Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Honours/Minor Degree Programme

for

Bachelor of Technology

in

Information Technology

(R-2023 Curriculum)

(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 are in line with the 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 curriculum, 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. In addition to this, the curriculum is augmented with Life Enrichment audit courses for knowledge inspiring experience.

Additionally, curriculum provides add-on Honours/Minor degree that involves field/ domain study. Learner can avail 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 Information Technology
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Vidyalankar Institute of Technology

[A] Guidelines for Award of Honours/ Minor Degree Programme

Honours and Minor Degree programme is introduced in order to facilitate learners to enhance the depth of knowledge, diversity, breadth and skills in emerging fields. An Honours or Minor Degree typically refers to a higher level of academic achievement either for research orientation or for improving employability. Learners can select any Honours or Minor Degree programme as per his/her choice.

In our curriculum, learners can choose to avail Honours/ Minor Degree programme by completing requirements of 18 credits, which will be over and above the minimum credits required for B.Tech. degree i.e. credit requirement for the award of degree programme and Honours/ Minor degree programme are required to be explicitly carried out. Learners shall opt for Honours or Minor specialisations during the break of Semester 5 and Semester 6. **Learners may complete the B.Tech. Degree programme without opting for Honours/Minor degree programme** i.e. opting for Honours/ Minor Degree programme is not mandatory as a part of B.Tech. degree programme

For an Honours/ Minor Degree, the learner shall select an Honours/ Minor programme offered by his/her home department.

Eligibility Criteria

- Basic eligibility for opting for Honours/Minor shall be minimum CGPA of 6.75 at the end of 4th semester and earned 80 credits from Sem 1 to Sem 4 (41 credits for DSY students).
- If student has already completed any course(s) that is listed in the chosen Honours/ Minor degree programme, as additional learning course(s), then the transfer credits for such course(s) can be carried out towards Honours/ Minor degree programme.
- For a student to get Honours/ Minor degree, it is mandatory that the student completes the relevant courses before graduating.

Syllabus Scheme Template

Course		Head of Learning	Preferred Semester	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name				ISA	MSE	ESE	
HM01	Industry Interaction	Theory	Break of Sem5 and Sem6	1	25	-	-	025
HMXX	Honours / Minor Degree Course 1	Theory	6	2	15	20	40	075
HMXX	Honours / Minor Degree Course 1 Lab	Practical	6	1	25	-	25	050
HM02	Survey Report/ Paper	Theory	Break of Sem6 and Sem7	2	25	-	25	050
HMXX	Honours / Minor Degree Course 2	Theory	7	2	15	20	40	075
HMXX	Honours / Minor Degree Course 2 Lab	Practical	7	1	25	-	25	050
HM03	Seminar	Theory	Break of Sem7 and Sem8	2	25	-	25	050
HMXX	Honours / Minor Degree Course 3	Theory	8	2	15	20	40	075
HMXX	Honours / Minor Degree Course 3 Lab	Practical	8	1	25	-	25	050
HM04	Capstone Project	Practical	8	4	75	-	50	125
			Total	**18**				

[B] Honours/ Minor Degree Programmes offered to B.Tech. Information Technology

The Institute offers the listed Honours Degree Programme for learners of B.Tech. Information Technology

Honours/ Minor Degree Programmes Offered

Sr. No.	Honours/Minor Degree Programme	Department offering Honours	Honours applicable for	Minors applicable for
1	Next-Gen Artificial Intelligence and Machine Learning (Next-Gen AI&ML)	Information Technology	B.Tech. Information Technology students who have opted for AI&ML specialization track.	None
2	Next-Gen Data Science (Next-Gen DS)	Information Technology	B.Tech. Information Technology students who have opted for DS specialization track.	None
3	Next Gen Cyber Security	Information Technology	B.Tech. Information Technology and Computer Engineering students who have opted for Cyber Security specialization track.	None
4	Virtual and Augmented Reality(VAR)	Information Technology	All B.Tech. Information Technology, Computer Engineering students, Electronics and Computer Science and Electronics and Telecommunication Department.	UG Engineering students of Biomedical Department
5	Next-Gen Internet of Things	Electronics and Telecommunication	B.Tech. Information Technology students who have opted for Internet of Things specialization track.	As stated in Honours/Minor Degree document of Electronics and Telecommunication department

6	Artificial Intelligence and Machine Learning	Computer Engineering	Information Technology students excluding those who have opted for Artificial Intelligence and Machine Learning specialization track.	UG students of any other department who haven't completed the courses mentioned in this degree programme (or equivalent courses) as a part of their B.Tech. degree. Bridge courses as needed would be required to be completed by the student. Admission to this degree, as Minor, is subject to permission from Head of Information Technology.
7	Data Science	Computer Engineering	Information Technology students excluding those who have opted for Data Science specialization track.	
8	Cyber Security	Computer Engineering	Information Technology students excluding those who have opted for Cyber Security specialization track.	
9	AI in Healthcare	Biomedical Engineering	Biomedical engineering students	As stated in Honours/Minor Degree document of Biomedical Engineering

List of courses under each Honours/ Minor Programme:

1. Next-Gen Artificial Intelligence and Machine Learning

Semester	Course Code	Course Name
VI	HMIT07T	Ethics in AI
VI	HMIT07P	Ethics in AI Lab
VII	HMIT08T	Scalable ML and BDA
VII	HMIT08P	Scalable ML and BDA Lab
VIII	HMIT09T	Generative AI models
VIII	HMIT09P	Generative AI models Lab

2. Next-Gen Data Science

Semester	Course Code	Course Name
VI	HMIT10T	Data Visualization Using R-Programming
VI	HMIT10P	Data Visualization Using R-Programming Lab
VII	HMIT11T	Time Series and Forecasting
VII	HMIT11P	Time Series and Forecasting Lab
VIII	HMIT12T	Data Ethics and Privacy
VIII	HMIT12P	Data Ethics and Privacy Lab

3. Next Gen -Cyber Security

Semester	Course Code	Course Name
VI	HMIT13T	IT Security Strategic Planning, Policy, and Leadership
VI	HMIT13P	IT Security Strategic Planning, Policy, and Leadership Lab
VII	HMIT14T	Advance Threat Intelligence and Penetration Testing
VII	HMIT14P	Advance Threat Intelligence and Penetration Testing Lab
VIII	HMIT15T	Advanced Computer Forensics Analysis
VIII	HMIT15P	Advanced Computer Forensics Analysis Lab

4. Virtual Augmented Reality

Semester	Course Code	Course Name
VI	HMIT16T	Foundation of UX and ARVR
VI	HMIT16P	Foundation of UX ARVR Lab
VII	HMIT17T	ARVR and Game Development
VII	HMIT17P	ARVR and Game Development Lab
VIII	HMIT18T	USECASE in ARVR
VIII	HMIT18P	USECASE in ARVR Lab

5. Next-Gen Internet of Things

Semester	Course Code	Course Name
VI	HMET01T*	Embedded Linux System
VI	HMET01P*	Embedded Linux System Lab
VII	HMET02T*	IoT & Data Analytics
VII	HMET02P*	IoT & Data Analytics Lab
VIII	HMET03T*	IoT Applications & Web Development
VIII	HMET03P*	IoT Applications & Web Development Lab

* Detailed Syllabus of these courses can be obtained from the Honours/ Minor document of Electronics and Telecommunication department.

6. Artificial Intelligence and Machine Learning

Semester	Course Code	Course Name
VI	HMCE07T	Soft Computing
VI	HMCE07P	Soft Computing Lab
VII	HMCE08T	Natural language processing
VII	HMCE08P	Natural language processing Lab
VIII	HMCE09T	Deep Learning
VIII	HMCE09P	Deep Learning Lab

7. Data Science

Semester	Course Code	Course Name
VI	HMCE10T	Advanced Databases
VI	HMCE10P	Advanced Databases Lab
VII	HMCE11T	Big Data Analytics
VII	HMCE11P	Big Data Analytics Lab
VIII	HMCE12T	Text, Web & Social Media Analytics
VIII	HMCE12P	Text, Web & Social Media Analytics Lab

8. Cyber Security

Semester	Course Code	Course Name
VI	HMCE13T	Cryptography and Network Security
VI	HMCE13P	Cryptography Lab and Network Security Lab
VII	HMCE14T	Web Application Security
VII	HMCE14P	Web Application Security Lab
VIII	HMCE15T	Digital Forensics
VIII	HMCE15P	Digital Forensics Lab

9. AI in Healthcare

Semester	Course Code	Course Name
VI	HMBM01T*	Ethics, Privacy, & Security in AI Driven Healthcare
VI	HMBM01P*	Ethics, Privacy, & Security in AI Driven Healthcare Lab
VII	HMBM02T*	Applied Machine Learning for Biomedical Signals Lab
VII	HMBM02P*	Applied Machine Learning for Biomedical Signals
VIII	HMBM03T*	Application of ML in Healthcare
VIII	HMBM03P*	Application of ML in Healthcare Lab

Learners of Information Technology Department who wish to opt for Minor Degree Programme offered by other department can obtain details of the same from Section-B and Section C of the Honour/ Minor Degree Programme document of respective department.

[C] Honours/ Minor Degree Programmes Course Syllabus

Course Name: Ethics in AI

Course Code: HMIT07T

Category: Honors in Next-Gen AI&ML

Preamble:

The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has revolutionized numerous industries and daily life, introducing unprecedented opportunities and challenges. As these technologies integrate deeply into societal structures, it becomes imperative to consider their ethical, social, and environmental implications. This course aims to provide learners with a foundational understanding of ethical principles and frameworks as applied to AI/ML systems.

Pre-requisites:

Artificial Intelligence, Machine Learning

Course Objectives:

- Understand ethical considerations in AI and ML development and deployment.
- Explore frameworks for ethical decision-making in AI systems.
- Assess potential biases, privacy issues, and impacts of AI on society.
- Learn legal and policy implications related to AI and ML.
- Develop skills to implement ethical practices in AI projects.
- Foster critical thinking to address ethical challenges in real-world scenarios.

Course Outcomes:

Learner will be able to:

1. Demonstrate understanding of ethical principles in AI/ML.
2. Identify and mitigate bias and fairness issues in datasets and algorithms.
3. Apply ethical frameworks to evaluate AI systems.
4. Design AI systems with accountability, transparency, and fairness.
5. Understand societal impacts
6. Engage in ethical decision-making during AI system development.

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 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 Ethics in AI/ML	Overview of Ethics: Moral principles, ethics vs. legality. Why Ethics in AI/ML? Risks and challenges. Key Ethical Issues in AI: Bias, fairness, accountability, transparency. Case Studies: Real-world AI ethical dilemmas.	5
2	Bias and Fairness in AI/ML	Definition and Types of Bias in AI: Dataset bias, algorithmic bias. Techniques to Detect and Mitigate Bias in ML Models. Fairness Frameworks: Disparate impact, equalized odds. Ethical Data Collection and Preprocessing.	5
3	Privacy and Security Concerns	Privacy Challenges in AI: Data collection, storage, and sharing. Ethical Guidelines for User Data Protection. Security Risks in AI Systems: Deepfakes, adversarial attacks. GDPR and Other Privacy Regulations.	5
4	Accountability and Transparency	Need for Explainable AI (XAI). Strategies for Creating Transparent AI Systems. Accountability in AI Decision-Making. Ethical Implications of Autonomous Systems.	5
5	Societal Impacts of AI/ML	Impacts on Employment and Workforce. AI and Social Inequality. Misinformation and AI-Generated Content. AI in Healthcare, Education, and Governance.	5
6	Legal and Ethical Frameworks in AI	Overview of AI Ethics Guidelines (IEEE, UNESCO, etc.). AI Laws and Policies: International and regional perspectives. Intellectual Property and AI-Generated Content. Future Directions in AI Ethics.	5
Total			30

Textbooks:

AI Ethics: A Textbook by Paula Boddington - A comprehensive introduction to ethical challenges in AI systems.
Atlas of AI by Kate Crawford - Discusses the societal and environmental impact of AI

Reference Books:

The Ethical Algorithm by Aaron Roth & Michael Kearns - Explores designing socially aware algorithms
Human Compatible by Stuart Russell - Focuses on aligning AI with human values
Moral Machines: Teaching Robots Right From Wrong by Wendell Wallach and Colin Allen - Examines embedding ethics into AI systems.
Online Resources for Learning:

1. Responsible AI Toolkit Reading List - A curated set of academic papers and books focusing on responsible AI development and ethics Responsible AI Toolkit
.2. Oxford Academic Journals - Offers edited volumes on AI ethics and related fields, often authored by leading experts

Course Name: Ethics in AI Lab

Course Code: HMIT07P

Category: Honors in Next-Gen AI&ML

Preamble:

The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has revolutionized numerous industries and daily life, introducing unprecedented opportunities and challenges. As these technologies integrate deeply into societal structures, it becomes imperative to consider their ethical, social, and environmental implications. This lab manual is designed to equip learners with practical skills to address ethical concerns in AI and ML systems while fostering a deeper understanding of fairness, accountability, transparency, and privacy. Through guided experiments and critical discussions, students will explore the balance between technological innovation and ethical responsibility, preparing them to design and deploy AI systems that respect human values and promote societal good.

