec)	CE36T	Mobile and Wireless Security	Theory	2	15	20	40	075
	CE36P	Mobile and Wireless Security Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Final Year B. Tech. Computer Engineering **Semester: VIII**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OEXX*	Any three from the offered Open Elective courses	Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
CE48	Project-2 (Final)	Theory + Practical	6	100	-	75	175
		Total	**15**				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

*Selection is based on subset of OE courses offered by the Institute for the semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

List of Open Elective Courses (OEXX)

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OE21	Cyber Law	Theory	3	20	30	50	100
OE22	Project Management	Theory	3	20	30	50	100
OE23	Product Lifecycle Management	Theory	3	20	30	50	100
OE24	Sustainability Management	Theory	3	20	30	50	100
OE25	Operation Research	Theory	3	20	30	50	100
OE26	IPR and Patenting	Theory	3	20	30	50	100
OE27	Research Methodology	Theory	3	20	30	50	100
OE28	Renewable Energy Management	Theory	3	20	30	50	100
OE29	Energy Audit and Management	Theory	3	20	30	50	100
OE30	Bioinformatics	Theory	3	20	30	50	100
OE31	Nanotechnology	Theory	3	20	30	50	100

Detailed syllabus of Final Year Semester-VII

Course Name: Programming with R

Course Code: CE17

Category: Core

Preamble:

R Programming for Data Science equips students with the essential skills for data analysis and statistical computing. This course covers fundamental R syntax, data manipulation, visualization techniques, and machine learning applications. Students will learn to apply statistical methods and predictive modeling to real-world datasets. By the end, they will be proficient in using R to extract insights and solve data-driven problems.

Pre-requisites:

Structured Programming (ES04T), Object Oriented Programming (ES05T), Engineering Mathematics-II (BS03)

Course Objectives:

- Develop proficiency in R programming for data handling, manipulation, and visualization.
- Apply statistical methods and hypothesis testing to analyze and interpret data effectively.
- Implement machine learning techniques using R for predictive modelling and clustering.
- Design and execute real-world data science projects using R, from data preprocessing to model deployment.

Course Outcomes:

Learner will be able to:
CO1: Recall fundamental R concepts, data structures (vectors, matrices, data frames), and basic syntax.
CO2: Explain data manipulation techniques (dplyr), visualization (ggplot2), and statistical concepts (hypothesis testing, regression)
CO3: Apply R programming to import/export data, perform statistical tests, and implement basic machine learning models.
CO4: Evaluate model performance (cross-validation, ROC-AUC) and optimize R code for efficiency (data.table, parallel computing).
CO5: Compare different machine learning algorithms and select appropriate models for real-world datasets.
CO6: Design and implement an end-to-end data science project using R, from data cleaning to model deployment.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to R & Data Handling	○ **Introduction to R & RStudio:** Why R is essential for Data Science & Analytics?. Setting up R, RStudio, and essential packages (tidyverse). ○ **R Basics & Data Structures:** Vectors, Matrices, Lists, Data Frames, Factors. Subsetting, Indexing, and Vectorized Operations. ○ **Control Flow & Functions:** Loops (for, while), if-else, switch. Writing efficient functions and error handling (tryCatch). ○ Handling missing values (NA, NULL, NaN)	5
2	Data Manipulation & Visualization	○ **Data Import/Export:** Reading CSV, Excel, JSON, SQL Databases. Writing Data to Files. ○ **Data Manipulation with** dplyr: select(), filter(), mutate(), group_by(), summarize() .Joins (inner_join, left_join). ○ **Data Visualization with** ggplot2: Bar Plots, Histograms, Scatter Plots, Box Plots. Customizing Plots (Labels, Themes, Colors). ○ **Interactive Visualizations (plotly, shiny basics).**	6
3	Statistical Analysis & Hypothesis Testing	○ **Descriptive & Inferential Statistics:** Central tendency, dispersion, skewness, kurtosis. Confidence intervals, p-values, effect size. ○ **Hypothesis Testing:** t-tests (one-sample, two-sample, paired). ANOVA, Chi-square, Wilcoxon tests. ○ **Regression Analysis:** Linear & Logistic Regression. Model diagnostics (R^2, RMSE, multicollinearity).	5

Module No.	Module Name	Content	No of Hours
4	Machine Learning with R	○ **Supervised Learning:** Linear & Logistic Regression, Decision Trees (rpart),Random Forest (randomForest), SVM (e1071), XGBoost (xgboost). ○ **Unsupervised Learning:** K-Means, Hierarchical Clustering, PCA for Dimensionality Reduction. ○ **Model Evaluation & Tuning:** Cross-validation (caret), Hyperparameter tuning, ROC-AUC, Precision-Recall, Confusion Matrix.	5
5	Advanced R for Big Data & Optimization	○ **Working with Big Data:** data.table for Fast Operations, Parallel Computing (parallel, foreach). ○ **Functional Programming in R:** apply(), lapply(), sapply(), Writing Efficient R Code. ○ **Web Scraping & APIs:** rvest for Web Scraping, Connecting to REST APIs (httr).	5
6	Applying R to Real-World Challenges	○ **End-to-End Data Science Project:** Problem Definition → Data Cleaning → Modeling → Visualization. ○ **R in Industry (Case Studies):** Finance, Healthcare, E-commerce Applications.	4
Total			**30**

Textbooks:

1. Hadley Wickham and Garrett Grolemund, “R for Data Science”, First Edition, O’Reilly Media.
2. Norman Matloff, “The Art of R Programming: A Tour of Statistical Software Design”, First Edition, No Starch Press.

Reference Books:

1. Hadley Wickham, “Advanced R”, Second Edition, Chapman and Hall/CRC.
2. Garrett Grolemund, “Hands-On Programming with R: Write Your Own Functions and Simulations”, First Edition, O’Reilly Media.
3. Peter Bruce, Andrew Bruce, and Peter Gedeck, “Practical Statistics for Data Scientists”, Second Edition, O’Reilly Media.

Course Name: Natural Language Processing

Course Code: CE25T

Category: Professional Elective -4 (AIML Track)

Preamble:

Natural Language Processing (NLP) is a foundational field at the intersection of Artificial Intelligence and Linguistics, concerned with the design and development of algorithms that enable computers to understand, interpret, and generate human language. With the increasing demand for intelligent systems that can process text and speech, NLP has become an essential area in computer science and data science. This course introduces the theoretical and practical aspects of NLP, covering linguistic fundamentals, core text analysis techniques, parsing, semantics, discourse processing, and real-world applications. Emphasis is also placed on the challenges of processing Indian languages and the development of interpretable NLP systems.

Pre-requisites:

CE13 (Machine Learning), CE21 (Soft Computing) and CE15 (System Programming and Compiler Design).

Course Objectives:

- Understand the fundamental concepts of Natural Language Processing, including language structure, morphology, grammar, ambiguities, and foundational language modeling techniques.
- Apply various parsing algorithms, semantic analysis, and word representation models to process and analyze natural language data in both English and regional Indian languages.
- Analyze neural network-based language models and embedding techniques such as Word2Vec, GloVe, LSTM, and attention mechanisms for NLP tasks.
- Evaluate and implement NLP applications like machine translation, text summarization, sentiment analysis, and question answering using modern tools and deep learning approaches.

Course Outcomes:

Learner will be able to:

CO1: Recall fundamental concepts of NLP such as stages of language processing, grammar, and basic text preprocessing techniques like tokenization and stemming.

CO2: Explain morphological, syntactic, and semantic components of language using appropriate models and tools.

CO3: Apply parsing algorithms and semantic techniques (like WSD and discourse resolution) to analyze linguistic structures.

CO4: Analyze the structure and relationships in lexical resources (e.g., WordNet, BabelNet) and evaluate semantic similarity and ambiguity.

CO5: Evaluate the performance of various neural language models and word embedding techniques on language tasks.

CO6: Design and implement real-world NLP applications like machine translation or sentiment analysis using advanced deep learning models.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Foundations of NLP and Language Modelling	Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP. Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Morphological Models: Dictionary lookup, finite state morphology; Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace Smoothing, Good-Turing Discounting. ***Self-Learning Topics***: *Variety types of tools for regional languages pre-processing and other functionalities, Noisy channel models, various edit distance, Advance Issues in Language Modelling.*	6
2	Parsing Techniques and Syntax Modelling	Parsers: Top down and bottom up; Modelling constituency; Bottom-Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; TopDown Parser: Early Parser, Predictive Parser.	5

		Self-Learning Topics: *Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks*	
3	Semantics, and Discourse	Introduction, meaning representation; Lexical Semantics; Corpus study; Knowledge Graphs & Ontologies; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Semantic Similarity and Relatedness. Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs Algorithm ***Self-Learning Topics***: *Dictionaries for regional languages, Topic Models, Discourse segmentation, Conference resolution*	5
4	Word Representations and Embedding Models	Word2Vec, CBOW and Skip-Gram Models, One word learning architecture, Forward pass for Word2Vec, Matrix Operations, Word Representation: Word2Vec & fastText, Word Representation: GloVe, Tokenization Strategies	6
5	Neural Language Models and Sequence Learning	Neural Language Models - CNN, RNN, RNN - Based Language Model, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling, Attention in Sequence-to-Sequence Models	5
6	Applications of NLP in Real-World Scenarios	Case studies on (preferable in regional language): Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system ***Self-Learning Topics***: *Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.*	3

Textbooks:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018
2. Christopher D.Manning and Hinrich Schutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
4. Daniel and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Second Edition, Prentice Hall of India, 2008.

Reference Books:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing
3. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012

Course Name: Natural Language Processing Lab

Course Code: CE25P

Category: Professional Elective-4 (AIML Track)

Preamble:

Natural Language Processing (NLP) is a foundational field at the intersection of Artificial Intelligence and Linguistics, concerned with the design and development of algorithms that enable computers to understand, interpret, and generate human language. With the increasing demand for intelligent systems that can process text and speech, NLP has become an essential area in computer science and data science. This course introduces the theoretical and practical aspects of NLP, covering linguistic fundamentals, core text analysis techniques, parsing, semantics, discourse processing, and real-world applications. Emphasis is also placed on the challenges of processing Indian languages and the development of interpretable NLP systems.

Pre-requisites:

CE13 (Machine Learning), CE21 (Soft Computing) and CE15 (System Programming and Compiler Design).

Lab Objectives:

- To understand the key concepts of NLP.
- To design and implement various language models and POS tagging techniques.
- To understand various NLP Algorithms
- To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
- To design and implement applications based on natural language processing

Course Outcomes:

Learner will be able to:

LO1. Apply various text processing techniques.

LO2. Design language model for word level analysis.

LO3. Design, implement and analyze NLP algorithms.

LO4. To apply NLP techniques to design real world NLP applications such as machine translation, sentiment analysis, text summarization, information extraction, Question Answering system etc.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Build a Tokenizer and Stemmer for English and a selected Indian regional language (e.g., Hindi or Tamil).
2	Implement a language model to predict the next word using Trigram with Laplace smoothing.
3	Linguistic Analysis using POS Tagging and Named Entity Recognition
4	Feature Extraction: TF-IDF, N-grams, and Word Embeddings
5	Build a Word Sense Disambiguation (WSD) tool using dictionary-based and machine learning approaches.
6	Develop an Anaphora Resolver using Hobbs' Algorithm for English narratives.
7	Train Word2Vec (CBOW and Skip-Gram) models on a regional language corpus.
8	Build and train an RNN-based language model to generate simple sentences from a dataset.
9	Create a Seq2Seq translation model with attention for English to regional language (e.g., English to Hindi).
10	Design a sentiment analysis system for product reviews in a regional language using LSTM.

Textbooks:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018
2. Christopher D.Manning and Hinrich Schutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
4. Daniel and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Second Edition, Prentice Hall of India, 2008

Reference Books:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing
3. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012

Course Name: Text, Web and Social Media Analytics

Course Code: CE27T

Category: Professional Elective-4 (DS Track)

Preamble:

In today's data-driven world, understanding insights from unstructured and dynamic sources such as text, web, and social media has become vital for organizations. This course introduces the foundational concepts and advanced techniques in Text, Web & Social Media Analytics. Students will explore the structure of social networks, analyze user actions, hyperlinks, and geospatial trends, and apply modern tools for visualizing and interpreting online behavior. The course bridges traditional analytics with the evolving landscape of digital interaction. By the end, students will be equipped to design actionable strategies using analytics tools across multiple online platforms.

Pre-requisites:

Web Design Lab (CE12P), Data Warehousing and Data Mining (CE22T)

Course Objectives:

- To provide foundational knowledge of social media platforms, their core characteristics, and the evolving landscape that drives the need for Social Media Analytics (SMA) in business contexts.
- To equip students with analytical skills for interpreting social network structures and applying network analysis tools to understand influence, engagement, and connectivity in digital environments.
- To develop competency in extracting actionable insights from social media text, user behavior (actions), and hyperlink structures using modern text and action analytics techniques.
- To introduce students to location-based and search engine analytics by exploring data sources, privacy concerns, user query behaviour, and relevant analytics tools and dashboards.
- To enable learners to design data-driven strategies through web analytics, recommendation systems, KPI measurement, and privacy-conscious approaches for managing social media and web presence effectively

Course Outcomes:

Learner will be able to:
CO1: Understand the concepts, characteristics, and evolving trends of social media and its analytics.
CO2: Apply appropriate techniques to analyze social media data, including text, actions, and networks.
CO3: Use tools and platforms to perform social media, web, and search engine analytics effectively.
CO4: Analyze user behavior, content diffusion, and engagement metrics across social and web platforms.
CO5: Evaluate the impact of social media analytics on strategic decision-making and digital marketing.
CO6: Design ethical, privacy-aware, and data-driven strategies for social media and web-based environments.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Social Media Analytics: An Overview	○ Core Characteristics of social media, social media landscape and trends, Need for Social Media Analytics for small & large organizations. ○ Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools.	6
2	Social Network Structure, Measures & Visualization	Introduction to social network structures including nodes, edges, and ties. Network measures such as degree distribution, density, connectivity, centralization, tie strength, and trust. Basics of network visualization including graph layouts, visualization of features, and scale-related challenges. Key graph terminologies such as hubs, authorities, bridges, ego networks, modularity, clustering coefficient, and homophily. Introduction to network analysis tools such as Gephi, NodeXL, and SocNetV.	6
3	Social Media Text, Action & Hyperlink Analytics	Social Media Text Analytics - Types, purpose of text analytics in extracting user sentiment, intent, and trends and tools. Steps in social media text analytics including data collection, cleaning, tokenization, sentiment detection, and topic modeling. Action analytics —definition, scope, and significance of analyzing user actions and tools. Hyperlink analytics—types of hyperlinks used in social platforms, categories of hyperlink analysis (inbound, outbound, anchor text, etc.), and tools.	8

4	Social Media Location and Search Engine Analytics	Location Analytics- sources of location data in social media, including GPS tags, check-ins, and user metadata, categories of location analytics, privacy concerns related to location-based. Search engine analytics, exploring types of search engines like crawler-based and metasearch engines, methods for analyzing user queries and search behaviors, and popular tools such as Google Analytics, Search Console, and SEMrush.	6
5	Social Information Filtering	Social Sharing and filtering, Type of Recommendation Traditional vs social recommendation systems, understanding social media and Business Alignment, social media KPI, formulating a Social Media Strategy, Managing Social Media Risks. Privacy policies	6
6	Web Analytics	Fundamentals of web analytics, user behavior metrics such as page views, bounce rate, and session duration. Search engine performance analysis using rank positions, click-through rates, and keyword tracking. challenges like spam content and techniques to ensure data accuracy and quality	5
Total			**30**

Textbooks:

1. Matthew Ganis and Avinash Kohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", First Edition, IBM Press..
2. Marshall Sponder, "Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics", First Edition, McGraw-Hill Education.

Reference Books:

1. Charu C. Aggarwal, "Social Network Data Analytics", First Edition, Springer.
2. Glen L. Urban, "Digital Marketing Strategy: Analytics, Technology, and Customer Engagement", First Edition, Pearson Education.
3. S. Srinivasan, "Web and Social Media Analytics: A Practical Guide to Data Collection and Analysis", First Edition, Wiley.

Course Name: Text, Web and Social Media Analytics Lab

Course Code: CE27P

Category: Professional Elective-4 (DS Track)

Preamble:

In today's data-driven world, understanding insights from unstructured and dynamic sources such as text, web, and social media has become vital for organizations. This course introduces the foundational concepts and advanced techniques in Text, Web & Social Media Analytics. Students will explore the structure of social networks, analyse user actions, hyperlinks, and geospatial trends, and apply modern tools for visualizing and interpreting online behaviour. The course bridges traditional analytics with the evolving landscape of digital interaction. By the end, students will be equipped to design actionable strategies using analytics tools across multiple online platforms.

Pre-requisites:

Web Design Lab (CE12P), Data Warehousing and Data Mining Lab (CE22P)

Course Objectives:

- To provide foundational knowledge of social media platforms, their core characteristics, and the evolving landscape that drives the need for Social Media Analytics (SMA) in business contexts.
- To equip students with analytical skills for interpreting social network structures and applying network analysis tools to understand influence, engagement, and connectivity in digital environments.
- To develop competency in extracting actionable insights from social media text, user behavior (actions), and hyperlink structures using modern text and action analytics techniques.
- To introduce students to location-based and search engine analytics by exploring data sources, privacy concerns, user query behaviour, and relevant analytics tools and dashboards.
- To enable learners to design data-driven strategies through web analytics, recommendation systems, KPI measurement, and privacy-conscious approaches for managing social media and web presence effectively

Course Outcomes:

Learner will be able to:
CO1: Understand the concepts, characteristics, and evolving trends of social media and its analytics.
CO2: Apply appropriate techniques to analyze social media data, including text, actions, and networks.
CO3: Use tools and platforms to perform social media, web, and search engine analytics effectively.
CO4: Analyze user behavior, content diffusion, and engagement metrics across social and web platforms.
CO5: Evaluate the impact of social media analytics on strategic decision-making and digital marketing.
CO6: Design ethical, privacy-aware, and data-driven strategies for social media and web-based environments.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Title of Practical
1.	Sentiment Analysis of YouTube Comments
2.	Visualize a Twitter Follower Network Using Gephi
3.	Trend and Sentiment Analysis for a Twitter Hashtag.
4.	Analyze Social Media Metrics of a Brand Page.
5.	Explore tools like Hootsuite, Brandwatch, and Sprinklr and compare them based on features and usability.
6.	Follower Engagement Network for Instagram Influencer
7.	Location Heatmap using Social Media Metadata.
8.	Web Analytics Dashboard Interpretation.
9.	Design a content recommendation system based on user preferences and sentiment data collected from YouTube video interactions or tweets liked/shared.
10.	Perform tokenization, stop word removal, stemming, and vectorization on sample tweets or posts.
11.	Conduct a case-based discussion or prepare a brief report on data privacy, consent, and platform policies when scraping user data.

Textbooks:

1. Matthew Ganis and Avinash Kohirkar, “Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media”, First Edition, IBM Press.
2. Marshall Sponder, “Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics”, First Edition, McGraw-Hill Education.

Reference Books:

1. Charu C. Aggarwal, “Social Network Data Analytics”, First Edition, Springer.
2. Glen L. Urban, “Digital Marketing Strategy: Analytics, Technology, and Customer Engagement”, First Edition, Pearson Education.

Course Name: Internet of Things and Edge Computing

Course Code: CE37T

Category: Professional elective - 4 (IoT Track)

Preamble:

This course explores the convergence of Internet of Things (IoT) and Edge Computing, delving into the technologies and applications that are transforming our world. This course delves into the rapidly evolving landscape where everyday objects are becoming intelligent and interconnected. Students will explore how sensors, actuators, and embedded systems are weaving a web of data, transforming how we live, work, and interact with the environment.

The course will equip students with a foundational understanding of IoT, its core technologies, and communication protocols. Students will delve into the power of Edge Computing, a paradigm shift that brings processing capabilities closer to the data source, enabling real-time analytics, faster decision-making, and improved efficiency.

Pre-requisites:

- C Programming
- Microprocessor and Microcontroller
- IoT Sensor Technology

Course Objectives:

- To understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem**.**
- Evaluate the security challenges and potential vulnerabilities within IoT deployments.
- Understand the fundamental concepts of IoT, CPS, and their convergence.

Course Outcomes:

Student will be able to:

CO1: Understand the interaction between IoT devices, cloud platforms, and physical systems in CPS.
CO2: Apply principles of Edge Computing to analyze data at the network edge.
CO3: Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem.
CO4: Identify and discuss security best practices for secure IoT deployments.
CO5: Analyze the role of cloud computing in managing and processing data from IoT device
CO6: Develop creative applications of IoT technology in chosen fields.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to IoT and CPS	1.1 Introduction to Cyber-Physical Systems (CPS) 1.2 Characteristics and applications of CPS 1.3 Convergence of IoT and CPS: creating intelligent systems	5
2	Introduction to Edge Computing	2.1 What is Edge Computing? 2.2 Benefits of Edge Computing in the IoT ecosystem (e.g., reduced latency, improved efficiency) 2.3 Edge Computing architectures (e.g., edge nodes, fog computing) Resource constraints and limitations of edge devices	5
3	Edge Computing Applications and Programming	3.1 Case studies of Edge Computing applications in IoT (e.g., predictive maintenance, autonomous vehicles) 3.2 Introduction to Edge Computing development tools and frameworks 3.3 Programming for edge devices (e.g., embedded systems programming)	5
4	Security Considerations in IoT	4.1 Security vulnerabilities in IoT deployments 4.2 Authentication and authorization mechanisms 4.3 Data encryption and privacy concerns 4.4 Secure coding practices for IoT devices	5
5	Cloud Computing for IoT	5.1 Cloud service models for IoT (IaaS, PaaS, SaaS) 5.2 Benefits of cloud computing in managing and processing IoT data (scalability, security, etc.) 5.3 Cloud platforms for IoT (e.g., AWS IoT, Azure IoT)	5

		5.4 Data pipelines for transferring and processing sensor data in the cloud	
6	Future Trends in IoT CPS and Edge Computing	6.1 Emerging technologies (e.g., Artificial Intelligence, Block chain) in IoT 6.2 Impact of 5G on IoT and Edge Computing 6.3 Ethical considerations and responsible development of CPS solutions	5
Total			**30**

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Internet of Things and Edge Computing Lab

Course Code: CE37P

Category: Professional elective - 4 (IoT track)

Preamble:

This laboratory course delves into the practical applications of the Internet of Things (IoT), Edge Computing, Cloud Computing, and Cyber-Physical Systems (CPS). Students will gain hands-on experience by working with real-world scenarios and exploring the interaction between these technologies

The lab will equip students with the skills to:

- Design and implement basic IoT systems
- Utilize Edge Computing platforms for data processing closer to the source
- Leverage cloud services for data storage, analysis, and visualization
- Integrate IoT devices with Cyber-Physical Systems for real-world applications

Pre-requisites:

C Programming, Microprocessor and Microcontroller and IoT Sensor Technology

Course Objectives:

- Gain practical experience in setting up and configuring IoT devices.
- Understand and implement data collection and processing techniques on edge devices.
- Analyze and visualize data generated by IoT devices using cloud platforms.
- Design and implement basic Cyber-Physical Systems using IoT and cloud integration.
- Apply security best practices in developing and deploying IoT solutions.

Course Outcomes:

Student will be able to:

CO1: Successfully configure and program various IoT devices (sensors, actuators).

CO2: Utilize Edge Computing platforms for data processing tasks on edge nodes.

CO3: Develop data pipelines to transfer data from IoT devices to the cloud.

CO4: Analyze and visualize sensor data using cloud-based tools and services.

CO5: Design and prototype a basic Cyber-Physical System with IoT and cloud integration.

CO6: Implement secure communication protocols for data transmission in an IoT system.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

List of Practical's:

Experiment 1: Setting Up an IoT Development Environment

- Familiarize with development boards (e.g., Arduino, Raspberry Pi)
- Install necessary software and libraries

Experiment 2: Sensor Interfacing and Data Acquisition

- Interface various sensors (e.g., temperature, humidity) with the development board
- Write code to collect and record sensor data

Experiment 3: Communication Protocols for IoT

- Experiment with different communication protocols (e.g., Wi-Fi, Bluetooth)
- Develop code to send and receive data between devices

Experiment 4: Introduction to Edge Computing Platforms

- Explore popular Edge Computing platforms (e.g., AWS Greengrass, Azure IoT Edge)
- Deploy simple applications for data processing on edge devices

Experiment 5: Cloud Integration for IoT Data

- Connect IoT devices to a cloud platform (e.g., AWS IoT, Azure IoT Hub)
- Develop code to send sensor data to the cloud

Experiment 6: Data Visualization with Cloud Services

- Utilize cloud platform tools to visualize sensor data in real-time (e.g., dashboards, charts)

Experiment 7: Introduction to Cyber-Physical Systems (CPS)

- Simulate a basic CPS scenario (e.g., smart home, industrial automation)
- Integrate IoT devices with actuators to control physical processes

Experiment 8: Security Considerations in IoT Systems

- Implement secure communication protocols (e.g., encryption)
- Understand best practices for securing data transmission and storage in IoT

Mini Projects / Case Study:-

Design and develop a complete IoT-based system with Edge Computing and Cloud integration

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Web Application Security

Course Code: CE32T

Category: Professional Elective-4 (CSec Track)

Preamble:

This course focuses on identifying, analysing, and mitigating vulnerabilities specific to web applications. It empowers students with practical skills using industry-standard tools and frameworks and promotes secure web development practices aligned with OWASP and modern threat landscapes.