Pre-requisites:

Artificial Intelligence Lab, Machine Learning Lab

Course Objectives:

- Understand ethical considerations in AI and ML development and deployment.
- Explore frameworks for ethical decision-making in AI systems.
- Assess potential biases, privacy issues, and impacts of AI on society.
- Learn legal and policy implications related to AI and ML.
- Develop skills to implement ethical practices in AI projects.
- Foster critical thinking to address ethical challenges in real-world scenarios.

Course Outcomes:

Learner will be able to:

1. Demonstrate understanding of ethical principles in AI/ML.
2. Identify and mitigate bias and fairness issues in datasets and algorithms.
3. Apply ethical frameworks to evaluate AI systems.
4. Design AI systems with accountability, transparency, and fairness.
5. Understand societal impacts
6. Engage in ethical decision-making during AI system development.

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 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 Practicals:

1. Bias Detection and Mitigation in ML Models
2. Privacy Preservation Using Differential Privacy
3. Explainable AI (XAI): Interpreting Black-Box Models
4. Adversarial Attack and Defense Strategies
5. Fairness in AI-Powered Recommendation Systems
6. Simulating Ethical Dilemmas in Autonomous Systems
7. Energy Efficiency Analysis of ML Models
8. Ethical Concerns in NLP Models for Sentiment Analysis
9. Misinformation Detection Using AI
10. Guidelines for Ethical Data Collection and Labeling

Course Name: Scalable ML and Big Data Analytics

Course Code: HMIT08T

Category: Honours/Minors

Preamble:

This course introduces students to scalable techniques in Machine Learning and Big Data Analytics, focusing on processing large-scale datasets using distributed frameworks like Apache Spark and Hadoop. It emphasizes the design, implementation, and optimization of machine learning and deep learning models in scalable environments.

Pre-requisites:

Data Structure & Analysis - IT01T, Machine Learning - IT15T

Course Objectives:

- Understand the fundamentals of big data, its architecture, and the need for scalable machine learning systems.
- Explore and implement scalable machine learning algorithms using distributed computing frameworks like Apache Spark and Hadoop.
- Apply deep learning techniques in distributed environments and analyze their performance on large-scale datasets.
- Design and evaluate end-to-end big data analytics pipelines, integrating real-time data processing and model deployment.

Course Outcomes:

Learner will be able to:

CO1: Explain the architecture and components of big data and scalable ML systems.

CO2: Use big data tools such as Hadoop, Spark, and Kafka for distributed data processing.

CO3: Implement and evaluate scalable ML algorithms using Spark MLlib or equivalent libraries.

CO4: Train and fine-tune deep learning models on large datasets using distributed training approaches.

CO5: Build and deploy real-time data analytics pipelines for practical applications.

CO6: Analyze and interpret the performance and limitations of scalable ML models using appropriate metrics and techniques.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
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 Scalable Machine Learning	Overview of Big Data: Characteristics, sources, and challenges (Volume, Variety, Velocity, Veracity, Value) Traditional vs. Big Data approaches Introduction to Scalable ML: Need for scalability, distributed computing, ML pipeline in the context of big data Tools and frameworks overview: Hadoop, Spark, Flink, etc.	4
2	Big Data Storage and Processing Frameworks	Distributed File Systems: HDFS architecture, data replication, block storage Introduction to Hadoop Ecosystem: MapReduce paradigm Apache Spark: RDDs, DataFrames, DAGs In-memory computing and performance benefits Streaming and batch processing frameworks (Spark Streaming, Flink, Kafka basics)	6
3	Scalable Machine Learning Algorithms	Introduction to scalable ML libraries: MLlib, H2O.ai, TensorFlow on Spark Scalable versions of ML algorithms: Linear/Logistic Regression, Decision Trees and Random Forest, K-Means Clustering, Gradient Boosted Trees	6
4	Feature Engineering and Model Optimization at Scale	Handling high-dimensional data Feature selection, dimensionality reduction (e.g., PCA, t-SNE) Data preprocessing at scale (Spark DataFrames, pipelines) Hyperparameter tuning at scale (Grid Search, Random Search using MLlib/Hyperopt) Model evaluation and cross-validation in distributed environments	6

5	Deep Learning with Big Data	Introduction to Deep Learning at scale Distributed training techniques (data parallelism, parameter servers) Using TensorFlow, PyTorch with Spark and BigDL Case study: Image/Text classification using distributed DL frameworks Use of GPU clusters and cloud-based training (Google Colab, AWS SageMaker basics)	4
6	Applications, Case Studies & Emerging Trends	Real-world applications: Fraud detection, recommender systems, IoT analytics Case studies: Netflix, Uber, Amazon, etc. Ethical issues in large-scale data analysis (bias, privacy, fairness) Edge computing and federated learning overview Trends: AutoML, MLOps, Large Language Models at scale	4
		Total	**30**

Textbooks:

1. Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "Advanced Analytics with Spark: Patterns for Learning from Data at Scale", O'Reilly Media
2. Nick Pentreath,""Machine Learning with Spark", Packt Publishing
3. Jure Leskovec, Anand Rajaraman, Jeff Ullman,"Mining of Massive Datasets", Cambridge University Press

Reference Books:

1. Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi,"Big Data: Principles and Paradigms", Morgan Kaufmann
2. Vijay Kotu, "Data Science for Engineers", Elsevier
3. Tomasz Drabas, Denny Lee, "Deep Learning with PyTorch and Spark", O'Reilly Media

Course Name: Scalable ML and Big Data Analytics Lab

Course Code: HMIT08P

Category: Honors/Minors

Preamble:

This course introduces students to scalable techniques in Machine Learning and Big Data Analytics, focusing on processing large-scale datasets using distributed frameworks like Apache Spark and Hadoop. It emphasizes the design, implementation, and optimization of machine learning and deep learning models in scalable environments.

Pre-requisites:

Data Structure & Analysis Lab - IT01P
Machine Learning Lab- IT15P

Course Objectives:

- Understand the fundamentals of big data, its architecture, and the need for scalable machine learning systems.
- Explore and implement scalable machine learning algorithms using distributed computing frameworks like Apache Spark and Hadoop.
- Apply deep learning techniques in distributed environments and analyze their performance on large-scale datasets.
- Design and evaluate end-to-end big data analytics pipelines, integrating real-time data processing and model deployment.

Course Outcomes:

Learner will be able to:
CO1: Explain the architecture and components of big data and scalable ML systems.
CO2: Use big data tools such as Hadoop, Spark, and Kafka for distributed data processing.
CO3: Implement and evaluate scalable ML algorithms using Spark MLlib or equivalent libraries.
CO4: Train and fine-tune deep learning models on large datasets using distributed training approaches.
CO5: Build and deploy real-time data analytics pipelines for practical applications.
CO6: Analyze and interpret the performance and limitations of scalable ML models using appropriate metrics and techniques.

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.

Suggested list of experiments:

Sr. No.	List of experiments
1	Perform file operations on HDFS – uploading, reading, and deleting files.
2	Write a MapReduce program to count word frequency in a large text file.
3	Use Spark RDDs and DataFrames to perform transformations and actions on a large dataset
4	Apply Logistic Regression and Decision Trees using Spark MLlib on a classification dataset.
5	Cluster high-dimensional data using K-Means in Spark, visualize clusters using t-SNE/PCA.
6	Compare the performance of Random Forest and Gradient Boosting using large datasets.
7	Implement feature selection and normalization pipelines using Spark ML.
8	Build a simple deep learning model (e.g., MNIST classifier) using TensorFlow or PyTorch.
9	Integrate a deep learning model with Spark for inference on streaming or batch data.
10	Mini Project

Textbooks:

1. Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "Advanced Analytics with Spark: Patterns for Learning from Data at Scale", O'Reilly Media
2. Nick Pentreath,""Machine Learning with Spark", Packt Publishing
3. Jure Leskovec, Anand Rajaraman, Jeff Ullman,"Mining of Massive Datasets", Cambridge University Press

Reference Books:

1. Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi,"Big Data: Principles and Paradigms", Morgan Kaufmann
2. Vijay Kotu, "Data Science for Engineers", Elsevier
3. Tomasz Drabas, Denny Lee, "Deep Learning with PyTorch and Spark", O'Reilly Media

Course Name: Generative AI models

Course Code: HMIT09T

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: IT21T (Artificial Intelligence), IT15T (Machine Learning)

Pre-requisite for: NIL

Recommended Semester: 8

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
HMIT09T	2	--	2	--
HMIT09P	--	2	--	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
HMIT09T	15	20	40	75
HMIT09P	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.

Preamble:

Generative AI represents a dynamic field at the forefront of technological advancement, where algorithms are imbued with the capacity to imagine, create, and innovate. In this course, we aim to provide you with a comprehensive understanding of the principles, techniques, and applications of Generative AI, while offering you the opportunity to delve into specialized topics and hands-on projects tailored to your

interests.

Course Objectives:

- Understand the mathematical foundations of generative models.
- Learn popular deep generative architectures such as GANs and VAEs.
- Explore real-world applications of generative AI.
- Develop and evaluate generative models using Python and deep learning libraries.

Course Outcomes:
Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Understand the fundamental concepts of generative models and distinguish between discriminative and generative approaches	Understanding
CO2	Apply probabilistic concepts and latent variable models to interpret and construct generative frameworks like VAEs and GANs.	Applying
CO3	Develop and train Variational Autoencoders and analyze their effectiveness in generating high dimensional data.	Applying
CO4	Implement Generative Adversarial Networks and explore advanced architectures like DCGAN, cGAN, and StyleGAN.	Applying
CO5	Experiment with and evaluate transformer-based and diffusion-based generative models for tasks such as text generation and image synthesis.	Applying
CO6	Demonstrate practical skills in using industry tools (like Hugging Face, OpenAI API, Stable Diffusion) and create a mini-project applying generative AI to real-world problems.	Applying

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours
1	Introduction to Generative Models and Gen AI	What are Generative Models? Discriminative vs Generative Approaches History and Evolution of Generative AI Key Applications: • Image generation (DALL·E, Midjourney) • Text generation (ChatGPT, GPT-4) • Code generation (Copilot, CodeGen) • Music, Art, and Video synthesis Introduction to ethical and social concerns • Deepfakes, hallucination, biases Overview of major models: GANs, VAEs, Diffusion Models, Transformers	5
2	Probability & Mathematical Foundations	Random Variables, Probability Distributions (Gaussian, Bernoulli, etc.) Maximum Likelihood Estimation (MLE) KL Divergence and Cross-Entropy Jensen's Inequality, Bayesian Inference: Priors, Posteriors Latent Variable Models Review of Autoencoders: Encoder, Decoder, Reconstruction Concept of Latent Space	4
3	Variational Autoencoders (VAEs)	Probabilistic Encoder/Decoder Reparameterization Trick Loss Function: Reconstruction + KL Divergence Sampling from Latent Space Applications in image denoising, style transfer	5

4	Generative Adversarial Networks (GANs)	GAN Architecture: Generator vs Discriminator Adversarial Loss and Training Procedure Instabilities and Training Tricks • Label smoothing, BatchNorm, Learning rates GAN Variants: • DCGAN (Deep Convolutional GAN) • Conditional GAN (cGAN) • CycleGAN, StyleGAN Evaluation Metrics: FID, Inception Score	6
	Diffusion Models & Transformer- based Gen AI	Overview of Diffusion Models • Forward and Reverse Process • Sampling and Noise Scheduling • Models: DDPM, Stable Diffusion Transformer Architectures: • Encoder-Decoder, Self-Attention • GPT-style Autoregressive Models Training Large Language Models (LLMs) Prompt Engineering Basics	5
5	Tools, Projects, and Applications	**Contents:** Using Gen AI tools: Hugging Face, OpenAI, RunwayML, Replicate Design Thinking for GenAI projects Capstone Mini-Project Options: • Story generator • Chatbot • AI artist or designer Educational tutor	5
6		• Deployment basics (Streamlit/Gradio) Ethics and the Future of Generative AI	
		Total	**30**

Sr. No.	List of experiments
1	Visualizing Probability Distributions: Plot Gaussian, Bernoulli, and Multinomial distributions.
2	Build a Simple Autoencoder
3	Train a VAE on Fashion-MNIST
4	Train a DCGAN on MNIST or CIFAR-10
5	Conditional GAN for Digit Generation
6	Text-to-Image Generation with Stable Diffusion

7	Generate Text using GPT-2 or GPT-Neo
8	Build an AI Art Generator or Chatbot
9	Face Aging or Style Transfer using GANs

Course Name: Data visualization using R Programming

Course Code: HMIT10T

Category: Honors in Next-Gen DS

Preamble:

It introduces fundamental concepts, advanced techniques, and best practices while introducing tools and libraries within the R ecosystem. It will train learners to interpret, design, and communicate insights effectively with real-world applications that bring into closer view the role of data visualization in decision- making.

Course Objectives:

- Develop a good understanding of the theoretical underpinnings of data visualization, including principles of clarity, accuracy, and storytelling.
- Learn how to use R programming and its visualization libraries such as ggplot2, plotly, and sf to create a range of charts and graphs.
- Learn to clean, manipulate, and prepare data effectively for visualization using R's data wrangling packages like dplyr and tidyr.
- Explore advanced visualization techniques, including geospatial mapping, interactive dashboards, and visualizations for complex datasets such as networks and time series.
- Understand how to design and present visualizations that clearly communicate insights, supported by reproducible reports and presentations using R Markdown.
- Demonstrate the ability to apply data visualization methods to real-world problems from a variety of domains, including business, healthcare, and environmental studies, through case studies and projects.

Course Outcomes:

Learner will be able to:

CO1: Understand and apply data visualization principles to enhance decision-making and avoid common pitfalls.

CO2: Demonstrates competence in using R and key libraries for visualization (ggplot2, dplyr, plotly) for data analysis.

CO3: Create and customize appropriate visualizations, such as scatter plots, bar charts, and histograms. CO4: Prepare and maintain data for visualization through transformation and tidy data principles. CO5: Improve advanced visualizations for multivariate, time series, and geospatial data, both statically and interactively.

CO6: Design accessible, effective visualizations using strong communication and aesthetic principles for diverse audiences.

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 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 Data Visualization and R Basics	Importance of Data Visualization: Role in data analysis and decision-making, Definition and importance of data visualization in analytics and decision-making, Principles of effective visualization (clarity, simplicity, and accuracy), how to avoid misleading visualizations, Differences between exploratory and explanatory data visualization. Components: data, visual encodings, and context, Understanding visual perception and cognitive load. Introduction to R Programming: Overview of R and RStudio, Key libraries for visualization: ggplot2, dplyr, plotly Understanding Data Structures in R: Vectors, data frames, tibbles, and lists, Loading and exploring datasets in R	5
2	Fundamentals of Data Visualization	Types of Data and Their Visualization Needs: Categorical, numerical, temporal, and geospatial data, Matching chart types to data types. Overview of Chart Types; Scatter plots, bar charts, and line charts, Histograms, density plots, boxplots, and pie charts The Grammar of Graphics (ggplot2): Understanding layers: data, aesthetics, and geometries, Customizing plots with themes, labels, and legends. Understanding data mappings and coordinates Best Practices for Chart Selection: Choosing appropriate charts for categorical, numerical, and temporal data.	5
3	Data Preparation for Visualization	Data transformation: filtering, aggregating, and reshaping. Tidy Data Principles: Importance of structured data for visualization, Using tidyr and dplyr for data preparation.	5

Module No.	Module Name	Content	No of Hours
		Handling Large Datasets: Sampling techniques and data summarization. Efficient visualization strategies for big data	
4	Advanced Visualization Techniques	Visualization of Multivariate Data: Techniques for high-dimensional data (e.g., scatterplot matrices, parallel coordinates), Visualizing clustering and classification results. Multi-Panel Visualizations: Faceting techniques for subset comparison, Overlaying plots and combining visualizations Time Series Visualizations: Trend lines and seasonal patterns, Temporal patterns and trends, Smoothing and seasonal decomposition Geospatial Visualizations: Mapping spatial data and geospatial patterns, Incorporating layers, heatmaps, and choropleth maps, maps with ggplots and sf	5
5	Design Principles and Aesthetic Customization	Designing Visualizations for Communication: Structuring narratives for data-driven presentations, Color Theory and Accessibility: Effective use of color in data visualization, Ensuring accessibility (e.g., colorblind-friendly palettes), Customizing Visualization Elements: Titles, labels, legends, and annotations for clarity, Layout and spacing for better readability.	
6	Interactive and Specialized Visualizations	Interactive Visualization Concepts: The need for interactivity in data exploration, Overview of tools for creating interactive visualizations Specialized Visualization Types: Network visualizations (e.g., node-link diagrams), Statistical visualizations: regression plots, confidence intervals, and distributions, Representing regression results and confidence intervals, Diagnostic plots and residual analysis Tree maps and hierarchical data visualizations, Visualization for Big Data, Techniques for summarizing and aggregating large datasets, Sampling and visual encoding strategies	5
Total			**30**

Textbooks:

1. R for Data Science by Hadley Wickham and Garrett Grolemund
2. Data Visualization: A Practical Introduction by Kieran Healy

Reference books:

1. Practical Data Science with R by Nina Zumel and John Mount

Course Name: Data visualization using R Programming Lab

Course Code: HMIT10P

Category: Honors in Next-Gen DS

Preamble:

The Data & Feature Engineering Lab provides hands-on experience in applying data preprocessing and feature engineering techniques to real-world datasets. Students will learn to collect, clean, preprocess, and transform data to prepare it for analysis and modeling. In the feature engineering process, you start with your raw data and use your own domain knowledge to create features that will make your machine learning algorithms work. In this module we explore what makes a good feature. Through practical exercises and projects, students will develop proficiency in using tools and libraries commonly employed in data engineering tasks.

Prerequisites: Skill Based Lab-Python

Objective:

- Master R programming and manipulate various data structures effectively.
- Perform exploratory data analysis (EDA) and analyze data patterns.
- Match appropriate visualizations to different data types for meaningful insights.
- Create and customize visualizations using the grammar of graphics (ggplot2).
- Transform and prepare data for visualization using dplyr and tidyr.
- Visualize high-dimensional and geospatial data and communicate insights clearly.

Course Outcomes:

Learner will be able to:

CO1: Apply R and RStudio tools to manipulate and explore data structures.
CO2: Perform basic exploratory data analysis and find insights in the data.
CO3: Select and apply the appropriate visualizations for categorical and numerical data.
CO4: Create and customize visualizations using ggplot2 and the grammar of graphics.
CO5: Transform and aggregate data for visualization using dplyr and tidyr.
CO6: Visualize high-dimensional and geospatial data and effectively communicate 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	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

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

Suggested list of experiments:

Sr. No.	List of experiments
1	Introduction to R and RStudio
2	Create, access, and modify various data structures in R
3	Loading and Exploring Datasets and perform basic exploratory data analysis (EDA).
4	Visualizing Categorical and Numerical Data and Match the right chart type to different data types
5	Understand the grammar of graphics and create plots like scatter plots, line charts, and box plots using ggplot2
6	Data transformation techniques for data visualization (filtering, aggregating, reshaping).Using dplyr and tidyr to filter and aggregate a dataset
7	Implement data sampling techniques, perform summarization
8	Visualize high-dimensional data using techniques like scatterplot matrices and parallel coordinates.
9	Visualize geospatial data using ggplot2 and sf using choropleth maps
10	Design effective visualizations for storytelling and communication.

Textbooks:

1. R for Data Science by Hadley Wickham and Garrett Grolemund
2. Data Visualization: A Practical Introduction by Kieran Healy

Reference books:

1. Practical Data Science with R by Nina Zumel and John Mount

Course Name: Time Series and Forecasting & Time Series and Forecasting

Course Code: HMIT11T

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Data Visualization Using R-Programming (HMIT10T and HMIT10P)

Pre-requisite for: Data Ethics and Privacy (HMIT12T and HMIT12P)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
HMIT11T	2	-	2	-
HMIT11P	-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (HMIT11T)	15 (20%)	20 (30%)	40 (50%)	75 (100%)
Practical (HMIT11P)	25 (50%)	-	25 (50%)	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.

Preamble:

The course Time Series and Forecasting introduce students to the analysis of time-dependent data, focusing on identifying patterns, modeling trends and seasonality, and forecasting future values. It combines statistical techniques with practical implementation using tools like Python/R, preparing students for real-world applications in finance, economics, environmental science, and engineering.

Course Objectives:

- To develop a strong foundation in time series concepts, including trend, seasonality, stationarity, and autocorrelation, along with their significance in real-world data analysis.
- To equip students with practical skills to apply statistical and machine learning-based forecasting techniques using tools like Python or R.

- To enable critical thinking and problem-solving by analyzing time-dependent data and designing effective forecasting models for domains such as finance, healthcare, environment, and operations.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	To recall fundamental concepts and terminology related to time series data and forecasting methods.	Remembering
CO2	To explain the components of time series data and the theoretical foundations of various forecasting models.	Understanding
CO3	To apply classical and modern forecasting models (e.g., ARIMA, exponential smoothing) to real-world time series datasets.	Applying
CO4	To analyze time series data using decomposition, autocorrelation, and diagnostic tools to identify suitable forecasting techniques.	Analysing
CO5	To evaluate the accuracy and performance of different forecasting models using standard metrics and validation methods.	Evaluating
CO 6	To design and implement complete forecasting solutions for practical problems using programming tools and domain-specific data.	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours

1	Introduction to Time Series Analysis	Definition and examples of time series
		Components: trend, seasonality, cyclicity, noise
		Types: univariate vs. multivariate, discrete vs. continuous
		Time series visualization
		Applications across domains (finance, healthcare, environment)
		• **Self-Learning Topics:**
		  ○ Exploring open time series datasets
		  ○ Domain-wise application studies
			2

2	Time Series Decomposition and Smoothing	Additive vs. multiplicative models Moving average, weighted moving average Exponential smoothing: SES, DES (Holt), TES (Holt-Winters) STL decomposition (Seasonal-Trend decomposition) **Self-Learning Topics:** • Visualization and implementation using Python/R/Excel Hands-on experimentation with smoothing methods	5

3	Stationarity and ARIMA Modeling	Stationarity: concept, importance, visual detection Differencing and transformations ACF and PACF Unit root tests: ADF, KPSS AR, MA, ARMA, ARIMA models Model selection: AIC, BIC **Self-Learning Topics:** • ACF/PACF analysis on sample datasets • Using Python (statsmodels) for ARIMA	5
4	Advanced Time Series Models	Seasonal ARIMA (SARIMA), SARIMAX Vector Autoregression (VAR) Granger causality Cointegration Introduction to state space models and Kalman filters **Self-Learning Topics:** o Application of VAR and SARIMAX in real-world datasets o Financial time series examples	6
5	Machine Learning for Time Series Forecasting	Time-based feature engineering (lags, rolling windows) Train-test split for time series Regression models: Decision Tree, Random Forest Basics of deep learning: RNN, LSTM Evaluation metrics: RMSE, MAE, MAPE **Self-Learning Topics:** • Hands-on with ML models using Python (scikit-learn, Keras) • Walk-forward validation techniques	5
6	Applications, Case Studies & Project Work	Case studies: stock market, weather prediction, demand forecasting Forecasting dashboard basics (e.g., Streamlit/Flask for Python) Ethics in forecasting Mini-project: problem selection, modeling, evaluation, and presentation **Self-Learning Topics:** • Deployment tools for model sharing • Business storytelling with data	2
		Total	**30**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1	Time Series Visualization and Component Analysis
2	Smoothing Techniques: MA, WMA, and Exponential Smoothing
3	Stationarity Testing using ADF and KPSS Tests
4	ARIMA Model Building and Forecasting
5	Seasonal ARIMA (SARIMA) Model for Periodic Data
6	Vector Autoregression (VAR) for Multivariate Time Series
7	Feature Engineering for ML-based Time Series Forecasting
8	Forecasting using Decision Tree and Random Forest
9	LSTM Model for Sequence Forecasting (Deep Learning)
10	Mini-Project: End-to-End Forecasting Pipeline

Course Name: Data Ethics and Privacy & Data Ethics and Privacy

Course Code: HMIT12T & HMIT12P

Vertical/ Sub-Vertical:

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Computer Networks, Introduction to Artificial Intelligence, Database Management Systems

Pre-requisite for: -

Recommended Semester: 8

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
HMIT12T	2	-	2	-
HMIT12P	-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (HMIT12T)	15 (~20%)	20 (~30%)	40 (~50%)	75 (100%)
Practical (HMIT12P)	25 (50%)	-	25 (50%)	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.

Preamble:

In the era of data-driven decision making, ensuring ethical handling and privacy of data is paramount. This course equips students with the foundational principles of data ethics, privacy laws, and responsible data usage. It explores the ethical dilemmas, legal frameworks, and technical measures needed to protect individual rights and societal values in the digital age. The subject prepares students to develop and deploy data-centric solutions with accountability, transparency, and fairness.