Pre-requisites: Web Design Lab(CE12P)

Course Objectives:

- To reveal the underlying web application.
- To identify and aid in fixing any security vulnerabilities during the web development process.
- To understand the security principles in developing a reliable web application.

Course Outcomes:

Learner will be able to:

1. Identify the vulnerabilities in the web applications
2. Identify the various types of threats and mitigation measures of web applications.
3. Apply the security principles in developing a reliable web application.
4. Use industry standard tools for web application security.
5. Create detailed reports on findings, mitigations, and secure design.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Overview of Web Applications	Introduction history of web applications interface and structure benefits and drawbacks of web applications Web application Vs Cloud application, Web architecture, HTTP/HTTPS, sessions, cookies, authentication, same-origin policy, common attack vectors.	4
2	Web Application Security Fundamentals	Security Fundamentals: Input Validation - Attack Surface Reduction Rules of Thumb- Classi- fying and Prioritizing Threads, Origin Policy - Exceptions to the Same-Origin Policy - Cross-Site Scripting and Cross-Site Request Forgery - Reflected XSS - HTML Injection.	7
3	Web Application Vulnerabilities	Understanding vulnerabilities in traditional client server applications and web applications, client state manipulation, cookie-based attacks, SQL injection, cross domain attack (XSS/XSRF/XSSI) http header injection. SSL vulnerabilities and testing - Proper encryption use in web application - Session vulnerabilities and testing - Cross-site request forgery, OWASP Top 10: SQLi, XSS, CSRF, IDOR, File Inclusion, SSRF, XXE. Understanding root causes and testing techniques	6
4	Tools for Security Testing	Burp Suite, ZAP Proxy, Nikto, WFuzz, HTTP interceptors, crawling, fuzzing, authentication testing	6
5	Secure Website Design	Secure website design: Architecture and Design Issues for Web Applications, Deployment Considerations Input Validation, Authentication, Authorization, Configuration Management, Sensitive Data, Session Management, Cryptography, Parameter Manipulation, Exception Management, Auditing and Logging, Design Guidelines, Forms and validity, technical implementation	4
6	Case Studies and Emerging Trends	Recent high-profile web application breaches, evolving attack trends (e.g., API abuse, supply chain), real-world secure architecture examples	3
Total			**30**

Textbooks:

1. Stuttard, D., & Pinto, M. (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws (2nd ed.). Indianapolis: Wiley Publishing. ISBN: 978-1118026472
2. Gowadia, V., & Parekh, A. (2022). Web Application Security: Exploitation and Countermeasures for Java, Python, and Node.js. Berkeley, CA: Apress. ISBN: 978-1484285066

Reference Books:

1. Shema, M. (2014). Hacking Web Apps: Detecting and Preventing Web Application Security Problems. Waltham, MA: Syngress. ISBN: 978-0124166004
2. Erickson, J. (2008). Hacking: The Art of Exploitation (2nd ed.). San Francisco, CA: No Starch Press. ISBN: 978-1593271442
3. Andress, J. (2014). The Basics of Information Security: Understanding the Fundamentals of InfoSec (2nd ed.). Waltham, MA: Syngress. ISBN: 978-0128007440

Online Resources for Learning:

1. OWASP Foundation. Web Security Testing Guide (WSTG). Retrieved from https://owasp.org/www-project-web-security-testing-guide/
2. PortSwigger. Web Security Academy (Interactive Learning Platform). Retrieved from https://portswigger.net/web-security

Course Name: Web Application Security Lab

Course Code: CE32P

Category: Professional Elective-4 (CSec Track)

Preamble:

This course focuses on identifying, analysing, and mitigating vulnerabilities specific to web applications. It empowers students with practical skills using industry-standard tools and frameworks and promotes secure web development practices aligned with OWASP and modern threat landscapes.

Pre-requisites:

Course Objectives:

- To reveal the underlying web application.
- To identify and aid in fixing any security vulnerabilities during the web development process.
- To understand the security principles in developing a reliable web application.

Course Outcomes:

Learner will be able to:

1. Identify the vulnerabilities in the web applications
2. Identify the various types of threats and mitigation measures of web applications.
3. Apply the security principles in developing a reliable web application.
4. Use industry standard tools for web application security.
5. Create detailed reports on findings, mitigations, and secure design.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

1. Web application reconnaissance and spidering using ZAP/Burp Suite
2. Exploit SQL Injection on a vulnerable application (DVWA or Juice Shop)
3. Detect and exploit Cross-Site Scripting (XSS)
4. Perform vulnerability scans using Nikto or ZAP
5. Analyse secure HTTP headers and apply security configurations (CSP, HSTS, etc.)
6. Build and Deploy a Secure Login Module (Design login with input sanitization, secure cookies, and rate-limiting.)
7. Prepare a Security Assessment Report

Course Name: Advance Machine Learning

Course Code: CE29T

Category: Professional Elective-5 (AIML Track)

Preamble:

Advanced Machine Learning is designed to equip undergraduate students with cutting-edge techniques and practical skills in machine learning. Building on foundational ML knowledge, it covers advanced topics such as ensemble methods, probabilistic models, graph-based learning, meta learning, and AutoML. Through a blend of theory and hands-on applications, students will learn to develop, interpret, and deploy sophisticated ML models for real-world challenges. The course aims to bridge the gap between academic concepts and industry-ready expertise.

Pre-requisites:

Machine Learning(CE13T), Analysis of Algorithms (CE04T), Engineering Mathematics-III (BS05), Machine Vision using Python Lab (CE44).

Course Objectives:

- Recall key concepts of advanced ML techniques (regularization, kernels, ensembles, clustering, text analysis) and explain their mathematical foundations (GLMs, EM algorithm, bias-variance tradeoff).
- Implement ML pipelines in Python (e.g., regularized regression, SVM kernels, ensemble models) and compare the performance of clustering, dimensionality reduction, and feature selection methods.
- Assess model robustness through statistical testing, hyperparameter optimization, and concept drift detection to ensure reliability in production systems.
- Design and deploy an end-to-end ML solution integrating advanced techniques while addressing ethical implications (bias, privacy) and sustainability (computational efficiency).

Course Outcomes:

Learners will be able to:
CO1: Recall key concepts of advanced ML techniques including regularization methods, kernel functions, ensemble models, clustering algorithms, and text analysis approaches.
CO2: Explain mathematical foundations of GLMs, kernel tricks, bias-variance tradeoff, EM algorithm, and feature importance methods.
CO3: Implement ML pipelines using Python for regularized regression, SVM with custom kernels, ensemble methods, clustering, and text classification.
CO4: Compare performance of different ML techniques including clustering algorithms, dimensionality reduction methods, and feature selection approaches.
CO5: Assess model robustness through statistical testing, hyperparameter optimization, and monitoring for concept drift in production systems.
CO6: Design and deploy an end-to-end ML solution integrating advanced techniques while considering ethical and sustainability aspects

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Advanced Supervised Learning	• Advanced Regression:Ridge, Lasso, Elastic Net (L1/L2 Regularization), Generalized Linear Models (GLMs) • Support Vector Machines (SVM) – Advanced:Kernel Methods (RBF, Polynomial, Sigmoid), Multiclass SVM (One-vs-Rest, One-vs-One) • Ensemble Learning – Beyond Basics:Gradient Boosting (XGBoost, LightGBM, CatBoost), Stacking & Blending Meta-Models	6
2	Model Evaluation & Hyperparameter Tuning	• Advanced Model Metrics: Precision-Recall Curves, AUC-ROC, Fβ-Score, Statistical Significance Testing (McNemar's Test). • Bias-Variance Tradeoff: Learning Curves, Overfitting Remedies, Hyperparameter Optimization: Grid Search, Random Search, Bayesian Optimization.	5
3	Unsupervised Learning – Beyond Clustering	• Advanced Clustering: Gaussian Mixture Models (EM Algorithm), Hierarchical & Spectral Clustering • Density-Based Methods: HDBSCAN, OPTICS • Dimensionality Reduction: t-SNE, UMAP (vs. PCA)	6
4	Text Analysis with Classical ML	• Topic Modeling: Latent Dirichlet Allocation (LDA), Non-Negative Matrix Factorization (NMF) • Text Classification: Naive Bayes for Text,SVM & Logistic Regression for NLP.	7

		• Sentiment AnalysisLexicon-Based Methods (VADER), Machine Learning Approaches	
5	Feature Engineering & Selection	• Feature Importance:SHAP, LIME (Model Interpretability) • Feature Selection:Recursive Feature Elimination (RFE), Mutual Information & Chi-Square Tests.	5
6	Optimization & ML Systems	• Advanced Optimization:Stochastic Gradient Descent (SGD) Variants,Proximal Methods (for Sparsity) • ML in Production:Concept Drift, Model Monitoring	2
Total			**30**

Textbooks:

1. Ethem Alpaydın, "Introduction to Machine Learning", 4th edition, MIT Press
2. Peter Harrington, "Machine Learning in Action", 1st Edition, Manning Publication
3. Ian Goodfellow, Yoshua, "Deep Learning", 1st Edition, MIT Press

Reference Books:

1. Harsh Bhasin, "Machine Learning for beginners", BPB Publication.
2. Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw Hill.

Course Name: Advance Machine Learning Lab

Course Code: CE29P

Category: Professional Elective-5 (AIML Track)

Preamble:

Advanced Machine Learning Lab is designed to provide hands-on experience with modern machine learning techniques that go beyond the basics. It focuses on regularization methods, kernel-based models, ensemble learning, model evaluation metrics, hyperparameter tuning, clustering, dimensionality reduction, topic modeling, and real-time deployment considerations such as concept drift and monitoring.

Pre-requisites:

Machine Learning Lab(CE13P), Analysis of Algorithms Lab (CE04P), Machine Vision using Python Lab (CE44).

Lab Objectives:

- To understand and apply regularization techniques (Ridge, Lasso, Elastic Net) in regression problems.
- To explore the effect of different SVM kernels on classification tasks
- To build and evaluate ensemble learning models using XGBoost, LightGBM, and CatBoost.
- To analyze classification models using evaluation metrics such as Precision-Recall, AUC-ROC, and Fβ-score.
- To optimize machine learning models through Grid Search, Random Search, and Bayesian Optimization techniques.
- To compare Gaussian Mixture Models with K-Means clustering using real-world datasets.

Lab Outcomes:

Learners will be able to:

CO1: Apply regularization techniques such as Ridge, Lasso, and Elastic Net to improve model generalization and interpret their impact on coefficients.

CO2: Implement and evaluate classification models using SVM with various kernel functions and ensemble techniques like XGBoost, LightGBM, and CatBoost.

CO3: Use advanced evaluation metrics such as Precision-Recall, AUC-ROC, and Fβ-Score to analyze model performance and support decision-making.

CO4: Perform hyperparameter tuning using Grid Search, Random Search, and Bayesian Optimization to improve model accuracy and robustness.

CO5: Apply unsupervised learning algorithms (GMM, K-Means) and dimensionality reduction techniques (PCA, t-SNE, UMAP) for clustering and visualization.

CO6: Design ML pipelines incorporating feature selection (RFE, SHAP), topic modeling (LDA), sentiment analysis, and concept drift detection for real-world deployment.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Implementation of Ridge, Lasso, and Elastic Net Regression
2	SVM with Different Kernels (RBF, Polynomial, Sigmoid) for Classification
3	Gradient Boosting (XGBoost, LightGBM, CatBoost) for Predictive Modeling
4	Model Evaluation with Precision-Recall Curves and AUC-ROC Analysis
5	Hyperparameter Tuning using Grid Search, Random Search, and Bayesian Optimization
6	Gaussian Mixture Models (GMM) vs. K-Means Clustering
7	Dimensionality Reduction using PCA, t-SNE, and UMAP
8	Topic Modeling with LDA and Sentiment Analysis using VADER
9	Feature Selection using Recursive Feature Elimination (RFE) and SHAP
10	Concept Drift Detection and Model Monitoring in ML Systems

Textbooks:

1. Ethem Alpaydın, "Introduction to Machine Learning", 4th edition, MIT Press
2. Peter Harrington, "Machine Learning in Action", 1st Edition, Manning Publication
3. Ian Goodfellow, Yoshua, "Deep Learning", 1st Edition, MIT Press

Reference Books:

1. Harsh Bhasin, "Machine Learning for beginners", BPB Publication.
2. Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw Hill.

Course Name: Big Data Analytics

Course Code: CE34T

Category: Professional Elective-5 (DS Track)

Preamble:

In today's digital era, organizations generate and process enormous volumes of structured and unstructured data. Big Data Analytics has emerged as a critical area in computing to extract actionable insights and support data-driven decisions. This course equips students with foundational knowledge and hands-on skills to handle Big Data using modern platforms and tools like Hadoop, MapReduce, NoSQL, and Apache Spark. It bridges theoretical understanding with industry-relevant applications across domains like e-commerce, healthcare, transportation, and finance.

Pre-requisites:

Data Warehousing and Data Mining (CE21T), Distributed System (CE16T), Advanced Databases (CE26T), Python Programming

Course Objectives:

- Introduce the fundamental concepts, characteristics, and architecture of Big Data systems including HDFS, NoSQL, and Spark components
- Explain the working principles and models of distributed storage and processing frameworks like HDFS, MapReduce, and stream mining systems.
- Provide practical exposure to implementing distributed algorithms, similarity metrics, and stream data processing techniques.
- Equip students to design and develop scalable Big Data solutions by integrating storage, computation, and analytics for real-world applications.

Course Outcomes:

Learners will be able to:
CO1: Recall fundamental concepts: Big Data characteristics (5Vs), HDFS components, NoSQL database types, stream mining algorithms, and Spark architecture.
CO2: Explain the working of HDFS, MapReduce model, NoSQL types, and Big Data stream algorithms with examples.
CO3: Implement MapReduce algorithms (Word Count, Join), streaming algorithms (like Bloom filters, DGIM, and Flajolet-Martin), similarity metrics, and Spark transformations.
CO4: Analyze trade-offs between traditional vs. Big Data systems, CAP theorem applications, stream algorithm efficiency, and clustering performance (CURE).
CO5: Design integrated Big Data solutions using HDFS/NoSQL storage, MapReduce/Spark processing, real-time stream mining, and similarity/clustering analytics for real-world applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Big Data and Hadoop	Introduction to Big Data & Its characteristics (5 Vs); Type of Big Data; Traditional vs Big Data systems; Hadoop architecture; Core Hadoop Components; Hadoop Limitations. (CO1, CO2).	6
2	HDFS & MapReduce	HDFS: Namenode, Datanode, block storage, replication; Reading & Writing Mechanism in HDFS; MapReduce programming model: mapper, reducer, combiner; Algorithms: Word Count, Matrix multiplication, Union, Join.	5
3	NoSQL	Need for NoSQL database; Types of NoSQL: Document, Key-Value, Columnar, Graph; CAP Theorem.	4
4	Mining Data Streams	Stream processing model & Examples of Stream Sources; Stream Queries & Issues in Stream Processing; Filtering Streams: Bloom Filter with Analysis; Counting distinct elements: Flajolet-Martin algorithm; Counting frequent items in a stream, decaying windows; Counting ones in a sliding window: DGIM algorithm.	5
5	Similarity Measures & Clustering	Similarity Measures: Euclidean, Jaccard, Cosine, Edit distance, and Hamming distance; Frequent Itemset Mining: Apriori Algorithm, Algorithm of Park Chen-Yu; Clustering algorithms in big data; CURE algorithm	5
6	Introduction to Apache Spark	Spark architecture: RDDs, DataFrames, DAG; Transformations & Actions; Spark SQL	4
Total			**30**

Textbooks:

1. Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets||, Cambridge UniversityPress
2. Alex Holmes —Hadoop in Practice||, Manning Press, Dreamtech Press
3. Dan Mcary and Ann Kelly - Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.
4. DT Editorial Services, —Big Data Black Book, Dreamtech Press
5. EMC Education Services, Data Science and Big Data Analytic, Wiley

Reference Books:

1. Bill Franks,- Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams with Advanced Analytic, Wiley.
2. Chuck Lam, - Hadoop in Action, Dreamtech Press
3. Jared Dean, - Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, - Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, - Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition,2010.
6. Ronen Feldman and James Sanger, - The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
7. Vojislav Kecman, - Learning and Soft Computing, MITPress, 2010.

Course Name: Big Data Analytics Lab

Course Code: CE34P

Category: Professional Elective-5 (DS Track)

Preamble:

In today's data-driven world, traditional data processing systems are unable to handle the volume, variety, and velocity of big data. The Big Data Lab aims to equip learners with practical skills in distributed computing, data stream processing, NoSQL databases, and large-scale data analysis frameworks.

Pre-requisites:

Data Warehousing and Data Mining Lab (CE21P), Distributed System Lab (CE16P), Advanced Databases Lab (CE26P), Python Programming.

Lab Objectives:

- To understand the architecture and working of big data processing frameworks like Hadoop and Spark.
- To perform HDFS operations and implement distributed computing using MapReduce.
- To explore and interact with NoSQL databases like MongoDB.
- To implement streaming algorithms for frequency and distinct element estimation.
- To analyze similarity and pattern detection using distance measures and frequent itemset mining.
- To design complete big data pipelines involving ingestion, processing, and visualization using open-source tools..

Lab Outcomes:

Learners will be able to:
LO1: Install and configure big data environments such as Hadoop and Spark, and perform basic HDFS and RDD operations.
LO2: Develop and execute distributed applications using MapReduce for data aggregation and joining tasks.
LO3: Perform CRUD operations and visualize semi-structured data using NoSQL systems like MongoDB.
LO4: Implement stream processing algorithms (Bloom Filter, Flajolet-Martin, DGIM) to handle data with high velocity.
LO5: Analyze large datasets using similarity metrics, clustering, and frequent itemset mining to extract meaningful patterns and insights.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Install and configure Hadoop in pseudo-distributed mode.
2	Perform file operations (upload, read, delete) in HDFS using CLI.
3	Implement Word Count using MapReduce.
4	Implement Reduce Side Join using MapReduce.
5	Perform CRUD operations on MongoDB and visualize documents.
6	Implement Bloom Filter for stream filtering
7	Implement Flajolet-Martin and DGIM algorithms for stream frequency and distinct counting
8	Apply similarity metrics (Jaccard, Cosine, Edit Distance) on sample datasets.
9	Implement Apriori algorithm for frequent itemset mining.
10	Set up Apache Spark and execute RDD transformations and actions.
11	Perform clustering using CURE or KMeans algorithm and visualize clusters.
12	Capstone Project: Design an End-to-End Big Data Solution – Ingest, process, analyse, and visualize a large dataset using Hadoop/Spark, and NoSQL

Textbooks:

1. Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets, Cambridge
2. University Press
3. Alex Holmes —Hadoop in Practice‖, Manning Press, Dream Tech Press
4. Dan Mcary and Ann Kelly - Making Sense of NoSQL – A guide for managers and the
5. rest of us, Manning Press.
6. DT Editorial Services, —Big Data Black Book, Dream Tech Press
7. EMC Education Services, Data Science and Big Data Analytic, Wiley

Reference Books:

1. Bill Franks,- Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams with Advanced Analytic, Wiley.
2. Chuck Lam, - Hadoop in Action, Dreamtech Press

3. Jared Dean, - Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, - Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, - Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition,2010.
8. Ronen Feldman and James Sanger, - The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
9. Vojislav Kecman, - Learning and Soft Computing, MITPress, 2010.

Course Name: Internet of Things Security and Trust

Course Code: CE39T

Category: Professional elective - 5 (IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches fundamental aspects of security and different techniques for providing security to IoT application.

Pre-requisites:

C Programming
Object Oriented Programming
Microprocessor and Microcontroller

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:

CO1: Understand the concepts of security in IoT system.
CO2: Implement mechanism to handle IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use monitoring tools for providing IoT security.
CO5: Use techniques for efficient firmware design of IoT application.
CO6: Identify different attacks.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction	Overview of industrial control systems (ICS), ICS operation & components, Perdue model, SCADA systems, Cyber-physical systems (CPS) & IoT	4
2	IoT Vulnerabilities and Threats	STRIDE methodology, OWASP Iot vulnerabilities, Privacy & trust, Insufficient authentication/authorization, Insufficient access control, Attacks on IoT data, Attacks on IoT layered architecture, Security concerns in IoT applications, Security concerns in SCADA	6
3	IoT Pen Testing	Active vulnerability analysis tools, Port scanning, Operating system fingerprinting and version scanning, Penetration testing, Attack surface mapping	6
4	Monitoring Tools	Exploitation using I2C & SPI, JTAG debugging and exploitation, Boundary scan, Test access ports	6
5	Firmware Implementation	Understanding firmware, Extracting firmware, Manual firmware extraction, Automated file system extraction, Firmware internals, Backdooring a firmware, Static & dynamic analysis	4
6	Attack Surfaces	Software defined radio, Exploiting ZIGBEE & BLE, Power analysis attack, Invasive attack, Perturbation -attacks, Electromagnetic side channel attack, fault injection attack, timing attack, covert channel attacks	4
Total			**30**

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.

2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.
3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Course Name: Internet of Things (IoT) Security and Trust Lab

Course Code: CE39P

Category: Professional Elective- 5 (IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches implementation of different security techniques for IoT application. It also enables learner to use standard tools and frameworks for developing efficient security solutions.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:
CO1: Identify metrics for providing security in IoT system.
CO2: Implement techniques for handling IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use tools and frameworks for providing security to IoT applications.
CO5: Design efficient secure firmware for IoT applications.
CO6: Implement mechanism to handle different types of attacks in IoT application.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following concepts

1. Identification and implementation of standard metrics for providing security.
2. Handle different types of threats and vulnerabilities in IoT application.
3. Perform security testing of IoT application.
4. Identify and explore different tools for monitoring and providing security to IoT applications.
5. Design secure firmware for IoT application.
6. Handle different types of attacks in IoT application.

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.
2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.
3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction. ***Student will lose the marks if he or she remains absent for the Laboratory Practical Session.***

Course Name: Malware Analysis

Course Code: CE35T

Category: Professional Elective-5 (CSec Track)

Preamble:

The course "Malware Analysis" is designed to equip students with the theoretical knowledge and practical skills required to detect, analyze, and respond to malicious software threats. With the increasing complexity and frequency of cyberattacks, understanding the techniques used by attackers and reverse engineering malware is crucial for cyber defense professionals.

Pre-requisites:

CE28 (System Security and Ethical Hacking) and CE41 (Digital Forensics)

Course Objectives:

After completing this course, you will be able to learn:

- Introduce the fundamentals of malware and its impact on computing systems.
- Enable students to perform static and dynamic analysis of malware.
- Equip students with the knowledge to use forensic and reverse engineering tools.
- Familiarize students with malware detection, classification, and reporting techniques.
- Develop hands-on skills to safely analyze malware in controlled environments.

Course Outcomes:
Learner will be able to learn:

CO1: Describe various types of malware, their behavior, and infection mechanisms.
CO2: Apply static and dynamic malware analysis techniques to extract and interpret behavior and artifacts.
CO3: Use tools for reverse engineering and demonstrate understanding of anti-analysis techniques.
CO4: Utilize automated analysis tools and synthesize malware analysis reports including IOCs.
CO5: Analyze and evaluate real-world malware samples using forensic approaches and document the findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a

panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Malware	Definition, types, history, and trends of malware Malware lifecycle and delivery mechanisms Real-world case studies	5
2	Malware Behavior and Infection Vectors	Persistence mechanisms, privilege escalation Fileless malware, macro malware, polymorphism Indicators of Compromise (IOCs)	6
3	Static Malware Analysis	PE file structure, hashing, strings extraction Disassembly using IDA Free/Ghidra Assembly code basics	7
4	Dynamic Malware Analysis	Sandboxing, system call monitoring Behavioral analysis using Process Monitor, ProcMon Network behavior using Wireshark	7
5	Reverse Engineering & Anti-Analysis Techniques	Anti-debugging and anti-VM techniques Unpacking and decryption Debugging with x64dbg/OllyDb	5
6	Automated Malware Analysis & Reporting	Cuckoo Sandbox and Any.Run usage Classification and signature creation Threat Intelligence Platforms Malware reporting and IOCs	2
Total			**30**

Textbooks:

1. Practical Malware Analysis by Michael Sikorski and Andrew Honig
2. The IDA Pro Book by Chris Eagle
3. Malware Analyst's Cookbook and DVD by Ligh et al.

Reference books:

1. The Art of Memory Forensics by Ligh, Case, Levy, Walters
2. Rootkits: Subverting the Windows Kernel by Greg Hoglund
3. Online Resources: VirusTotal, Hybrid Analysis, Any.Run, Cuckoo Sandbox Documentation

Course Name: Malware Analysis Lab

Course Code: CE35P

Category: Professional Elective-5 (CSec Track)

Preamble:

The course "Malware Analysis" is designed to equip students with the theoretical knowledge and practical skills required to detect, analyze, and respond to malicious software threats. With the increasing complexity and frequency of cyberattacks, understanding the techniques used by attackers and reverse engineering malware is crucial for cyber defense professionals.