Course Objectives:

- Understand fundamental principles of data ethics and privacy, including key concepts, challenges, and societal implications.
- Analyze legal and regulatory frameworks governing data protection and privacy in different jurisdictions.
- Apply ethical decision-making and privacy-preserving techniques to design responsible data-driven systems.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Recall fundamental concepts of data ethics, privacy, and related terminologies.	Remembering
CO2	Explain the importance of data privacy and ethical considerations in data usage and management.	Understanding
CO3	Apply relevant data protection laws and ethical guidelines to real-world data handling scenarios.	Applying
CO4	Analyze ethical dilemmas and privacy challenges in data-driven applications and technologies..	Analysing
CO5	Evaluate different privacy-preserving techniques and ethical frameworks for compliance and effectiveness.	Evaluating
CO 6	Design data-driven systems and policies that integrate ethical principles and privacy safeguards.	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Data Ethics and Privacy	**Learning Objective:** To introduce students to the fundamental concepts, importance, and scope of data ethics and privacy. **Contents:** • Definition and history of data ethics • Importance of ethics in data handling • Key concepts: data privacy, confidentiality, consent, ownership • Overview of ethical challenges in data science and AI • Privacy principles and ethical frameworks **Self-Learning Topics:** • Case studies of ethical breaches in data use • Research on ethical codes (ACM, IEEE) **Learning Outcomes:** • LO1.1: Define key terms related to data ethics and privacy (PI 1.4.1) (CO1) • LO1.2: Explain the importance of ethical considerations in data usage (PI 6.1.2) (CO2)	2

Module No.	Module Name	Content	No of Hours
2	Ethical Theories and Frameworks in Data	**Learning Objective:** To understand various ethical theories and frameworks applicable to data ethics. **Contents:** • Overview of normative ethical theories: utilitarianism, deontology, virtue ethics • Ethical decision-making models • Principles of fairness, accountability, transparency (FAT) • Stakeholders and their responsibilities in data ecosystems **Self-Learning Topics:** • Compare different ethical theories with real-world examples • Analyze a data ethics dilemma using multiple frameworks **Learning Outcomes:** • LO2.1: Summarize major ethical theories relevant to data (PI 8.1.2) (CO2) • LO2.2: Apply ethical frameworks to analyze data-related dilemmas (PI 8.2.3) (CO4)	5
3	Legal and Regulatory Landscape for Data Privacy	**Learning Objective:** To familiarize students with major data protection laws and regulatory standards worldwide. **Contents:** • Overview of GDPR, HIPAA, CCPA, and other major regulations • Data subject rights and data controller responsibilities • Consent and data breach notification requirements • Cross-border data flow and compliance challenges **Self-Learning Topics:** • Study a selected privacy law in detail • Research recent legal cases involving data privacy violations **Learning Outcomes:**	5

Module No.	Module Name	Content	No of Hours
		• LO3.1: Identify key provisions of major data privacy laws (PI 6.2.1) (CO3) • LO3.2: Interpret the implications of legal requirements on data management (PI 6.2.3) (CO3)	
4	Privacy-Preserving Technologies and Techniques	**Learning Objective:** To explore technical methods for protecting data privacy and minimizing risks. **Contents:** • Data anonymization and pseudonymization • Differential privacy and its applications • Encryption and secure data storage • Access control and identity management • Emerging techniques: federated learning, homomorphic encryption **Self-Learning Topics:** • Hands-on with open-source privacy tools • Review recent research on privacy-enhancing technologies **Learning Outcomes:** • LO4.1: Describe various privacy-preserving techniques (PI 5.1.1) (CO5) • LO4.2: Apply suitable techniques to protect sensitive data (PI 5.1.3) (CO5)	6
5	Ethical Issues in AI and Data-Driven Systems	**Learning Objective:** To analyze ethical challenges in AI, machine learning, and automated decision-making. **Contents:** • Algorithmic bias and fairness • Transparency and explainability of AI models • Accountability in automated systems • Social impact and unintended consequences of AI • Case studies of ethical dilemmas in AI deployments **Self-Learning Topics:** • Explore datasets for bias and fairness analysis • Review prominent AI ethics guidelines	5

Module No.	Module Name	Content	No of Hours
		Learning Outcomes: • LO5.1: Identify sources of bias and ethical risks in AI (PI 7.1.1) (CO5) • LO5.2: Evaluate methods to improve fairness and transparency (PI 8.2.5) (CO5)	
6	Designing Responsible Data Systems and Policies	**Learning Objective:** To enable students to design data systems and organizational policies incorporating ethical and privacy principles. **Contents:** • Privacy by design and default principles • Ethical data governance frameworks • Risk assessment and mitigation strategies • Developing data usage policies and user consent mechanisms • Role of audits and compliance monitoring **Self-Learning Topics:** • Draft a data privacy policy for a hypothetical organization • Conduct a risk assessment for a data system **Learning Outcomes:** • LO6.1: Design data systems integrating privacy and ethics principles (PI 3.4.6) (CO6) • LO6.2: Develop organizational policies for ethical data management (PI 6.1.5) (CO6)	2
Total			**30**

Suggested List of Practical's:

Sr No.	List of experiments
1.	Case Study Analysis of Data Ethics Breaches Learning Outcomes: A learner will be able to: 1.1 Identify ethical violations in real-world data usage cases. (PI 8.1.1) (CO1) 1.2 Analyze the impact of unethical data practices on individuals and society. (PI 6.1.2) (CO2)
2.	Applying Ethical Frameworks to Data Dilemmas Learning Outcomes: A learner will be able to: 2.1 Apply ethical theories such as utilitarianism and deontology to data scenarios. (PI 8.2.3)

	(CO2) 2.2 Evaluate the consequences of different ethical decisions. (PI 8.2.5) (CO4)
3.	Comparative Study of Data Privacy Laws Learning Outcomes: A learner will be able to: 3.1 Summarize key provisions of GDPR, HIPAA, and CCPA. (PI 6.2.1) (CO3) 3.2 Compare and contrast legal requirements across jurisdictions. (PI 6.2.3) (CO3)
4.	Implementing Data Anonymization Techniques Learning Outcomes: A learner will be able to: 4.1 Apply anonymization and pseudonymization to sample datasets. (PI 5.1.3) (CO4) 4.2 Assess the effectiveness of privacy-preserving methods. (PI 5.3.5) (CO5)
5.	Bias Detection in AI Models Learning Outcomes: A learner will be able to: 5.1 Identify bias in sample AI datasets or models. (PI 7.1.1) (CO5) 5.2 Suggest strategies to mitigate bias and improve fairness. (PI 8.2.5) (CO5)
6.	Designing a Data Privacy Policy for an Organization Learning Outcomes: A learner will be able to: 6.1 Develop a data privacy policy incorporating legal and ethical guidelines. (PI 3.4.6) (CO6) 6.2 Justify policy choices based on ethical and regulatory standards. (PI 6.1.5) (CO6)

Course Name: IT Security Strategic Planning, Policy, and Leadership

Course Code: HMIT13T

Category: Honours in Cyber Security

Preamble:

In the rapidly evolving digital landscape, organizations face complex and persistent cybersecurity challenges. IT Security Strategic Planning and Policy is a critical discipline that empowers professionals to design and implement structured approaches to safeguarding information assets. This course aims to equip learners with the knowledge and tools required to develop comprehensive security strategies and policies aligned with organizational goals and regulatory requirements.

Pre-requisites: Computer Networks, Computer Network & Security

Course Objectives:

1. Understand the principles and significance of IT security strategic planning.
2. Learn the structure and components of IT security policies.
3. Explore methods for performing risk assessments and integrating them into strategic plans.
4. Gain knowledge of compliance with regulatory frameworks and standards.
5. Understand the evaluation and maintenance of security policies.

Course Outcomes:

Learner will be able to:
CO1: Explain the key components of IT security strategic planning.
CO2: Design theoretical IT security policies for organizational use.
CO3: Perform conceptual risk assessments and recommend appropriate mitigations.
CO4: Evaluate compliance requirements and propose strategies for regulatory adherence.
CO5: Assess and refine IT security policies based on organizational needs and industry best practices.
CO6: Utilize metrics to evaluate the effectiveness of security strategies.

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	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 IT Security Strategic Planning	Definition and importance of strategic planning in IT security. Alignment of IT security strategies with business objectives. Overview of security frameworks: NIST CSF, ISO 27001, COBIT.	4
2	Fundamentals of IT Security Policies	Policy structure: Definitions, objectives, scope, and responsibilities. Types of IT security policies: Acceptable use, data protection, access control, and incident management. Policy lifecycle: Development, approval, communication, and review.	6
3	Risk Management and Business Impact Analysis	Risk assessment fundamentals: Threats, vulnerabilities, and impact. Risk management methodologies (e.g., NIST SP 800-30). Business Impact Analysis (BIA): Identifying critical assets and dependencies.	6
4	Regulatory and Compliance Requirements	Introduction to major regulations: GDPR, HIPAA, PCI DSS, SOX. Compliance as part of IT security strategy. Industry best practices for achieving and maintaining compliance.	6
5	Security Metrics and Policy Evaluation	Security metrics: Types, importance, and measurement techniques. Methods for evaluating the effectiveness of security policies. Reporting and improving policies using feedback and audit results.	4
6	Emerging Trends and Challenges in IT Security Strategic Planning	Emerging security threats and their impact on strategic planning: Advanced Persistent Threats (APTs), ransomware, and zero-day vulnerabilities. Incorporating Artificial Intelligence (AI) and Machine Learning (ML) in IT security strategies. Cloud security considerations in policy development. Challenges in aligning policies with new technologies such as IoT and blockchain. Future directions in IT security frameworks and standards.	4
Total			**30**

Textbooks:

1. "Information Security Policies, Procedures, and Standards: A Practitioner's Reference" by Douglas J. Landoll
2. "Managing Risk in Information Systems" by Darril Gibson
3. Cybersecurity and Cyberwar: What Everyone Needs to Know by P.W. Singer and Allan Friedman

Reference Books:

1. "Handbook of Digital Forensics and Investigation" edited by Eoghan Casey
2. "Windows Forensic Analysis Toolkit: Advanced Analysis Techniques for Windows 10" by Harlan Carvey
3. "Network Forensics: Tracking Hackers through Cyberspace" by Sherri Davidoff and Jonathan Ham
4. "Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation" by Lee Reiber

Course Name: IT Security Strategic Planning, Policy, and Leadership Lab

Course Code: HMIT13P

Category: Honours in Cyber Security

Preamble:

This lab course provides practical, hands-on experience in developing, implementing, and evaluating IT security strategies, policies, and leadership practices. Through real-world simulations, case studies, and group projects, students will apply strategic planning frameworks, draft security policies, and practice leadership skills required for effective IT governance and risk management.

Pre-requisites:

Computer Networks Lab- IT06P, Operating system Lab- IT05P, Computer & Network Security Lab- IT24P

Course Objectives:

1. By the end of this course, students will be able to:
2. Design and implement strategic security plans aligned with organizational goals.
3. Develop IT security policies addressing regulatory and business requirements.
4. Use leadership and communication techniques to manage security teams effectively.
5. Conduct risk assessments and propose mitigation strategies.
6. Collaborate in a team to solve complex cybersecurity challenges.

Course Outcomes:

Learner will be able to:
LO1: Develop Comprehensive IT Security Strategies
LO2: Draft and Evaluate IT Security Policies
LO3: Conduct Effective Risk Assessments
LO4: Lead and Manage Cybersecurity Teams
LO5: Implement and Evaluate Incident Response Plans
LO6: Monitor and Report Cybersecurity Metrics

Course Scheme:

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

Assessment guidelines:

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

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.	Title of Practicals
1	Course Overview and Lab Setup • Overview of IT security leadership and strategic planning. • Introduction to lab tools and virtual environments. • Basics of organizational alignment in security planning.
2	Risk Assessment and Business Impact Analysis • Conducting a risk assessment using industry frameworks (e.g., NIST, ISO). • Analyzing and presenting business impact findings.
3	Designing IT Security Strategies • Hands-on: Creating a strategic security plan. • Balancing security with business objectives.
4	IT Security Policy Development • Drafting an IT security policy document (e.g., access control, incident response). • Addressing compliance requirements (e.g., GDPR, HIPAA).
5	Incident Response Planning • Developing an incident response plan and playbook. • Lab simulation: Responding to a security breach.
6	Governance, Risk, and Compliance (GRC) • Lab exercises in setting up GRC dashboards. • Conducting compliance audits and presenting findings.
7	Security Awareness and Training Programs • Designing employee security awareness programs. • Delivering mock training sessions for end-users.
8	Cybersecurity Metrics and Reporting • Creating and analyzing security dashboards and reports. • Lab: Presenting key metrics to a mock C-suite team.

Textbooks:

1. "Information Security Policies, Procedures, and Standards: A Practitioner's Reference" by Douglas J. Landoll.

Reference Books:

1. "CISO Desk Reference Guide: A Practical Guide for CISOs" by Bill Bonney, Gary Hayslip, and Matt Stamper
2. "Managing Risk in Information Systems" by Darril Gibson
3. "IT Security Governance Guidebook with Security Program Metrics on CD-ROM" by Fred Cohen
4. "NIST Cybersecurity Framework: A Pocket Guide" by Alan Calder
5. "Cybersecurity Leadership: Powering the Modern Organization" by Mansur Hasib

Course Name: Advanced Threat Intelligence and Penetration Testing

Course Code: HMIT14T

Vertical/ Sub-Vertical: PE

Category : Honour -Minor Cyber Security

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Computer Networks (IT06T)

Pre-requisite for: IT62T (Detection & Mitigation of Cyber Threats)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
HMIT14T	2	-	2	-
HMIT14P	-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
HMIT14T	15 (20%)	20 (30%)	40 (50%)	75 (100%)
HMIT14P	25 (50%)	-	25 (50%)	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.

Preamble:

This course explores the landscape of cyber threats and countermeasures. It introduces students to advanced threat intelligence concepts, attack simulation techniques, and penetration testing methodologies. Students gain hands-on experience in discovering, analysing, and mitigating real-world security vulnerabilities.

Course Objectives:

- Understand the advanced concepts in cyber threat intelligence and actor profiling.
- Perform vulnerability assessments and penetration testing on networked environments.
- Use industry-standard tools to collect, process, and report threat intelligence.
- Apply ethical and legal considerations in offensive security practices.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Describe the principles of threat intelligence and penetration testing	Remembering
CO2	Identify and classify threat actors, TTPs, and attack vectors using threat models	Understanding
CO3	Conduct penetration tests using tools and techniques across various attack surfaces	Applying
CO4	Analyse threat data and penetration test results to assess organizational risks	Applying
CO5	Design threat reports and penetration test documentation with actionable recommendations	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Threat Intelligence	Definitions and types of threat intelligence (Strategic, Tactical, Operational, Technical), Threat intelligence lifecycle, Threat actors and motivations **Self-Learning Topics**: Cyber kill chain, Threat hunting basics	4
2	Threat Intelligence Tools and Techniques	STIX/TAXII standards, MITRE ATT&CK framework, MISP, OpenCTI, OSINT tools, IOCs and TTPs. **Self-Learning Topics:** YARA rules, Passive DNS, WHOIS lookups	6
3	Introduction to Penetration Testing	Phases of penetration testing; ethics and legal considerations; vulnerability scanning tools (Nessus, OpenVAS); CVEs and CVSS; Metasploit basics. **Self-Learning Topics:** SAST vs. DAST, manual code reviews, OSCP/CEH overview	6
4	Network and Web Application Testing	Network scanning (Nmap), Web application testing (Burp Suite, Nikto); OWASP Top 10 (SQLi, XSS, LFI); exploitation walkthroughs. **Self-Learning Topics:** Gobuster, Hydra, ZAP Proxy	6
5	Threat Reporting and Risk Mitigation	Types of reports (technical, executive); report structure; TTP documentation; risk ratings and mitigation strategy formulation. **Self-Learning Topics:** NIST Framework, ISO/IEC 27001	4
6	Case Studies and Emerging Threat Trends	Case studies (APT29, Lazarus, SolarWinds); current threat landscapes; dark web intelligence; threat hunting practices.	4

		Self-Learning Topics: Threat feeds (VirusTotal, OTX), annual threat reports (Mandiant, DBIR)	
			Total **30**

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Configure MISP and integrate a threat feed
2.	Map attacker techniques using MITRE ATT&CK Navigator
3.	Perform active and passive OSINT collection (e.g., Shodan, WHOIS, Google Dorks)
4.	Scan a network using Nmap and interpret port/service results
5.	Perform vulnerability assessment using Nessus or OpenVAS
6.	Exploit a system using Metasploit (e.g., SMB exploit)
7.	Conduct a web application attack using Burp Suite (e.g., SQLi or XSS on DVWA)
8.	Prepare a structured technical + executive report of test findings and recommendations

Course Name: Advanced Computer Forensics Analysis

Course Code: HMIT15T

Category: Honour – Minor (Cyber security)

Pre-requisites:

- Computer Network Security
- System Security and Ethical Hacking
- Digital Forensics

Course Objectives:

- To understand the nature and evolution of cyber threats and attack vectors.
- To learn various threat detection methodologies used in cybersecurity.
- To explore mechanisms and tools for mitigating different types of cyber threats.
- To understand the role of security frameworks and standards in cyber threat defense.
- To analyze case studies involving cyberattacks and their mitigation techniques.

Course Outcomes:

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

CO1: Identify and classify various types of cyber threats and vulnerabilities.
CO2: Explain the principles and techniques used in cyber threat detection.
CO3: Describe defense strategies including security technologies and policies.
CO4: Evaluate cybersecurity frameworks and their application in threat mitigation.
CO5: Analyze real-world cyber incidents to derive threat mitigation approaches.
CO6: Demonstrate awareness of current trends and tools in cyber threat intelligence.

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.

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

Assessment guidelines:

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

Sr. No.	Module	Detailed Content	Hrs
1	Introduction to Cyber Threats	Types of threats: malware, phishing, ransomware, insider threats, DDoS, APTs. Threat actors and motives. Threat intelligence lifecycle. OWASP Top 10.	5
2	Threat Detection Techniques	Signature-based vs. anomaly-based detection. Host-based and network-based detection. Behavioral analysis. Indicators of compromise (IoCs).	5
3	Cyber Threat Intelligence (CTI)	Threat intelligence sources, feeds, and platforms. STIX, TAXII standards. Open-source intelligence (OSINT). Role of CTI in threat detection.	5
4	Mitigation Techniques & Incident Response	Mitigation strategies: patching, segmentation, access control, encryption. Incident response process (NIST model). Containment, eradication, and recovery steps.	5
5	Security Technologies & Tools	Firewalls, antivirus, IDS/IPS, endpoint detection & response (EDR), security information and event management (SIEM). Modern defense tools (EDR/XDR, SOAR).	5
6	Cybersecurity Frameworks & Case Studies	MITRE ATT&CK, NIST CSF, ISO/IEC 27001. Case studies: SolarWinds, WannaCry, Target breach. Lessons learned and best practices.	5
Total			**30**

Textbooks

1. William Stallings, Computer Security: Principles and Practice, 4th Edition, Pearson, 2023.
2. Eric Conrad, Seth Misenar, Joshua Feldman, CISSP Study Guide, Syngress, 4th Edition.

Reference Books

1. Michael Sikorski & Andrew Honig, Practical Malware Analysis, No Starch Press.

2. Chris Sanders, Applied Network Security Monitoring, Syngress.
3. Paul E. Proctor, The Practice of Network Security Monitoring, No Starch Press.
4. MITRE ATT&CK Framework – https://attack.mitre.org
5. NIST SP 800-61 Rev. 2 – Computer Security Incident Handling Guide

Course Name: Foundations of UX and ARVR

Course Code: HMIT16T and HMIT16P

Category: Honour – Minor (Virtual Augmented Reality)

Preamble:

The course "Foundations of UX and AR/VR" introduces students to the principles of user- centered design and immersive technologies. It focuses on design thinking, usability, and interaction for creating intuitive and engaging digital experiences. Students learn to design and evaluate interfaces using UX tools and AR/VR frameworks, integrating human factors and ethical design. The course bridges theory and practice through prototyping, user testing, and immersive simulations, preparing learners to apply these skills across industries such as education, healthcare, and entertainment.

Pre-requisites: NIL

Course Objectives:

- To stress the importance of User Interface and User Experience.
- To Learn fundamentals of VR
- To know geometric models and transformations
- To Learn motion in VR
- To Learn fundamentals of VR
- To understand computer vision and AR

Course Outcomes:

Learner will be able to
CO1: To stress the importance of User Interface and User Experience. CO2: To
Learn fundamentals of VR
CO3: To know geometric models and transformations CO4:
To Learn motion in VR
CO5: To Learn fundamentals of VR
CO6: To understand computer vision and AR

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 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.

Sr. No.	Module	Detailed Content	Hrs	CO Mapping
1	**Introduction to UX**	Web Technologies, Software Engineering Process What is UX, Ubiquitous interaction, Emerging desire for usability, from usability to user experience, Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.	05	CO1
2	**Fundamentals of Virtual Reality**	Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality ***Case Studies:*** *Study the use of Virtual Reality at NASA. Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR* ***Case Studies:*** *GHOST (General Haptics Open Software Toolkit) software development toolkit.*	05	CO2

3	**Geometric models and transformations in VR**	Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR. ***Case Studies:*** *Sweeping coverage of eye movements Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates* ***Case Studies:*** *Automatic stitching of panoramas in Virtual Reality*	05	CO3
4	**Motion and VR**	Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies ***Case Studies:*** *A virtual Study Use Case- NICE, An Educational Experience Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering* ***Case Studies:*** *Side effects of using VR systems/ VR sickness.*	05	CO4
5	**Fundamentals of AR**	What Is Augmented Reality - Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality Augmented Reality Concepts- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience	05	CO5

		Case Studies *Timeline of evolution of AR from VR* *Augmented Reality Hardware – Displays – Audio Displays,* *Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications.Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion* ***Case Studies*** *Study the design of an AR application with C# and Unity*		
6	**Computer Vision and AR**	Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for theAugmented Reality Application. ***Case Studies*** *Study all the available AR toolkits.* *Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication* *Marker types- Template markers, 2D barcode markers, imperceptible markers.* *Marker-less approach- Localization based augmentation, real world examples* *Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialisation and Recovery.* ***Case Studies*** *Study on enhancement and improving markers with Vuforia engine.*	05	CO6

Online resources

https://nptel.ac.in/courses/107/103/107103083/

https://www.uxbeginner.com/ux-courses/

Books and References:

A. Books:

1. The UX Book by Rex Hartson and Pardha Pyla
2. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
3. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
4. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

B. References:

1. Human Computer Interaction by Alan Dix
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Suggested experiments and guidelines:

Preamble for LAB

The "Foundations of UX and AR/VR Lab" provides hands-on experience in designing, prototyping, and evaluating user-centered and immersive applications. Students apply UX design principles, interaction models, and usability testing using modern tools and AR/VR frameworks. The lab emphasizes practical experimentation, creative problem-solving, and iterative design improvement. Through projects and simulations, learners develop the skills to build intuitive, accessible, and engaging AR/VR experiences for real-world applications.

Experiment 1: Introduction to Unity Interface and Project Setup

- Objective: Learn Unity Editor layout, project creation, scene management, and asset organization.
- Tasks: Create a new 3D project, explore Hierarchy, Scene, Game, and Inspector panels.

Experiment 2: Working with GameObjects and Components

- Objective: Understand GameObjects, components, and transforms in Unity.
- Tasks: Add 3D objects (cube, sphere), manipulate position, rotation, and scale.

Experiment 3: Materials, Lighting, and Skyboxes

- Objective: Learn how to apply materials, textures, and lighting to enhance realism.
- Tasks: Create materials, adjust light sources, and apply a skybox to a scene.

Experiment 4: Prefabs and Object Reusability

- Objective: Create and manage prefabs to reuse assets efficiently.
- Tasks: Build a prefab object (like a tree or chair) and instantiate it multiple times in the scene.

Experiment 5: Introduction to C# Scripting in Unity

- Objective: Write basic scripts to control object behavior.
- Tasks: Use C# scripts to move or rotate a GameObject based on user input.

Experiment 6: Physics and Collisions

- Objective: Implement physics-based interactions using Rigidbody and Colliders.
- Tasks: Create a bouncing ball or object collision simulation using gravity and materials.

Experiment 7: Camera Controls and User Navigation

- Objective: Learn to control camera movement and set up user navigation in the scene.
- Tasks: Implement first-person or third-person camera controls for exploring a 3D environment.

Experiment 8: UI Elements and User Interaction

- Objective: Design basic user interfaces in Unity using Canvas, Buttons, and Text.
- Tasks: Create an interactive menu with start/exit buttons or a score counter display.

Experiment 9: Introduction to AR Foundation or Vuforia SDK

- Objective: Integrate AR SDK and create simple augmented reality experiences.
- Tasks: Use a marker-based AR setup to display 3D models on physical surface

Experiment 10: Mini Project – Design a Simple Interactive AR/VR Experience

- Objective: Apply all learned concepts to create a functional AR or VR prototype
- Tasks: Design an immersive scene (e.g., virtual gallery, product demo, or mini-game) and demonstrate user interaction.

Course Name: ARVR and GAME DEVELOPMENT

Course Code: HMIT17T and HMIT17P

Category: Honour – Minor (VAR)

Preamble:
The course "AR/VR and Game Development" introduces students to the principles, tools, and techniques used to design immersive and interactive virtual environments. It focuses on Augmented Reality (AR), Virtual Reality (VR), and game development frameworks to build engaging digital experiences. Students learn 3D modeling, interaction design, and real-time rendering using engines like Unity or Unreal. The course emphasizes creativity, usability, and storytelling in interactive systems, preparing learners to develop innovative AR/VR games and simulations for diverse real-world applications.