Pre-requisites:

CE28 (System Security and Ethical Hacking) and CE41 (Digital Forensics)

Course Objectives:

After completing this course, you will be able to learn:

- Introduce the fundamentals of malware and its impact on computing systems.
- Enable students to perform static and dynamic analysis of malware.
- Equip students with the knowledge to use forensic and reverse engineering tools.
- Familiarize students with malware detection, classification, and reporting techniques.
- Develop hands-on skills to safely analyze malware in controlled environments.

Course Outcomes:

Learner will be able to learn:

CO1: Describe various types of malware, their behavior, and infection mechanisms.
CO2: Apply static and dynamic malware analysis techniques to extract and interpret behavior and artifacts.
CO3: Use tools for reverse engineering and demonstrate understanding of anti-analysis techniques.
CO4: Utilize automated analysis tools and synthesize malware analysis reports including IOCs.
CO5: Analyze and evaluate real-world malware samples using forensic approaches and document the findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	2

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a

panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr. No.	Suggested Topic(s)
1	Perform string analysis and examine PE file headers.
2	Observe malware behavior using system monitoring tools.
3	Monitor and analyze malware's network behavior.
4	Analyze malware using an automated sandbox environment.
5	Disassemble malware and interpret logic.
6	Final Project: Perform end-to-end malware analysis and documentation.
7	Study and present a real-world case study where blockchain is used with cognitive applications.

Textbooks:

1. Practical Malware Analysis by Michael Sikorski and Andrew Honig

2. The IDA Pro Book by Chris Eagle

3. Malware Analyst's Cookbook and DVD by Ligh et al.

Reference books:

1. The Art of Memory Forensics by Ligh, Case, Levy, Walters

2. Rootkits: Subverting the Windows Kernel by Greg Hoglund

3. Online Resources: VirusTotal, Hybrid Analysis, Any.Run, Cuckoo Sandbox Documentation

Course Name: Deep Learning

Course Code: CE33T

Category: Professional Elective-6 (AIML Track)

Preamble:

Deep Learning has emerged as a transformative technology powering advancements in artificial intelligence, from computer vision and natural language processing to healthcare and autonomous systems. This course provides a comprehensive introduction to the foundational concepts, architectures, and applications of deep neural networks. Students will gain hands-on experience with modern frameworks (e.g., TensorFlow/PyTorch) and learn to design, train, and evaluate models for real-world problems.

Pre-requisites:

- Proficiency in Python programming.
- Familiarity with linear algebra, calculus, and probability.
- Basic knowledge of machine learning (supervised/unsupervised learning).

Course Objectives:

After completing this course, you will be able to learn:

- Understand the mathematical and computational principles behind deep learning.
- Implement and experiment with key architectures (CNNs, RNNs, Transformers, etc.).
- Develop skills in data preprocessing, model optimization, and hyperparameter tuning.
- Apply deep learning techniques to tasks like image classification, sequence modeling, and generative AI.
- Critically analyze the ethical and societal implications of deployed systems.

Course Outcomes:

Learner will be able to learn:

CO1: Explain fundamental concepts of neural networks (perceptrons, MLPs, activation functions) and analyze their representation power
CO2: Implement feedforward networks using gradient-based optimization and derive backpropagation mathematically.
CO3: Design autoencoders and apply regularization techniques to mitigate overfitting in deep networks.
CO4: Optimize deep architecture using advanced techniques (batch norm, attention, word embeddings).
CO5: Develop CNN/RNN models for vision and sequence tasks and diagnose vanishing gradient problems.
CO6: Build generative models (VAEs, GANs, transformers) and critique their ethical implications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Deep Learning	History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons	2
2	Neural Network Training Fundamentals	Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, FeedForward Neural Networks, Backpropagation	4
3	Autoencoders & Regularization	Autoencoders and relation to PCA, Regularization in autoencoders, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout	6
4	Advanced Architectures & Representations	Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations Of Words, Encoder Decoder Models, Attention Mechanism, Attention over image	6
5	Advancement of CNNs and RNNs	Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs	6
6	Generative Deep Learning	Variational Autoencoders (VAEs): Latent space, reparameterization trick, Applications in image generation, Transformer-based Gen Models: GPT architecture (decoder-only), Self-attention for text generation, Autoregressive Models: PixelRNN, WaveNet, Token-based generation (e.g., char-RNNs)	6
Total			**30**

Textbooks:

1. Deep Learning, Goodfellow, Ian, author, Cambridge, Massachusetts: The MIT Press
2. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, Springer
3. Pattern Recognition and Machine Learning, Christopher Bishop, Springer

Reference books:

1. Artificial Intelligence: A Modern Approach, Russell & Norvig, 4th Edition, Pearson
2. Machine Learning: A Probabilistic Perspective, Kevin Murphy, MIT Press
3. Speech and Language Processing, Jurafsky & Martin, Pearson

Course Name: Deep Learning Lab

Course Code: CE33P

Category: Professional Elective-6 (AIML Track)

Preamble:

This hands-on lab complements the theoretical foundations of deep learning by providing practical experience in designing, training, and evaluating neural networks. Through coding exercises, projects, and experiments, students will gain proficiency in modern frameworks (e.g., TensorFlow/PyTorch) and learn to solve real-world problems using state-of-the-art architectures.

Pre-requisites:

- Basic Python programming.
- Familiarity with linear algebra and calculus (gradients).
- Core deep learning concepts

Course Objectives:

After completing this course, you will be able to learn:

- Implement Core Neural Network Components.
- Develop End-to-End Deep Learning Pipelines
- Optimize Models with Advanced Techniques
- Generate and Evaluate Synthetic Data.

Course Outcomes:

Learner will be able to learn:

CO1: Implement Neural Networks from Scratch
CO2: Build and Deploy CNN/RNN Models.
CO3: Debug and Improve Model Performance.
CO4: Generate Data with Generative Models.
CO5: Evaluate Ethical and Technical Trade-offs.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	2

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr. No.	Suggested Topic(s)
1	Train a single-layer perceptron to perform binary classification (e.g., AND/OR gates) using Python and NumPy.
2	Develop an MLP using PyTorch/TensorFlow to classify handwritten digits (MNIST dataset).
3	Plot the loss landscape for a simple model and compare convergence rates of SGD, Momentum, and Adam optimizers.
4	Experiment with dropout, L2 regularization, and early stopping to improve model generalization on a noisy dataset.
5	Design a CNN (e.g., LeNet or custom architecture) to classify images from the CIFAR-10 dataset.
6	Fine-tune a pre-trained CNN (e.g., ResNet, VGG) on a custom dataset using PyTorch/TensorFlow.
7	Train an LSTM/GRU model to predict stock prices or perform sentiment analysis on text data.
8	Build and train a denoising autoencoder to reconstruct corrupted images (e.g., noisy MNIST digits).
9	Train a DCGAN to generate synthetic images (e.g., faces or handwritten digits) and evaluate output quality.
10	Implement a transformer-based model (e.g., simplified GPT or seq2seq with attention) for language translation tasks.

Textbooks:

1. Deep Learning with Python – François Chollet
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
3. PyTorch Pocket Reference" – Joe Papa

Reference books:

1. Deep Learning for Computer Vision with Python – Adrian Rosebrock
2. Natural Language Processing with PyTorch – Delip Rao & Brian McMahan
3. Generative Deep Learning – David Foster

Course Name: Recommendation System

Course Code: CE38T

Category: Professional Elective -6 (DS Track)

Preamble:

In the digital age, recommendation engines have become an integral part of personalized user experiences across various domains such as e-commerce, entertainment, education, and social media. This course introduces students to the fundamental concepts, methodologies, and algorithms used in designing and implementing recommendation systems. It explores collaborative filtering, content-based filtering, hybrid models, and the use of machine learning and deep learning techniques in personalization. Through theoretical foundations and practical applications, the course equips learners with the skills to analyse user behaviour, handle large-scale data, and build intelligent systems that deliver relevant and meaningful recommendations. The goal is to prepare students to design robust, scalable, and ethically responsible recommendation engines that enhance user satisfaction and engagement.

Pre-requisites:

CE13 (Machine Learning), CE21 (Soft Computing)

Course Objectives:

- To introduce the core concepts and techniques used in recommendation systems.
- To explore different recommendation algorithms, including collaborative filtering, content-based filtering, and hybrid approaches.
- To understand how deep learning and AI techniques enhance recommendations.
- To apply recommendation techniques to real-world datasets.
- To evaluate and optimize recommendation models using appropriate metrics.

Course Outcomes:

Learner will be able to:
CO1: Understand the principles and applications of recommendation systems.
CO2: Implement different recommendation techniques and compare their effectiveness.
CO3: Design and develop a recommendation system using machine learning models.
CO4: Evaluate the performance of recommendation systems using standard metrics.
CO5: Apply recommendation techniques to domains such as e-commerce, media, and healthcare.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Recommendation Systems	Definition and Types of recommendation systems Business value of Recommender System A conceptual framework for understanding recommender system Real World Applications, Challenges in building recommendation systems	4
2	Data for recommendation: Explicit Vs Implicit data collection	Scales of measurement, Statistical and machine learning foundations for recommender system, Data preprocessing	4
3	Collaborative Filtering	Collaborative filtering approaches: Memory based and model based, Memory based collaborative filtering foundations: Distance and similarity measures User based collaborative filtering, Item based collaborative filtering, Model based collaborative filtering foundations: matrix factorization, UV decomposition, Singular value decomposition Model based collaborative filtering techniques: SVD, SVD++ etc	6
4	Content based recommender System	Feature engineering: Feature extraction, feature selection, dimensionality reduction 4.2 Content-based recommended system examples with few supervised machine learning techniques	6
5	Evaluation of recommended systems	Online and offline evaluation, metrics such as RMSE, AME, Good Item MAE, Good predicted item MAE, Precision, Recall, F1 Measure, NDCG, Average Reciprocal Rank	6
6	Case Studies & Applications	Overview of other types of recommended systems such as trust based, social network based, and context aware systems, Case Studies (E.g.: Netflix, Flipkart)	4
Total			**30**

Textbooks:

1. Recommender Systems: An Introduction, Dietmar Jannach, Markus Zanker, Alexander Felfernig, Gerhard Friedrich,Cambridge University Press,First edition
2. Recommender Systems Handbook Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor,Springer, second edition
3. Hands-On Recommendation Systems with Python, Rounak Banik, Packt Publishing,First edition

Reference Books:

1. Practical Recommender Systems, Kim Falk, Manning Publications
2. Recommendation Engines, Michael Schrage, MIT Press
3. Deep Learning for Recommender Systems, Charu Aggarwal, Springer

Course Name: Recommendation Systems Lab

Course Code: CE38P

Category: Professional Elective-6 (DS Track)

Preamble:

The Recommendation Systems Laboratory is designed to provide hands-on experience in implementing and evaluating various recommendation algorithms. Students will work with real-world datasets and apply machine learning, deep learning, and hybrid approaches to build personalized recommendation systems. The course ensures that students gain practical exposure to industry-standard tools and libraries used for recommendation model development.

Pre-requisites:

CE13 (Machine Learning), CE21 (Soft Computing)

Lab Objectives:

- Provide hands-on experience in implementing different recommendation algorithms.
- Develop skills in working with real-world datasets for building recommendation models.
- Learn to evaluate and optimize the performance of recommendation systems.
- Apply deep learning techniques for recommendation models.
- Explore industry use cases and ethical considerations in recommendation systems.

Lab Outcomes:

Learner will be able to:
LO1: Understand and explore different types of recommendation systems.
LO2: Apply various recommendation algorithms using Python libraries.
LO3: Analyze the performance of recommendation models using evaluation metrics.
LO4: Evaluate and compare different recommendation techniques based on efficiency and accuracy.
LO5: Develop a complete recommendation system for a real-world application.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Introduction to Recommendation Systems
2	Content-Based Filtering
3	User-Based Collaborative Filtering
4	Item-Based Collaborative Filtering
5	Matrix Factorization using SVD
6	Hybrid Recommendation System
7	Implementing Recommendation Models using Surprise Library
8	Machine Learning for Recommendations
9	Evaluating Recommendation Systems
10	Project: Building a real-life application-based Recommendation System

Textbooks:

1. Recommender Systems: An Introduction, Dietmar Jannach, Markus Zanker, Alexander Felfernig, Gerhard Friedrich,Cambridge University Press,First edition
2. Recommender Systems Handbook Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor,Springer, second edition
3. Hands-On Recommendation Systems with Python, Rounak Banik, Packt Publishing,First edition

Reference Books:

1. Practical Recommender Systems, Kim Falk, Manning Publications
2. Recommendation Engines, Michael Schrage, MIT Press
3. Deep Learning for Recommender Systems, Charu Aggarwal, Springer

Course Name: Industrial Internet of Things (IIoT)

Course Code: CE40T

Category: Professional elective – 6 (IoT Track)

Preamble:
This course introduces students to IIoT complexity on a scale previously unseen in the software industry. Software architecture must accommodate these heterogeneous domains and competencies and handle the increasing levels of complexity. The IIoT generates large amounts of data that is subsequently stored, analysed, archived and eventually fed back into the product life cycle.