Pre-requisites: Foundations of UX and ARVR

Course Objectives:

- Explain the concept, purpose, and functioning of Virtual Reality systems.
- Understand high-level concepts of VR content creation and environmental design
- Learn human-centered interaction principles for intuitive and comfortable VR experiences.
- Apply design principles to create immersive AR/VR applications.
- Develop and present a **VR game prototype in Unity** implementing content creation and interaction principles.
- Understand health effects in AR-VR

Course Outcomes:

Learner will be able to

CO1 : Know the concept, purpose, and functioning of Virtual Reality systems.
CO2: Understand high-level concepts of VR content creation and environmental design.
CO3 : Learn human-centered interaction principles for intuitive and comfortable VR experiences.
CO4 : Apply Design principles to create immersive of AR-VR
CO5 : Develop and present a **VR game prototype in Unity** implementing content creation and interaction principles.
CO6 : Understand health effects in AR-VR.

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 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.

Sr. No	Module	Detailed Content	Hrs	CO Mapping
1	**Virtual Reality in a Nutshell**	What is virtual reality?, Types of head-mounted displays, The difference between virtual reality and augmented reality, Applications versus games, How virtual reality really works, Types of VR experiences, Technical skills that are important to VR ***Case Studies*** *Study about VR device interaction and working with OS(Windows/Linux) and IDE's (Unity/Unreal)*	05	CO1
2	**Content Creation & Interaction**	High-Level Concepts of Content Creation, Environmental Design, Affecting Behavior, Transitioning to VR Content Creation, Content Creation: Design Guidelines, Human-Centered Interaction, VR Interaction Concepts, Input Devices, Interaction Patterns and Techniques, Interaction: Design Guidelines ***Case Studies*** *Case study of a developed VR game in Unity with the above-mentioned features.*	05	CO2

3	**Iterative Design**	Philosophy of Iterative Design, The Define Stage, The Make Stage, The Learn Stage, Iterative Design: Design Guidelines ***Case Studies*** *Study of Iterative design of any VR game.*	05	CO3
4	**Game Development in Unity - Part I**	Overview, Building Your Project and Character, Getting Animated, The Town View, Working with Unity's UI System, NPCs and Interactions, The World Map, Encountering Enemies and Running Away ***Case Studies*** *Animation in Unreal Engine vs Unity Engine*	05	CO4
5	**Game Development in Unity - Part II**	Getting Ready to Fight, The Battle Begins, Shopping for Items, Sound and Music, Putting a Bow on It, Deployment and Beyond ***Case Studies*** Case study on considering windows mixed reality for game development in Unit	05	CO5
6	**Adverse Health Effects**	Motion Sickness, Eye Strain, Seizures, and Aftereffects, Hardware Challenges, Latency, Measuring Sickness, Summary of Factors That Contribute to Adverse Effects, Examples of Reducing Adverse Effects, Adverse Health Effects: Design Guideline ***Case Studies*** *Effect of any VR game on health.(Beat Saber/Rick and Morty: Virtual Rick-Ality/ Cloudlands VR Minigolf)*	05	CO6

Online resources

- **https://nptel.ac.in/courses/107/103/107103083/**
- **https://www.uxbeginner.com/ux-courses/**
- **Google UX Design Certificate**
- **Coursera AR/VR Development**

Books and References:

A. Books:

1. The Design of Everyday Things by Don Norman.
2. Jason Jerald- The VR Book: Human- Centered Design for Virtual Reality, Association for Computing Machinery and Morgan & Claypool Publishers (Aug. 5 2016), ISBN- B01JV1LAZW
3. Mastering Unity 2D Game Development - Second Edition,AshleyGodbold, Simon Jackson, Packt

Publishing, October 2016, ISBN: 9781786463456

4. Jonathan Linowes – Unity Virtual Reality Projects: Explore the world of virtual reality by building immersive and fun VR projects using Unity 3D Paperback||, 1st Edition, Packt Publications, 2015, ISBN 978-1783988556

References:

5. Tony Parisi – Learning Virtual Reality, O'Reilly Media, Inc., 2015, ISBN- 9781491922835
6. Virtual Reality with VRTK4, Create Immersive VR Experiences Leveraging Unity3D and Virtual Reality Toolkit, Authors: Baruah, Rakesh, ISBN 978-1-4842-5488-2

Tools:

7. Figma, Adobe XD, Sketch for UX.
8. Unity3D, Unreal Engine, ARKit, ARCore for AR/VR.

Suggested Lab Experiments:

SR. No	Title of Experiment	Objective	Task
1	Experiment 1: Introduction to Unity Game Engine	Familiarize with Unity Editor, interface components, and workflow for AR/VR game development.	Install Unity and create a new 3D project. Explore Hierarchy, Scene, Game, and Inspector panels. Understand Scene management and Asset import.
2	Experiment 2: Environment Design and Level Setup	Design a 3D game environment and set up a basic level layout	Create terrains, skyboxes, and lighting. Add objects like walls, floors, and props. Use Asset Store to import 3D models for a game world.
3	Experiment 3: Working with GameObjects and Physics	Implement realistic interactions using Unity's physics engine	Add Rigidbody and Collider components. Simulate object gravity and collisions. Create simple mechanics like a rolling ball or falling blocks.

4	Experiment 4: Player Controller and Camera System	Develop a controllable player character and a dynamic camera	Use Character Controller and input scripts for player movement. Add first-person or third-person camera controls. Implement camera follow and rotation logic.
5	Experiment 5: Game Mechanics and Object Interactions	implement basic gameplay interactions like pickups, triggers, or scoring	Use OnTriggerEnter and OnCollisionEnter for object interactions. Create collectible objects (coins, power- ups). Display score and game status using UI elements.
6	Experiment 6: AR/VR Integration in Unity	Implement scripts to handle core game logic, levels, and win/loss conditions	Install AR Foundation or Vuforia SDK for AR. For VR, use XR Plugin Management and connect to a headset. Display 3D models on markers (AR) or inside immersive scenes (VR).
7	Experiment 7: User Interface and Interaction Design	Design game menus, HUDs, and interaction panels for user experience	Use Canvas, Buttons, and Text components. Create main menu, pause, and game-over screens. Add UI transitions and event-based actions.
8	Experiment 8: Audio, Animation, and Particle Effects	Enhance immersion with sound, animation, and visual effects	Add background music, 3D spatial sounds, and sound effects. Animate characters and objects using Animator. Use particle systems for explosions, smoke, or fire.
9	Experiment 9: Game Logic and Event Handling	Implement scripts to handle core game logic, levels, and win/loss conditions	Use C# scripts for event- driven actions. Manage levels, timers, and scoring systems. Implement checkpoints and difficulty progression.

10	Mini Project – Develop a Complete AR/VR Game	Design and develop a small AR/VR-based game integrating all previous experiments	Conceptualize a simple game idea (e.g., puzzle, maze, shooter, or exploration). Implement environment, player controls, UI, and scoring system. Integrate AR/VR functionality and test gameplay. Prepare a short demo and report explaining game flow and interaction design

Course Name: USECASE in ARVR

Course Code: HMIT17T and HMIT17P

Category: Honour – Minor (VAR)

Pre-requisites:

- Foundations of UX and ARVR
- ARVR and GAME DEVELOMENT
- Basic knowledge of designing tools and languages like HTML

Course Objectives:

- Identify problem statement.
- Create project document.
- Plan and conduct user research
- Design and develop VR application
- Perform testing and evaluation.

Course Outcomes:

Learner will be able to

CO1: Identify problem statement from any domain.

CO2: Create and Complete project document.

CO3: Understand the process of user research and apply.

CO4: Design and develop high fidelity prototype

CO5: Evaluate and Test USECASE.

Course Scheme:

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

Assessment guidelines:

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

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

Assessment guidelines:

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

Guidelines for USECASE Discussion

Sr. No.	Module	Detailed Content	Hrs	CO Mapping
1	**Problem Identification**	Select a real-world problem relevant to your chosen domain. UI/UX Example: Redesign a website or app for improved accessibility and usability. AR-VR Example: Develop a VR training module for assembly line workers or an AR-based educational app.	05	CO1
2	**Project Proposal**	Create a proposal document with the following components: Title: A concise project title. Background: Context of the problem and why it's significant. **Objectives**: What the project aims to achieve. **Scope**: Define the boundaries of the project. **Methodology**: UI/UX: Design Thinking or Agile UX methodology. AR-VR: Software development lifecycle (SDLC) specific to AR/VR.	05	CO2
3	**Planning and Research**	**Conduct user research:** UI/UX: Surveys, interviews, usability tests. AR-VR: Use case analysis, technical feasibility study. Benchmark similar applications and identify gaps.	05	CO3
4	**Design and Prototyping**	**UI/UX Projects**: Use tools like **Figma**, **Adobe XD**, or **Sketch** for prototyping. Prepare: Wireframes (low-fidelity and high-fidelity).	05	CO4

		User flows and interaction designs. Include accessibility considerations (e.g., color contrast, keyboard navigation).		

5	**Development**	**UI/UX**: Develop functional prototypes or implement designs in a working product (e.g., using HTML/CSS/JavaScript). Integrate usability testing during the development phase. **AR-VR**: Develop AR/VR applications using SDKs (e.g., Vuforia for AR, Oculus SDK for VR). Optimize for performance and interactivity.	05	CO5
6	**Testing and Evaluation**	**UI/UX**: Conduct usability tests: Recruit participants matching your target audience. Use metrics like task success rate, error rate, and time-on-task. **AR-VR**: Evaluate: Immersion: How engaging is the experience? Performance: Frame rates, responsiveness.	05	CO6

Books and References:

Text Books:

1. Steve Aukstakalnis- Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, September 2016, ISBN: 9780134094328
2. Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with
3. Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178
4. William Sherif- Learning C++ by Creating Games with UE4 ||, Packt Publishing, 2015, ISBN 978-1-78439-657-2

Reference Books:

1. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality
2. Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13 : 978- 1838648183
3. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

MOOC Courses:
https://www.coursera.org/learn/augmented-reality
https://www.coursera.org/specializations/unity-xr

Certifications: Unity essentials, Jr. Programmer

Tools:
Figma, Adobe XD, Sketch for UX.
Unity3D, Unreal Engine, ARKit, ARCore for AR/VR.

Suggested domains for USECASE Development

AR/VR Use Cases in Education and Training
Focus Areas:
Immersive learning environments and virtual laboratories

- Simulation-based skill development (medical, mechanical, safety training)
- Virtual field trips and interactive storytelling
- Designing effective AR/VR educational content
- Case Studies:
  Google Expeditions / zSpace / Labster VR
  Indian EdTech case: Veative Labs or Simulanis

AR/VR in Healthcare and Well-being
Focus Areas:
VR for medical visualization, anatomy learning, and surgical training

- AR in diagnostics and remote assistance
- VR for rehabilitation, pain management, and therapy
- Ethical issues and data sensitivity in medical AR/VR
- Case Studies:
  - Surgical Theater VR / Touch Surgery / XRHealth
  - Indian initiatives in telemedicine and therapy applications

AR/VR in Industry, Manufacturing, and Retail
Focus Areas:
Industrial simulation and digital twins

- AR-assisted maintenance and assembly guidance
- Virtual product visualization and customer experience
- VR for collaborative design and prototyping
- Case Studies:
  - Boeing AR assembly training
  - IKEA Place App / Tata Motors Virtual Showroom
  - L&T or Mahindra manufacturing VR training systems

AR/VR in Entertainment, Tourism, and Cultural Heritage
Focus Areas:
AR/VR in gaming, movies, sports, and live events

- Immersive tourism experiences and heritage reconstruction
- 3D storytelling and virtual museums
- Designing emotional engagement through immersive media
- Case Studies:
    - The Louvre VR Tour / Google Arts & Culture VR
    - Indian heritage projects (Hampi VR, Taj Mahal VR tour)

Emerging Trends, Challenges, and Project Implementation
Focus Areas:

- Metaverse concepts, social VR, and multi-user environments
- AI and IoT integration in AR/VR systems
- Ethical, accessibility, and safety challenges
- Evaluation metrics: presence, usability, and engagement
- Mini Project: Develop a prototype or case presentation of an AR/VR use case in a chosen domain
- Case Studies: Meta Horizon, Niantic's AR platform, Indian startup ecosystem (AjnaLens, Whodat, Scapic)

Recommended Tools & Platforms

- Unity 3D, Unreal Engine, Blender, Vuforia, ARCore, ARKit, OpenXR, Oculus SDK.
- Devices: Oculus Quest, HTC Vive, Hololens, smartphone-based AR.

Text and Reference Books

1. Alan B. Craig, *Understanding Augmented Reality: Concepts and Applications*, Morgan Kaufmann.
2. Dieter Schmalstieg & Tobias Hollerer, *Augmented Reality: Principles and Practice*, Addison- Wesley.
3. Steve Aukstakalnis, *Practical Augmented Reality*, Pearson Education.
4. Tony Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications*, O'Reilly.
5. Tony Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications*, O'Reilly.