Pre-requisites:

- Modern Sensor Technology for IoT
- Principles of IoT

Course Objectives:
- To understand the concepts of Industry 4.0 and IIoT.
- To learn the reference architecture of IIoT
- To learn industrial data acquisition and transmission
- To learn the IIoT key technologies.
- To learn securities in IIoT.
- To learn application areas in IIoT.

Course Outcomes:

Student will be able to:
CO1: Understand the fundamentals of Industry 4.0 and IIoT.
CO2: Understand different types of architectures required in the IIoT applications.
CO3: Apply knowledge of data acquisition and transmission techniques required in IIoT.
CO4: Understand Key technologies required in the implementation of IIoT model.
CO5: Create a security system for IIoT application.
CO6: Design prototype model of IIoT system.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction	Overview of Industry 4.0 and Industrial Internet of Things, Industrial Internet, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Basics, IIOT and Industry 4.0, Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with Devices on the Edge, Determining a Request/Response Model	4
2	IIOT Reference Architecture	The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints. The Three-Tier Topology, Key Functional Characteristics of Connectivity. Software Architectural Style for the Industrial Internet of Things. Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, and The Architectural Style.	5
3	IIoT data acquisition and transmission	Introduction, Features and Components of - Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN) NB-IoT, IEEE 802.11AH, Distributed Control System, PLC, SCADA	6
4	Key Technologies in IIoT	Off-Site Technologies: Cloud Computing in IIOT Fog Computing: Principles, Architectures, and Applications. On-Site Technologies: Big Data and Advanced Analytics	5
5	IIoT securities	Securing the Industrial Internet- Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management. Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security. The IoT Security Lifecycle	6

Module no	Module name	Content	No of Hours
6	IIoT Applications	Develop New Business Models : Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce. Inventory Management and Quality Control: Introduction, Inventory Management and IIOT, Quality Control Case Studies: Manufacturing Industry, Automotive Industry and Mining Industry, Healthcare Applications in Industries, Challenges associated with Healthcare	4
Total			**30**

Textbooks:

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. "Introduction to Industrial Internet of Things and Industry 4.0",by Sudip Misra, Chandana Roy And Anandarup Mukherjee, CRC Press (Taylor & Francis Group)
3. "Internet of Things Principles and Paradigms", by Rajkumar Buyya, Amir Vahid Dastjerdi, ELSEVIER Inc.
4. Internet of things For Architects, Perry Lea Packt Publication,2018

Reference Books:

1. "Practical Internet of Things Security", by Brian Russell, Drew Van Duren (Packt Publishing)
2. "Industrial Internet of Things and Communications at the Edge", by Tony Paine, CEO, Kepware Technologies
3. "Architectural Design Principles For Industrial Internet of Things", Hasan Derhamy, Luleå University of Technology, Graphic Production

Course Name: Industrial Internet of Things (IIoT) Laboratory

Course Code: CE40P

Category: Professional elective – 6 (IoT Track)

Preamble:

The IIoT Lab is a hands-on learning environment where you will gain practical experience in designing, developing, and deploying IIoT solutions. By the end of this lab, students will have a strong foundation in IIoT concepts and be prepared to apply your knowledge to real-world industrial applications.

Pre-requisites:

Modern Sensor Technology for IoT and Principles of IoT

Course Objectives:

- Familiarize students with the fundamentals of Industrial IoT (IIoT)
- Understand the core concepts of IIoT, including sensors, actuators, communication protocols, and data analytics
- Gain insights into the applications of IIoT in various industries
- Develop the skills necessary to design and implement IIoT solutions

Course Outcomes:

Student will be able to:

CO1: Learn IIoT and its key components

CO2: Study and interface the different types of sensors and actuators used in IIoT applications

CO3: Analyze the various communication protocols used in IIoT

CO4: Analyze and interpret data collected from IIoT devices

CO5: Design and implement simple IIoT solutions

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

Suggested List of Practical:

1) **Familiarization with Development Boards:** This experiment will get students familiar with popular development boards like Arduino Uno or Raspberry Pi. Students will learn how to set up the board, install the necessary software, and write simple programs to control LEDs, read sensor data, and control actuators.
2) **Sensor Interfacing**: This experiment will introduce students to various sensors used in IIoT applications, such as temperature sensors, humidity sensors, light sensors, and pressure sensors. Students will learn how to interface these sensors with the development board and read the sensor data.
3) **Actuator Control:** This experiment will introduce students to actuators used in IIoT applications, such as relays, motors, and solenoids. Students will learn how to control these actuators using the development board based on sensor readings or user input.
4) **Data Visualization**: This experiment will teach students how to visualize the data collected from sensors. Students will use software tools to plot the data on graphs and charts, allowing for easier monitoring and analysis.
5) **Communication Protocols:** This experiment will cover various communication protocols used in IIoT, such as Modbus, Profibus, and MQTT. Students will learn how to configure these protocols for communication between devices and the cloud platform.
6) **Cloud Integration**: This experiment will introduce students to cloud platforms for IIoT applications. Students will learn how to connect their IIoT devices to the cloud platform, send sensor data to the cloud, and receive commands from the cloud.
7) **Remote Monitoring and Control:** This experiment will build on the previous experiments by creating a system where students can remotely monitor sensor data and control actuators over the internet.
8) **Data Analytics:** This experiment will introduce students to basic data analytics techniques used in IIoT applications. Students will learn how to analyze sensor data to identify trends, patterns, and anomalies.
9) Robotics arms and Industry 4.0 Setup

Textbooks:

1. Industrial Automation with the Internet of Things by Andreas Georgakopoulos and Peter Slyepen
2. Designing the Industrial Internet of Things by Adrian McEwen and Hakim El-Darwich

Reference Books:

1. Internet of Things (IoT) Prototyping with Arduino and Raspberry Pi by Colin Wong
2. Hands-On Industrial Internet of Things by Richard Radoczki

Course Name: Mobile & Wireless Security

Course Code: CE36T

Category: Professional Elective -6 (CSec Track)

Preamble:

The rapid proliferation of mobile devices and wireless networks has introduced unique security challenges. This course focuses on understanding threats, vulnerabilities, and defenses specific to mobile platforms and wireless communication. Students will learn about attack vectors, security protocols, and mitigation strategies, with an emphasis on practical tools for securing mobile and wireless systems.

Pre-requisites:

CE24T (Computer Network & Security)

Course Objectives:

- Understand the architecture and security challenges of mobile and wireless systems.
- Explore vulnerabilities and attack methods in mobile devices and wireless networks.
- Familiarize students with tools used for penetration testing and securing mobile and wireless platforms.
- Study security protocols and frameworks used in wireless communications.
- Develop strategies to protect against malware, phishing, and other mobile-based attacks.

Course Outcomes:

Learner will be able to:
CO1: Analyze and identify threats in mobile and wireless systems
CO2: Perform security assessments using industry-standard tools.
CO3: Understand and implement wireless security protocols.
CO4: Mitigate risks associated with mobile applications and platforms
CO5: Demonstrate knowledge of securing IoT devices and wireless communications

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Mobile & Wireless Security	Overview of mobile and wireless security landscape. Threats and vulnerabilities in mobile platforms. Introduction to mobile and wireless attack surfaces. Self-Learning Topics: Evolution of mobile communication technologies (2G to 5G), Mobile operating systems (Android, iOS) security features, Wireless communication standards and protocols (Wi-Fi, Bluetooth, LTE)	4
2	Mobile Device Security	Mobile operating systems (Android and iOS): Security architecture and features. Mobile device management (MDM) and policies. Securing mobile apps: Code 6 analysis, permissions, and data storage. Threats: Rooting/jailbreaking, malware, phishing. Tools Covered: MobSF (Mobile Security Framework): For mobile app security assessment. Frida: For runtime analysis of mobile applications. Self-Learning Topics: Android and iOS app security models , Best practices for secure mobile app development, Overview of OWASP Mobile Top 10 vulnerabilities, Static and dynamic mobile app analysis techniques, Case studies on real-world mobile security breaches, Introduction to mobile threat defense (MTD) solutions.	6
3	Wireless Network Security	Wireless protocols: Wi-Fi, Bluetooth, NFC, and Zigbee. WPA, WPA2, WPA3: Strengths and weaknesses. Common attacks: Eavesdropping, MITM, rogue access points, replay attacks. Wireless intrusion detection and prevention systems. Tools Covered: Aircrack-ng: For Wi-Fi penetration testing. Wireshark: For traffic capture and network analysis. Self Learning topics: Differences between personal and enterprise wireless security configurations, IEEE 802.11 standards and security extensions, Real-world case studies of wireless network breaches.	6
4	Mobile Application Security	To understand the principles of secure mobile application development, perform static and dynamic analysis, and identify vulnerabilities using industry-standard tools and frameworks. Self-Learning Topics: Mobile app development lifecycle and security checkpoints, Android	4

		app components and security implications (Activities, Services, Broadcast Receivers), Secure data storage and transmission practices in mobile apps	
5	IoT and Wearable Device Security	Security challenges in IoT and wearable devices. Protocols used in IoT communication (MQTT, CoAP). Securing IoT devices and gateways. Case studies: IoT attacks and their mitigation. Tools Covered: Shodan: For IoT device discovery and analysis. IoT Inspector: For IoT traffic analysis. Self-Learning Topics: Security implications of constrained devices and networks, Device authentication and firmware security in IoT, Threat modeling for IoT systems.	6
6	Mobile and Wireless Incident Handling	Steps in mobile and wireless incident response. Analyzing and preserving evidence from mobile and wireless systems. Case studies: Mobile malware and wireless network breaches. Tools Covered: Cellebrite UFED: For mobile device forensic investigation. Kali Linux Wireless Tools: For wireless incident analysis. Self-Learning Topics: Legal and ethical aspects of digital forensics, Chain of custody and evidence handling procedures, Mobile device acquisition techniques (logical, physical, and file system extraction)	4

Textbooks:

1. Mobile Application Security Himanshu Dwivedi, Chris Clark, David Thiel McGraw-Hill
2. Wireless and Mobile Device Security Jim Doherty Jones & Bartlett Learning

Reference Books:

1. The Mobile Application Hacker's Handbook Dominic Chell, Tyrone Erasmus, Shaun Colley, Ollie Whitehouse Wiley
2. Network Security Essentials: Applications and Standards William Stallings Pearson

Course Name: Mobile & Wireless Security Lab

Course Code: CE36P

Category: Professional Elective -6 (CSec Track)

Preamble:

The rapid proliferation of mobile devices and wireless networks has introduced unique security challenges. This course focuses on understanding threats, vulnerabilities, and defenses specific to mobile platforms and wireless communication. Students will learn about attack vectors, security protocols, and mitigation strategies, with an emphasis on practical tools for securing mobile and wireless systems.

Pre-requisites:

CE24P (Computer Network & Security Lab)

Course Objectives:

- Understand the architecture and security challenges of mobile and wireless systems.
- Explore vulnerabilities and attack methods in mobile devices and wireless networks.
- Familiarize students with tools used for penetration testing and securing mobile and wireless platforms.
- Study security protocols and frameworks used in wireless communications.
- Develop strategies to protect against malware, phishing, and other mobile-based attacks.

Course Outcomes:

Learner will be able to:
CO1: Analyze and identify threats in mobile and wireless systems
CO2: Perform security assessments using industry-standard tools.
CO3: Understand and implement wireless security protocols.
CO4: Mitigate risks associated with mobile applications and platforms
CO5: Demonstrate knowledge of securing IoT devices and wireless communications

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Setting Up a Mobile and Wireless Security Lab
2	Mobile Application Security Testing
3	Reverse Engineering Android Applications
4	Wireless Network Penetration Testing
5	Rogue Access Point and Evil Twin Attack Simulation
6	IoT Device Security Analysis
7	Bluetooth Security Testing

Textbooks:

- Mobile Application Security Himanshu Dwivedi, Chris Clark, David Thiel McGraw-Hill
- Wireless and Mobile Device Security Jim Doherty Jones & Bartlett Learning

Reference Books:

- The Mobile Application Hacker's Handbook Dominic Chell, Tyrone Erasmus, Shaun Colley, Ollie Whitehouse Wiley
- Network Security Essentials: Applications and Standards William Stallings Pearson

Detailed syllabus of Open Elective Courses

Course Name: Cyber Law

Course Code: OE21

Category: Open Elective

Preamble:

This course explores the evolving landscape of cyber law and security, equipping students with legal frameworks and technology insights necessary to navigate the challenges posed by digital crimes. It emphasizes both technical and legal aspects of cybersecurity, with a focus on Information Technology Act, 2000 (ITA 2000) and the amendments in the Information Technology Amendment Act, 2008 (ITAA 2008).