Course Name: Embedded Linux System

Course Code: HMET01T*

Category: Honours in Next-Gen IoT

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Learner will be able to:
CO1: Understand fundamental concepts of operating System.
CO2: Understand architecture of Linux operating system for embedded system applications.
CO3: Understand concept of kernel.
CO4: Use Linux kernel module.
CO5: Do communication between user space and kernel space.
CO6: Develop applications.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESE	Total (Passing @40% of total)
Theory	15	20	40	075

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	RTOS and Linux based Embedded Systems: An Introduction	Introduction to Real Time Operating Systems: Characteristics of RTOS, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter-process Communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling. Operating systems for embedded systems, Why Linux-based embedded systems? Linux evolution Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains. Linux-based embedded system: example	05
2	Embedded Linux Architecture and Kernel Architecture	Architecture of Embedded Linux- Real Time Executive, Monolithic kernels, Microkernel, Linux Kernel Architecture- Hardware Abstraction Layer (HAL), Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC. User space, Linux Start-up sequence.	05
3	Building and Debugging	Building the Kernel, Building Applications, Building the Root File System, Integrated Development Environment, Debugging Virtual Memory Problems, Kernel Debuggers, Profiling	05
4	Introduction to Linux kernel modules	Introduction, CPU – I/O interface, I/O interface with polling, I/O interface with interrupt, I/O interface, I/O interface latency, Direct memory access (DMA) architecture - transfer modes, I/O taxonomy, Typical operations, Linux devices, The Virtual File System (VFS) abstraction. Linux kernel modules – the initialization function, the cdev data structure, the initialization function, the clean-up function, custom VFS functions.	06

5	Communication Between Kernel and User Space	Introduction, The reference use case, The CPU/Device interface, The module level – file operations, ioctl() implementation, open()/release() implementation, read() implementation, Passing data to/from the kernel, write() implementation, communication with the device, Memory	06

Module no	Module name	Content	No of Hours
		mapped I/O – initialization, clean-up, read, write, GPIO-based I/O – initialization, clean-up, read, write, Interrupts, Requesting the interrupt line, Freeing the interrupt line, The interrupt handler, Interrupt handling, Top-half and bottom-half, Needed support, Work queue, The user level, The user level – the application	
6	Porting Applications	Architectural Comparison, Application Porting Roadmap, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.	03
		Total	**30**

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Course Name: Embedded Linux System Laboratory

Course Code: HMET01P*

Category: Honours in Next-Gen IoT

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Student will be able to:

CO1: Demonstrate fundamental concepts of operating System.

CO2: Demonstrate architecture of Linux operating system for embedded system applications.

CO3: Demonstrate concept of kernel.

CO4: Use Linux kernel module with standard commands.

CO5: Establish communication from user space to kernel space.

CO6: Develop embedded system applications based on Linux operating system.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESE	Total
Practical	25	-	25	050

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:

1. Introduction to the Board and Workspace Set-Up.
2. Custom Embedded Linux Build Using the Manual Approach.
3. Introduction to Linux Kernel Modules under Yocto.
4. Handling General Purpose I/O Using Linux Kernel Modules.
5. Handling Hc-Sr04 Ranging Sensor Using Linux Kernel Modules.
6. Introduction to Code Development and Debugging Using Yocto.
7. Introduction to Linux Kernel and Application Profiling.
8. Installing Linux kernel and configuration of Rasp-berry Pi computer (SBC)
9. Installation of Free RTOS and integration with Keil IDE for multithreaded application.

Practical can be designed using project-based approach.

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Course Name: IoT and Data Analytics

Course Code: HMET02T*

Category: Honor (IoT Track)

Preamble:

The Internet of Things (IoT) is revolutionizing the way we interact with the world around us. Billions of devices are now collecting and generating data, creating a vast treasure trove of information. This course equips students with the skills and knowledge to analyze this data and extract meaningful insights. Inthis course students will gain expertise in data collection, processing, visualization, and machine learning techniques specifically tailored for the IoT domain.

Pre-requisites: Modern Sensor Technology, IoT

Course Objectives:

- Understand the fundamental concepts of IoT and its data landscape.
- Develop proficiency in data collection, storage, and management techniques for IoT devices.
- Learn data analysis tools and methodologies for extracting insights from IoT data.
- Apply machine learning algorithms to solve real-world IoT problems.
- Effectively communicate findings through data visualization techniques.

Course Outcomes:

Student will be able to:
CO1: Design and implement data collection strategies for various IoT applications.
CO2: Clean, pre-process, and manage large volumes of IoT data.
CO3: Apply statistical and data mining techniques to analyze IoT data.
CO4: Build and deploy machine learning models for predictive maintenance, anomaly detection, and other IoT applications.
CO5: Create compelling data visualizations to communicate insights from IoT data analysis.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	15	20	40	075

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 Data Analytics	Fundamentals of IoT: Architecture, protocols, communication models. Introduction to data analytics for IoT: Data types, challenges, and opportunities. Data collection and storage for IoT devices: Sensor data acquisition, cloud platforms, and data lakes.	4
2	Data Preprocessing and Management for IoT	Data cleaning techniques: Handling missing values, outliers, and inconsistencies. Data integration and transformation: Combining data from diverse IoT sources. Data warehousing and big data management for IoT data.	6
3	Data Analysis Techniques for IoT	Exploratory data analysis (EDA) for IoT data: Understanding trends, patterns, and relationships. Statistical analysis for IoT data: Descriptive statistics, hypothesis testing, and correlation analysis. Time series analysis for IoT data: Forecasting trends, seasonality, and anomalies.	6
4	Machine Learning for IoT	Supervised learning for IoT: Classification, regression, and anomaly detection. Unsupervised learning for IoT: Clustering and dimensionality reduction techniques. Machine learning model selection and evaluation for IoT applications.	6
5	Data Visualization for IoT	Principles of data visualization: Effective communication through charts, graphs, and dashboards. Interactive data visualization tools for IoT data exploration. Storytelling with data: Creating compelling narratives from IoT insights.	4
6	Security, Privacy, and Case Studies in IoT Data Analytics	Security in IoT: Common threats, vulnerabilities, and security protocols. Privacy Issues: Data privacy concerns and regulatory requirements. Case Studies in IoT Analytics: Real-world examples and their impact. Future Trends in IoT and Data Analytics: Emerging technologies and their potential.	4
Total			30

Textbooks:

1. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016).
2. Data Mining: Practical Machine Learning Tools and Techniques (4th Edition). Morgan Kaufmann.
3. "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations" edited by Fei Hu.
4. "Data Science for IoT Engineers" by Manu Sharma.

Reference Books:

1. Learning IoT. Packt Publishing Ltd. Janeway, T. (2014).
2. Analytics for the Internet of Things. Packt Publishing Ltd. Minteer, A. (2017).

Deep Learning with Python. Manning Publications Co. Chollet, F. (2018

Course Name: IoT and Data Analytics Lab

Course Code: HMET02P*

Category: Honor (IoT Track)

Preamble:

This laboratory course complements the Data Analytics for IoT lecture series by providing hands-on experience with the tools and techniques introduced in the lectures. Students will have the opportunity to work with real-world IoT data, practice data analysis methods, and build their practical skills in data visualization and machine learning.

Pre-requisites: Modern Sensor Technology, IoT

Course Objectives:

- Apply data collection and processing techniques to real IoT datasets.
- Implement data cleaning and pre-processing steps for effective analysis.
- Utilize data analysis tools to explore and analyze IoT data.
- Develop proficiency in data visualization techniques for communicating findings.
- Gain practical experience in building and deploying machine learning models for IoT applications.

Course Outcomes:

Student will be able to:

CO1: Design and execute data collection scripts for various IoT sensors.

CO2: Clean and pre-process real IoT data using appropriate tools and techniques.

CO3: Perform exploratory data analysis (EDA) and extract insights from IoT datasets.

CO4: Create informative data visualizations to communicate data trends and patterns.

CO5: Build and evaluate machine learning models for specific IoT applications.

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:

- Setting Up an IoT Development Environment
- Data Collection from IoT Sensors (e.g., temperature, humidity)
- Data Cleaning and Pre-processing for IoT Data.
- Exploratory Data Analysis of IoT Datasets.
- Statistical Analysis for IoT Data (e.g., correlations, hypothesis testing).
- Time Series Analysis for IoT Data (e.g., forecasting, anomaly detection)
- Supervised Machine Learning for IoT Applications (e.g., classification, regression)
- Unsupervised Machine Learning for IoT Applications (e.g., clustering)
- Data Visualization for IoT using Python Libraries (e.g., Matplotlib, Seaborn)
- Capstone Project: Applying Data Analytics to an IoT Problem (This builds upon the skills learned throughout the course)

Textbooks:

1. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016).
2. Data Mining: Practical Machine Learning Tools and Techniques (4th Edition). Morgan Kaufmann.
3. "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations" edited by Fei Hu.
4. "Data Science for IoT Engineers" by Manu Sharma.

Reference Books:

1. Learning IoT. Packt Publishing Ltd. Janeway, T. (2014).
2. Analytics for the Internet of Things. Packt Publishing Ltd. Minteer, A. (2017).
3. Deep Learning with Python. Manning Publications Co. Chollet, F. (2018).

Course Name: IoT Applications and Web Development

Course Code: HMET03T*

Category: Honor (IoT Track)

Preamble:

This course focuses on equipping students with the web development skills necessary to create interactive interfaces for controlling and monitoring Internet of Things (IoT) devices. Students will gain a solid foundation in web development technologies like HTML, CSS, and JavaScript, explore popular frameworks, and learn how to integrate them with IoT systems for real-world applications.

Pre-requisites:

- Modern Sensor Technology for IoT
- Principles of Internet of Things (IoT)
- Embedded Linux System

Course Objectives:

Understand the fundamental principles of the Internet of Things (IoT). Identify various IoT components and their functionalities.

Learn web development basics using HTML, CSS, and JavaScript.

Explore frameworks for building interactive web interfaces.

Integrate web applications with IoT devices for data visualization and control. Develop a practical understanding of security considerations in IoT applications.

Course Outcomes:

Student will be able to:

CO1: Apply HTML and CSS to design and develop the structure and visual appearance of web pages for IoT applications.

CO2: Implement JavaScript to create interactive elements and user interfaces for web applications that interact with IoT devices.

CO3: Utilize web APIs to retrieve sensor data from IoT devices and integrate the data into the web application for visualization.

CO4: Implement secure coding practices to minimize vulnerabilities in web applications designed for IoT environments.

CO5: Develop functionalities within the web application to send control commands to IoT devices, enabling user interaction and device manipulation.

CO6: Design and develop a complete web application for a specific IoT use case, integrating the learned web development and IoT communication skills.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	15	20	40	075

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 Web Development	1.1 Introduction to the World Wide Web and its components 1.2 Hypertext Markup Language (HTML) for structuring web pages 1.3 Cascading Style Sheets (CSS) for styling and layout	5
2	Scripting for Interactive Applications	2.1 Introduction to JavaScript for adding interactivity to web pages 2.2 Event handling, DOM manipulation, and control flow statements in JavaScript 2.3 Building dynamic and user-responsive web interfaces using JavaScript	5
3	Client-Side Web Frameworks	3.1 Introduction to a popular web framework like React or Angular (choose one) 3.2 Building user interfaces with components and state management in the chosen framework 3.3 Creating reusable components and utilizing pre-built libraries for efficiency	5
4	Web Applications and IoT Integration	4.1 Introduction to communication protocols for IoT (REST APIs, WebSockets) 4.2 Fetching data from IoT devices and sensors using APIs	5

		4.3 Visualizing sensor data using JavaScript libraries like D3.js or Chart.js	
5	Data Management and Control	5.1 Sending commands to control IoT devices through web interfaces 5.2 Introduction to data storage and management options for IoT applications 5.3 Implementing user authentication and authorization for secure access	5
6	Security aspects	6.1 Web Security for IoT: Implementing secure coding practices for web applications. 6.2 Understanding authentication protocols and authorization mechanisms for user access control. 6.3 Importance of data encryption and secure data transfer protocols in IoT communication. Use cases: to design and develop a complete web application for a specific IoT application (e.g., smart home control panel, environmental monitoring dashboard).	5
Total			**30**

Textbooks & Reference Books :

1. "Head First HTML and CSS" by Elisabeth Robson and Eric Freeman
2. Eloquent JavaScript, Third Editionby Marijn Haverbeke
3. Securing Web Applications: Hands-On Prevention of Server-Side and Client-Side Attacks by Michael Ogata and Daniel Bracuk

Course Name: IoT Applications and Web Development Lab

Course Code: HMET03P*

Category: Honor (IoT Track)

Preamble:

This laboratory curriculum accompanies the "Web Development for IoT Applications" course. The labs are designed to provide students with hands-on experience in building interactive web interfaces for controlling and monitoring IoT devices. Students will gain practical skills in web development technologies like HTML, CSS, and JavaScript, while also exploring their application in the context of the Internet of Things

Pre-requisites:

Course Objectives:

- Reinforce theoretical concepts learned in the Web Development for IoT Applications course.
- Develop practical skills in building and deploying web applications for IoT.
- Gain experience with web development tools and frameworks.
- Learn how to integrate web applications with simulated and real IoT devices.