Pre-requisites: Nil

Course Objectives:

- To introduce students to the legal framework governing cyber activities, with a focus on ITA 2000 and ITAA 2008.
- To understand the technical foundations of cybersecurity and the role of various security mechanisms in preventing cyber threats.
- To explore different types of cybercrimes and the processes involved in investigating and addressing them.
- To examine the legal aspects of e-commerce, e-governance, and the use of electronic signatures in Indian law.
- To analyze the importance of privacy, data protection, and how international laws influence Indian regulations.
- To provide a global perspective on cyber law and international conventions, addressing challenges like intellectual property and cyber warfare.

Course Outcomes:

Student will be able to:
CO1: Explain the key provisions of ITA 2000 and ITAA 2008 and their impact on various legal domains.
CO2: Gain practical knowledge of cybersecurity tools and techniques such as encryption, firewalls, and digital signatures.
CO3: Identify different types of cybercrimes and apply forensic techniques to investigate digital crimes.
CO4: Assess the legal implications of e-commerce, e-governance, and electronic contracts in India.
CO5: Analyze privacy and data protection laws in India and evaluate them from an international perspective.
CO6: Understand global cyber law frameworks and how international treaties impact the regulation of cyberspace in India.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction to Cyber Law and IT Act	Evolution and necessity of ITA 2000 Overview of ITA 2000 and ITAA 2008: Key provisions, authorities, and penalties Amendments to Indian Penal Code, Evidence Act, and other laws Case studies on jurisdiction under cyber law	6
2	Cyber Security Framework	Definition and importance of cybersecurity Overview of threats: hacking, malware, phishing, and cyberterrorism Basic security mechanisms: firewalls, encryption, PKI, and digital signatures Role of CERT-IN and other agencies in India	7
3	Cyber Crimes and Investigation	Types of cybercrimes: data theft, identity theft, cyberstalking, cyberbullying, and online fraud Investigation procedures for cybercrimes Seizure of digital evidence and forensic procedures Digital forensics: tools and anti-forensics measures	8
4	E-Commerce, E-Governance, and Cyber Law	E-commerce regulations under ITA 2000 and ITAA 2008 Validity of electronic signatures and contracts in Indian law E-Governance and issues in e-taxation Cyber Tribunal and appellate processes	8
5	Privacy, Data Protection, and Emerging Trends	Sensitive Personal Data or Information (SPDI) under Indian law International perspectives on data protection and privacy (GDPR, HIPAA) Impact of cloud computing and data localization Case studies on privacy violations and legal recourse	8
6	International Cyber Law and Legal Framework	UNCITRAL model law and international conventions on cybercrime Intellectual property rights in cyberspace: trademarks, patents, and copyright Cyber warfare, digital sovereignty, and human rights Cyber law practices in other jurisdictions (US, EU, China)	8
Total			**45**

Textbooks:

1. "Cyber Law & Cyber Crimes" by Advocate Prashant Mali, Snow White Publications, Mumbai.
2. "Information Technology Law and Practice" by Vakul Sharma, Universal Law Publishing Co. Pvt. Ltd.
3. "The Indian Cyber Law" by Suresh T. Vishwanathan, Bharat Law House, New Delhi.

Reference Books:

1. "Digital Evidence and Computer Crime" by Eoghan Casey, Academic Press.
2. "Cyber Law in India" by Farooq Ahmad, Pioneer Books.
3. "Computer Forensics: Principles and Practices" by Linda Volonino et al., Pearson Prentice-Hall, 2007.

Course Name: Project Management

Course Code: OE22

Category: Open Elective

Preamble:

This course discusses tools that any organization can use to improve its ability to plan, implement, and control its activities as well as the ways in which it utilizes its people and resources.

Pre-requisites: Nil

Course Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes:

Student will be able to:
CO1. Apply selection criteria and select an appropriate project from different options.
CO2. Write work breakdown structure for a project and develop a schedule based on it.
CO3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
CO4. Use Earned value technique and determine & predict status of the project.
CO5. Capture lessons learned during project phases and document them for future reference

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Project Management Foundation	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	6
2	Initiating Projects	How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter, Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	8
3	Project Planning and Scheduling	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS)	8
4	Planning Projects	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	8
5	Executing Projects, Monitoring and Controlling Projects and Project Contracting	Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. Project Contracting: Project procurement management, contracting and outsourcing	8
6	Project Leadership and Ethics Closing the Project	Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project	7

Module no	Module name	Content	No of Hours
		termination, completing a final report; doing a lesson learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study	
Total			**45**

Reference Books:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7 th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Name: Product Life Cycle Management

Course Code: OE 23

Category: Open

Preamble:

This course aims to give students an overview of product Life Cycle Management (PLM) which is a strategic approach to managing the entire lifecycle of a product, from its inception through design, manufacturing, deployment, and disposal. This course gives student insights on various aspects such as PLM Strategies, Product design, Product Data Management, Virtual Product Development Tools, Integration of Environmental Aspects in Product Design, Life Cycle Assessment and Life Cycle Cost Analysis.

Pre-requisites:

Nil

Course Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Developmen

Course Outcomes:

Students will be able to:

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology

based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Product Lifecycle Management and PLM Strategies	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
2	Product Design	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering. and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	10
3	Product Data Management (PDM)	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
4	Virtual Product Development Tools	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case Studies	07

Module No.	Module Name	Content	No of Hours
5	Integration of Environmental Aspects in Product Design	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of- Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	06
6	Life Cycle Assessment and Life Cycle Cost Analysis	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06
Total			**45**

Textbooks:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229

Reference Books:

1. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
2. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Name: Sustainability Management

Course Code: OE24

Category: Open Elective

Preamble:

To provide learners with a comprehensive understanding of sustainability principles, strategies, and management practices that enable organizations to operate responsibly while achieving long-term success.

Pre-requisites:

NIL

Course Objectives:

- To provide a comprehensive understanding of sustainability concepts and their importance in global and organizational contexts.
- To equip participants with the tools and frameworks to develop and implement effective sustainability strategies.
- To foster the ability to analyze environmental, social, and economic impacts and propose practical solutions.
- To empower learners to lead and manage sustainable practices through innovation, technology, and ethical decision-making.

Course Outcomes:

Learner will be able to:

CO1: Understand the Core Principles of Sustainability: Comprehend the key environmental, social, and economic dimensions of sustainability

CO2: Analyze Environmental Impacts: Evaluate organizational and societal environmental footprints and recommend sustainable practices.

CO3: Develop Strategies for Social and Economic Sustainability: Formulate strategies that address social equity, community engagement, and economic resilience.

CO4: Implement Sustainability Practices: Design and implement sustainability strategies within an organizational context, including reporting and stakeholder management.

CO5: Leverage Technology and Innovation: Utilize emerging technologies to enhance sustainability outcomes.

CO6: Lead and Manage Change: Apply leadership and change management principles to foster a sustainability-focused culture.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Sustainability	Overview of Sustainability: Definition, history, and importance. Sustainable Development Goals (SDGs): UN's 2030 Agenda and its impact on global development. Three Pillars of Sustainability: Environmental, social, and economic dimensions. Current Challenges: Climate change, resource depletion, inequality, and global initiatives.	5
2	Environmental Sustainability	Understanding Environmental Impact: Carbon footprint, waste management, and biodiversity. Energy Management: Renewable energy sources, energy efficiency, and innovations in energy systems. Circular Economy: Concepts, examples, and transitioning to closed-loop systems. Sustainable Resource Management: Water, minerals, and sustainable agriculture.	8
3	Social Sustainability	Social Equity and Inclusion: Addressing diversity, equity, and inclusion in organizations. Community Engagement: Building partnerships and contributing to societal development. Labor Practices: Ethical employment practices, health, and safety. Corporate Social Responsibility (CSR): Importance, frameworks, and success stories.	7
4	Economic Sustainability	Sustainable Business Practices: Triple bottom line approach. Green Finance: ESG investing, green bonds, and carbon pricing. Sustainable Innovation: Developing products and services that align with sustainability goals. Regulatory Frameworks: Policies and standards for sustainable business operations.	5

Module No.	Module Name	Content	No of Hours
5	Sustainability Strategy & Implementation	Developing a Sustainability Strategy: Key steps and tools. Stakeholder Engagement: Identifying and collaborating with key stakeholders. Sustainability Reporting: Standards (GRI, SASB), metrics, and case studies. Measuring Impact: Life cycle assessment (LCA), carbon accounting, and sustainability indicators.	8
6	Technology and Innovation for Sustainability	Digital Transformation: Role of AI, IoT, and big data in achieving sustainability. Green Technologies: Innovations in clean energy, transportation, and waste management. Smart Cities: Integration of sustainable technologies in urban planning. Role of Blockchain: Transparency and traceability in sustainability practices.	6
7	Leadership and Change Management in Sustainability	Sustainability Leadership: Characteristics and examples of successful leaders. Driving Organizational Change: Overcoming resistance and fostering a sustainability culture. Ethical Decision Making: Frameworks for responsible leadership. Global Case Studies: Examining successful implementations of sustainability initiatives.	6
Total			**45**

Textbooks:

1. "Sustainability Principles and Practice" by Margaret Robertson.
2. "The Triple Bottom Line" by Andrew Savitz.
3. "The Business Guide to Sustainability" by Darcy Hitchcock and Marsha Willard.

Reference Books:

1. "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
2. "Sustainability: A Systems Approach" by Tony Clayton and Nicholas Radcliffe.

Course Name: Operations Research

Course Code: OE25

Category: Open Elective

Preamble:

This course discusses various tools in scientific management.

Course Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Course Outcomes:

Learner will be able to…
CO1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
CO2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
CO3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
CO4. Understand the applications of integer programming and a queuing model and compute important performance measures

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Operations Research	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost	15

Module No.	Module Name	Content	No of Hours
		Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem:** Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the steppingstone method and MODI method. **Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2	Queuing models	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	6
3	Simulation	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	6
4	Dynamic programming	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stagecoach/Shortest Path, cargo loading and Reliability problems.	6
5	Game Theory	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	6
6	Inventory Models	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	6
Total			**45**

References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Name: IPR and Patenting

Course Code: OE26

Category: Open Elective

Preamble:

This course discusses legal rights that can be registered with a legal authority in some presentable or tangible form which can be sold or bought or licensed, like physical property given to creator or innovator to harvest the economic benefits on their invention or creation.

Course Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as international treaty procedures
- To get acquainted with Patent search and patent filing procedure and application

Course Outcomes:

Learners will be able to…

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual
- Property and Patenting

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Intellectual Property Rights (IPR):	Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	6
2	Enforcement of Intellectual Property Rights:	Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, international agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	8
3	Emerging Issues in IPR:	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc	6
4	Basics of Patents:	Definition of Patents, Conditions of patentability, Patentable and nonpatentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	8
5	Patent Rules:	Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	9
6	Procedure for Filing a Patent (National and International):	Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	8
Total			**45**

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Name: Research Methodology

Course Code: OE27

Category: Open Elective

Preamble:

This course offers "An overview of research methodology including basic concepts employed in quantitative and qualitative research methods. Includes computer applications for research.

Pre-requisites: Nil

Course Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcome:

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction and Basic Research Concepts	Introduction and Basic Research Concepts 1.1 Research – Definition: Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10
2	Types of Research	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	8
3	Research Design and Sample Design	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	9
4	Research Methodology	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	8
5	Ethics in Research	Ethics in Research Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	5
6	ICT Tools for Research	ICT Tools for Research: Role of computers in research, maintenance of data using software such as Mendeley, Endnote, Tabulation and graphical presentation of research data and software tools.	5

Module No.	Module Name	Content	No of Hours
		Web search: Introduction to Internet, use of Internet and www, using search engines and advanced search tools.	
Total			**45**

Textbooks:

1 Donald Cooper and PS Schindler (2009) Business Research Methods, 9th edition, Tata McGraw Hill.
2 Kothari C. R Research Methodology
3 Uma Sekaran (2010) Research Methods for Business, 4th edition, Wiley.
4 Ranjit Kumar (2009) Research Methodology, 2nd edition, Pearson Education
5 Naresh Malhotra and S Dash (2009) Marketing Research, 5th edition, Pearson Prentice Hall.
6 Michael V. P Research Methodology.
7 Fred N. Kerlinger: Foundations of Behavioral Research.

Reference books

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course: Renewable Energy Management

Course Code: OE28

Category: Open Elective

Preamble:

Renewable Energy Management focuses on the development, implementation, and management of renewable energy projects. This course aims to equip students with the knowledge and skills required to effectively manage renewable energy resources, assess their impact, and implement sustainable energy solutions. The curriculum covers various renewable energy technologies, their applications, and the economic, environmental, and policy aspects of renewable energy systems.

Pre-requisites:
Nil

Course Outcomes:

- Understand the principles and technologies of various renewable energy sources.
- Analyse the economic, environmental, and social impacts of renewable energy projects.
  Evaluate and design renewable energy systems for specific applications.
- Develop strategies for the integration and management of renewable energy in the energy mix.
- Understand the policies, regulations, and incentives related to renewable energy.
- Gain practical skills in renewable energy project planning, implementation, and management.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head of Learning	ISA	MSE	Project	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Mod No.	Module Name	Content	No. of hrs.
1	Introduction to Renewable Energy	• Overview of global and national energy scenarios • Importance and benefits of renewable energy • Types of renewable energy sources: solar, wind, biomass, hydro, a geothermal • Comparison between renewable and non-renewable energy • Current trends and future prospects in renewable energy	7
2	Solar Thermal Energy	• Principles of solar thermal energy conversion • Solar collectors: flat plate, evacuated tube, and concentrating collectors • Solar thermal applications: water heating, space heating, and industrial processes • Solar thermal power plants: parabolic troughs, solar towers, and dish Stirling systems • Economic and environmental aspects of solar thermal energy	6
3	Solar Photovoltaics	• Principles of photovoltaic energy conversion • Types of photovoltaic cells: monocrystalline, polycrystalline, and thin film • Design and components of photovoltaic systems: modules, inverters, and batteries • Performance analysis of PV systems: efficiency, shading, and temperature effects • Grid integration and energy storage for PV systems	6
4	Wind Energy	• Fundamentals of wind energy conversion • Wind turbine types, components, and operation • Wind farm design and site selection • Environmental and social impacts of wind energy projects • Economic analysis and policy considerations for wind energy	6
5	Biomass, Hydro and Geothermal Energy	**Biomass & Bio Energy** • Biomass resources and conversion technologies • Bioenergy production: biogas, biofuels, and biomass power generation • Waste-to-energy systems • Environmental and economic aspects of bioenergy • Policies and incentives for bioenergy development **Hydro Energy** • Principles of hydro power generation • Small-scale and large-scale hydro power plants **Geothermal Energy** • Geothermal energy resources and extraction methods • Applications and challenges of geothermal energy • Environmental and economic considerations for hydro and geothermal energy	9
6	Renewable Energy and Management Policy	• Energy management principles and practices • Renewable energy project planning and management • Integration of renewable energy into the grid • Policies, regulations, and incentives for renewable energy • Case studies of successful renewable energy projects	11
		Total	45

Textbooks:

1. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
2. "Renewable Energy Systems: The Earthscan Expert Guide to Renewable Energy Technologies for Home and Business" by David Thorpe
3. "Energy Management Handbook" by Wayne C. Turner and Steve Doty

Reference Books:

1. "Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman
2. "Wind Energy Explained: Theory, Design and Application" by James F. Manwell, Jon G. McGowan, and Anthony L. Rogers
3. "Biomass to Renewable Energy Processes" by Jay Cheng
4. "Hydropower: Renewable Energy for a Sustainable Future" by Dirk Aschenbach
5. "Geothermal Energy: Renewable Energy and the Environment" by William E. Glassley
6. "Renewable Energy Policy and Politics: A Handbook for Decision-Making" by Volker M. Quaschning

Course Name: Energy Audit and Management

Course Code: OE29

Category: Open Elective

Preamble:
Energy Audit is a systematic approach for decision-making in energy management to balance the total energy inputs with its use. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization to minimize energy costs/waste without affecting production & quality with minimum environmental effects.

Pre-requisites: Nil

Course Objectives:

- To understand the importance energy security for sustainable development and the
- fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to
- facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of
- energy saving opportunities.

Course Outcomes:
Student will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyse the data collected during performance evaluation and recommend energy saving measures

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Energy Scenario	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	5
2	Energy Audit Principles	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	10
3	Energy Management and Energy Conservation in Electrical System	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	Energy Management and Energy Conservation in Thermal Systems	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	Energy Performance Assessment	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis	5
6	Energy conservation in Buildings:	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	5
Total			**45**

Reference Books:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy
5. Research Institute (TERI).
6. Energy Management Principles, C.B.Smith, Pergamon Press
7. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont
8. Press
9. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
10. www.energymanagertraining.
11. http://www.bee-india.nic.in

Course Name: Bioinformatics

Course Code: OE30

Category: Open Elective

Preamble:
This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how computational methods can enhance the comprehension of biological processes. It also emphasizes on real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics.

Pre-requisites:

- Basic Knowledge of Computers and Biology

Course Objectives:

- To enable learners to understand the basic principles of bioinformatics.
- To provide a foundational understanding of key bioinformatics concepts, including biological data types and analysis methods.
- To develop the skills necessary for analyzing and interpreting genomic and proteomic datasets using computational techniques.
- To familiarize students with essential bioinformatics tools and databases, enabling effective selection and application in research.
- To encourage the integration of bioinformatics approaches into biological research, fostering the ability to formulate and test hypotheses.

Course Outcomes:

Learner will be able to:

- Understanding of foundational bioinformatics concepts.
- Comprehending and applying knowledge of basic principles of mathematics and statistics.
- Implementing efficient and reliable bioinformatics solutions by optimizing the usage of existing tools.
- Apply problem-solving skills to multivariate methods in bioinformatics.
- Search and apply bioinformatics tools to analyze and interpret biological data

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Bioinformatics	Basics of Biology: Characteristics and Principles of cells, DNA and chromosome, genes and the genomes. Types of biological data, Sequencing Methods: DNA & Protein, Genomic Sequencing, and Human Genome Project Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology, Applications of Bioinformatics	9
2	Biological databases and their classification	Based on storage techniques (Flat, Relational, Object Oriented). Based on data (Primary, Secondary, Specialized and Composite). Search engines: Entrez& SRS Sequence databases: NCBI, EMBL, DDBJ Structural Databases: PDB Protein Databases: PIR, SWISS PROT Other Databases: Chemical and Drug Molecule Databases	9
3	Algorithms in Bioinformatics	Sequence Alignment: Heuristic Method (BLAST, FASTA) Pairwise Sequence Alignment: Local and Global Alignment (Dynamic programming Methods: Needleman Wunch Algorithm, Smith Waterman Algorithm.), Multiple Sequence Alignment: CLUSTAL W, Phylogenetic Analysis.	9
4	Introduction to drug designing	History of drug design, Stages of drug discovery and development; Drug properties, likeness. Preparation of Protein Structure: In silico Structure Prediction - Homology Modeling; Threading; Fold Recognition. Ab initio modeling; Model refinement and validation Molecular Visualization Software: Methods for representing biological data, 3D Structure Viewers Concept of pharmacophore mapping and	10

Module No.	Module Name	Content	No. of Hours
		pharmacophore based Screening	
5	Computer aided drug designing	High throughput Virtual Screening and Molecular Docking: Rigid and Flexible Docking Analysis of Protein-Ligand interactions Quantitative Structure Activity Relationship (QSAR) (3D-QSAR approaches like COMFA and COMSIA.) Molecular Mechanics and Molecular Dynamics Simulations: Understanding the structural stability of protein and protein-ligand complex ADMET analysis	8
Total			**45**

Suggested list of Assignments:

1. Retrieving sequences, it's structural and functional data from the set of databases.
2. Analyzing sequences through alignment tools - BLAST, FASTA and CLUSTAL s.
3. 3D Protein modelling, validation and visualization
4. Protein ligand interaction by docking techniques
5. Designing a potential drug candidate.

Suggested List of Value-Added Home Assignments:

1. Mapping genes to biological pathways and analyze their interactions.
2. Construct and interpret a phylogenetic tree.

Suggested Online Courses:

1. Bioinformatics: Algorithms and Applications, offered by NPTEL Swayam, https://onlinecourses.nptel.ac.in/noc21_bt06/preview
2. Bioinformatics: Introduction and Methods, offered by Peking University through Coursera, https://coursesity.com/r/site/bioinformatics-introduction-and-methods-

Reference Books:

1. Bioinformatics and Functional genomics, Jonathan Pevsner, Wiley Blackwell, 2015, Third edition.
2. Bioinformatics: Sequence and genome analysis, David mount, Cold Spring Harbor, N.Y press, 2004, Second edition.
3. Strategies for Organic Drug Discovery Synthesis and Design, Daniel Lednicer, Wiley International Publishers, 1998, Second Edition.
4. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

Course Name: Nanotechnology

Course Code: OE31

Category: Open elective

Preamble:
The course aims to provide a comprehensive understanding of nanotechnology fundamentals, its scientific principles, fabrication techniques, applications in engineering, and the ethical considerations associated with its usage. Students will explore how nanotechnology can be applied to different fields of engineering, including electronics, materials science, biomedical applications, and energy.

Pre-requisites:
Nil

Course Objectives:

- To enable learners to understand the basic principles and concepts of nanotechnology.
- To enable learners to explain the properties and behavior of materials at the nanoscale.
- To enable learners to describe the fabrication and characterization techniques used in nanotechnology.
- To enable learners to explore the applications of nanotechnology in various engineering fields.
- To enable learners to analyze the societal and ethical implications of nanotechnology advancements.

Course Outcomes:

Learner will be able to:

- Understand nanotechnology fundamentals.
- Analyze nanoscale phenomena
- Understand and apply key nanofabrication methods for creating nanoscale structures and devices.
- Understand the principles behind various characterization techniques for nanoscale materials.
- Explore engineering applications of nanotechnology.
- Evaluate ethical, environmental, and societal Impacts.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a

panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Nanotechnology	Definition, scope, and multidisciplinary nature of nanotechnology. Historical development of nanotechnology and key breakthroughs. Types of nanomaterials: nanoparticles, nanotubes, nanowires, quantum dots, and nanocomposites. Nanoscale dimensions: importance of size, surface area, and quantum effects. Exploration of nanotechnology's role in various industries (electronics, medicine, energy, etc.).	9
2	Properties of Nanomaterials	In-depth study of the physical, chemical, electrical, optical, and mechanical properties of nanomaterials. Surface energy, surface-to-volume ratio, and its impact on material properties. Detailed study of quantum confinement and its influence on electrical and optical properties. Toxicity and environmental concerns of nanomaterials: impact on living organisms and ecosystems.	9
3	Nanofabrication Techniques	Comprehensive overview of top-down and bottom-up nanofabrication methods. In-depth study of lithographic techniques: photolithography, electron-beam lithography. Advanced deposition techniques: Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), Physical Vapor Deposition (PVD). Molecular self-assembly, nanoimprint lithography, and soft lithography techniques.	9
4	Characterization of Nanomaterials	Detailed study of key characterization tools: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), X-ray diffraction (XRD). Optical spectroscopy and Raman spectroscopy techniques. Importance of precision and resolution in nanomaterial characterization.	6
5	Applications of Nanotechnology in Engineering	Nanotechnology in Electronics: nanoscale transistors, quantum dots, and nanomaterials for next-gen electronics. Energy Applications: nanomaterials for solar cells, energy storage, supercapacitors, and batteries.	8

Module No.	Module Name	Content	No. of Hours
		Biomedical Applications: drug delivery, diagnostic tools, nanomedicine, and tissue engineering. Environmental Applications: nanotechnology in water purification, air filtration, and pollution control. Mechanical and Civil Engineering: nanocomposites, self-cleaning surfaces, and smart materials.	
6	Societal, Ethical, and Environmental Implications	Ethical issues related to nanotechnology: privacy concerns, nanotoxicology, and regulation. Environmental impacts of nanomaterials: nanowaste management and recycling. Public perception of nanotechnology and its societal impacts. Responsible innovation and future directions for ethical development of nanotechnology. Regulatory frameworks for nanomaterials in India and worldwide.	4
Total			**45**

Suggested list of Assignments:

1. Explore one specific application of nanotechnology in any engineering field (e.g., electronics, medicine, or energy).
2. Comparative Analysis of Nanoscale vs. Bulk Properties.
3. Design of a Nanofabrication Process for a device.
4. Nanomaterials Characterization Report interpretation.
5. Propose a simple nanotechnology-based solution for an engineering challenge in your chosen field.
6. Ethical and Environmental Implications of Nanotechnology.

Suggested List of Value-Added Home Assignments:

1. Reviewing Nano products and new technologies.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on Nano sensor development.

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", Wiley-Interscience, 2003.
3. Sulabha Kulkarni, "Nanotechnology: Principles and Practices", Springer, 2015.
4. R.S. Tiwari and A. Gosh, "Nanomaterials and Nanotechnology", S. Chand & Company, 2017.
5. Patricia I. Dolez, "Nanoengineering: Global Approaches to Health and Safety Issues", Elsevier, 2015.