Course Outcomes:

Student will be able to:

CO1: Apply HTML, CSS, and JavaScript to create functional web pages for IoT applications.

CO2: Utilize a web development framework to build interactive user interfaces.

CO3: Write code to communicate with simulated or real IoT devices through APIs.

CO4: Visualize sensor data fetched from IoT devices using JavaScript libraries.

CO5: Implement basic functionalities for controlling IoT devices through the web interface.

CO6: Demonstrate an understanding of security considerations in web development for IoT.

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:

- Introduction to the chosen web development framework
- Creating a static web page for an IoT application (e.g., smart home dashboard)
- Building interactive elements using JavaScript (e.g., buttons, forms)
- Simulating an IoT device and API using online tools
- Implementing functionalities to send control commands to a simulated device (e.g., turning on/off lights)
- Implementing secure coding practices in the web application
- Implementing the web application functionality based on the project design
- Understanding basic user authentication mechanisms

Textbooks & Reference Books :

1. "Head First HTML and CSS" by Elisabeth Robson and Eric Freeman
2. Eloquent JavaScript, Third Editionby Marijn Haverbeke
3. Securing Web Applications: Hands-On Prevention of Server-Side and Client-Side Attacks by Michael Ogata and Daniel Bracuk

Course Name: Soft Computing
Course Code: PEIT25T
Category: PEC (AIML)
Preamble:

Soft computing is an emerging approach to computing based on some biological inspired methodologies such as genetics, evolution, ant's behaviors, particles swarming, human nervous systems, etc. Now, soft computing is the only solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), needs a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization,
VLSI design, etc.

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

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

- Fuzzy logic and its applications.
- Artificial neural networks and their applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learner will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugeno models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

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	Module	Content	No. of

No.	Name		Hours
1	Introduction to Soft Computing	Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	4
2	Fuzzy Set Theory	Fuzzy Sets, Fuzzy relations, Fuzzification and Defuzzification. Features of the membership Functions, Fuzzy Max-Min and Max-Product Composition	4
3	Fuzzy Rules, Reasoning and Inference System	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between, Mamdani and Sugeno FIS	4
4	Genetic Algorithm	An Introduction to genetic Algorithms Genetic Algorithms Mathematical Foundations, Schemata Revisited Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA, Generation of Graph Results of Handwriting Recognition, Effect of Genetic Algorithms, Distance Optimization, Style Optimization Solving single-objective optimization problems using GA, Multi-objective Optimization Problem Solving	6
5	Neural Networks	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model Supervised Learning algorithms: Perceptron (Single Layer, Multi-layer), Linear separability, Delta learning rule, Back Propagation algorithm Un-Supervised Learning algorithms: Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	8
6	Hybrid system	Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System (ANFIS).	4
Total			**30**

Text Books:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education
3. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional

Course Name: Soft Computing Lab
Course Code: PEIT25P
Category: PEC (AIML)
Preamble:

Soft computing provides a reliable solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

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

- Fuzzy logic and its applications.
- Artificial neural networks and their applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learners will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugeno models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

Course Scheme:

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

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.	Study of Fuzzy set and Theory
2.	Implementing basic fuzzy Operations
3.	Implementation of fuzzy set close to N
4.	Study of the Fuzzy toolbox.
5.	Implementing Train Controller problem
6.	Implementing Washing machine problem
7.	Implementing Water purification problem
10.	Implementing Tipper problem
11.	Implementing the Perceptron learning rule.
12.	Implementing the Curve Fitting using Genetics algorithm.
13.	Development of an Adaptive Neuro-Fuzzy Inference System (ANFIS)
14.	Backpropagation Algorithm for Multilayer Perceptrons.

Text Books:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education
3. Fuzzy Logic: A Practical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional

Course Name: Natural language processing

Course Code: HMCE08T

Category: Honors/ Minor in Artificial Intelligence and Machine Learning

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: Soft Computing, Soft Computing Lab

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:

1. Recall fundamental concepts of NLP such as stages of language processing, grammar, and basic text preprocessing techniques like tokenization and stemming.
2. Explain morphological, syntactic, and semantic components of language using appropriate models and tools.
3. Apply parsing algorithms and semantic techniques (like WSD and discourse resolution) to analyze linguistic structures.
4. Analyse the structure and relationships in lexical resources (e.g., WordNet, BabelNet) and evaluate semantic similarity and ambiguity.
5. Evaluate the performance of various neural language models and word embedding techniques on language tasks.
6. 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
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	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. ***Self-Learning Topics***: *Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks*	5
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.	5

		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*	
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
Total			**30**

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

Online Resources for Learning:

1. NLTK Project (Natural Language Toolkit): https://www.nltk.org
2. spaCy Documentation: https://spacy.io

Course Name: Natural language processing Lab

Course Code: HMCE08P

Category: Honors/ Minor in Artificial Intelligence and Machine Learning

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: Soft Computing, Soft Computing Lab

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:

1. Recall fundamental concepts of NLP such as stages of language processing, grammar, and basic text preprocessing techniques like tokenization and stemming.
2. Explain morphological, syntactic, and semantic components of language using appropriate models and tools.
3. Apply parsing algorithms and semantic techniques (like WSD and discourse resolution) to analyze linguistic structures.
4. Analyse the structure and relationships in lexical resources (e.g., WordNet, BabelNet) and evaluate semantic similarity and ambiguity.
5. Evaluate the performance of various neural language models and word embedding techniques on language tasks.
6. 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	-	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. 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 Embedding
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.

Course Name: Deep Learning

Course Code: HMCE09T

Category: Honors/ Minor in Artificial Intelligence and Machine Learning

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: HMCE09P

Category: Honors/ Minor in Artificial Intelligence and Machine Learning

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: Advanced Databases

Course Code: HMCE10T

Category: Honours/ Minor in Data Science

Preamble:

Mastering advanced database systems requires a well-structured and comprehensive approach. Our roadmap encompasses key areas such as query processing, advanced data management, distributed databases, NoSQL and enhanced data models. These modules integrates theoretical concepts with practical applications, offering hands-on experience. This carefully designed curriculum equips learners with a thorough understanding of modern database systems, preparing them to tackle the complexities of today's data-driven environments.

Pre-requisites:

Database Management System

Course Objectives:

- To provide insights into distributed database designing
- To impart knowledge related to query processing and query optimization phases of a database management system.
- To introduce the concepts of access control models (DAC, MAC, and RBAC) and their implementation in database management systems.
- To specify the various approaches used for using XML and JSON technologies.
- To apply the concepts behind the various types of NoSQL databases and utilize it for Mongodb
- To learn about the trends in advance databases

Course Outcomes:

Learner will be able to:
CO1: Design distributed database using the various techniques for query processing
CO2: Measure query cost and perform distributed transaction management
CO3: Analyze and implement access control mechanisms such as Discretionary Access Control (DAC), Mandatory Access Control (MAC), and Role-Based Access Control (RBAC) to ensure data security in database systems
CO4: Organize the data using XML and JSON database for better interoperability
CO5: Compare different types of NoSQL databases
CO6: Describe various trends in advance databases through temporal, graph based and spatial based databases

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	Distributed Databases	Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design.	4
2	Query Processing and Optimization	Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression, Estimating Statistics of Expression Results Choice of Evaluation Plans.	6
3	Advanced Database Access protocols	Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role Based Access Control, Remote Database access protocol.	4
4	Data interoperability – XML and JSON	XML Databases: Document Type Definition, XML Schema, Querying and Transformation: XPath and XQuery. Basic JSON syntax, (Java Script Object Notation),JSON data types, Stringifying and parsing the JSON for sending & receiving, JSON Object retrieval using key-value pair and JQuery, XML Vs JSON	6
5	NoSQL Distribution Model	NoSQL database concepts: NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system. Types of NoSQL databases: Key-value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	5

Module No.	Module Name	Content	No of Hours
6	Trends in advance databases	Temporal database: Concepts, time representation, time dimension, incorporating time in relational databases. Graph Database: Introduction, Features, Transactions, consistency, Availability, Querying, Case Study Neo4J. Spatial database: Introduction, data types, models, operators and queries	5
Total			**30**

Textbooks:

1. Korth, Siberchatz, Sudarshan, "Database System Concepts", 6thEdition, McGraw Hill.
2. Elmasri and Navathe, "Fundamentals of Database Systems", 5thEdition, Pearson Education
3. Pramod Sadalge, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesely/ Pearson
4. Jeff Friesen , Java XML and JSON,Second Edition, 2019, après Inc.

Reference Books:

1. Peter Rob and Carlos Coronel,Database Systems Design, Implementation and Management, Thomson Learning, 5th Edition.
2. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3. Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.

Course Name: Advanced Databases Lab

Course Code: HMCE10P

Category: Honours/ Minor in Data Science

Preamble:

The Advanced Database Lab focuses on practical applications of advanced database concepts. Students will work on EER modeling, SQL-based database design, distributed database fragmentation, query cost estimation, and security features in PostgreSQL. The lab also covers XML databases, MongoDB setup, queries, triggers, and database connectivity with front-end applications. This hands-on approach equips students with the skills to manage and implement advanced database systems effectively.

Pre-requisites:

Database Management System Lab

Course Objectives:

- To understand advanced database concepts through practical applications.
- To design and implement Enhanced Entity-Relationship (EER) models.
- To explore distributed database techniques like fragmentation.
- To analyze and estimate query costs for efficient database operations.
- To gain hands-on experience with NoSQL databases like MongoDB.
- To explore database security, triggers, and connectivity with front-end systems

Lab Outcomes:

Learners will be able to:
LO1: Students will create and implement EER models for real-world scenarios.
LO2: They will perform distributed database fragmentation and query optimization.
LO3: Students will demonstrate secure database access using PostgreSQL.
LO4: They will implement and query XML and MongoDB databases.
LO5: Learners will create active database triggers and understand their functionalities.
LO6: They will connect databases to front-end applications and perform operations seamlessly.

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	Design EER Model for a real-life scenario and implement it using SQL
2	Implementation of fragmentation in distributed database environment.
3	Implement the Program to estimate cost of the query for various join operation
4	Explore the security and access control features of PostgreSQL (or equivalent system)
5	Implement XML Database
6	Install and Configure client and server for MongoDB
7	Design and implement any 5 queries using MongoDB
8	Implementation of triggers for understanding features of active database
9	Implement Database connectivity with any front end and perform database operations

Textbooks:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision wesley, 2007 [2].
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011

Reference Books:

1. T. Ozsu and P. Valduriez, Distributed Database Systems. Prentice Hall, Oct. 2011. [ISBN: 013616736X]
2. "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Martin Fowler and Pramod J. Sadalage

Course Name: Big Data Analytics

Course Code: HMCE11T

Category: Honors in Data-Science

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: Advance Databases

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:

1. Recall fundamental concepts: Big Data characteristics (5Vs), HDFS components, NoSQL database types, stream mining algorithms, and Spark architecture.
2. Explain the working of HDFS, MapReduce model, NoSQL types, and Big Data stream algorithms with examples.
3. Implement MapReduce algorithms (Word Count, Join), streaming algorithms (like Bloom filters, DGIM, and Flajolet-Martin), similarity metrics, and Spark transformations.
4. Analyze trade-offs between traditional vs. Big Data systems, CAP theorem applications, stream algorithm efficiency, and clustering performance (CURE)
5. 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	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	Introduction to Big Data and Hadoop	troduction 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.	6
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 **Self-Learning:** Practice similarity metrics and clustering using Scikit-learn or PySpark. Explore recommendation systems based on similarity scores	5
46	Introduction to Apache Spark	Spark architecture: RDDs, DataFrames, DAG; Transformations & Actions; Spark SQL **Self-Learning:** Build Spark jobs in Databricks / Google Colab Watch Spark tutorials from DataBricks, LinkedIn Learning	4
Total			**30**

Textbooks:

1. Marz, N., & Warren, J. (2015). *Big Data: Principles and best practices of scalable real-time data systems*. Manning Publications.
2. White, T. (2015). *Hadoop: The definitive guide* (4th ed.). O'Reilly Media.

Reference Books:

1. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). Mining of massive datasets (3rd ed.). Cambridge University Press.
2. Sadalage, P. J., & Fowler, M. (2012). NoSQL distilled: A brief guide to the emerging world of polyglot persistence. Addison-Wesley.
3. Damji, J. S., Wenig, B., Das, T., & Lee, D. (2020). Learning Spark: Lightning-fast big data analysis (2nd ed.). O'Reilly Media.

Online Resources for Learning:

1. Databricks. (n.d.). *Databricks Academy*. Retrieved June 6, 2025, from https://academy.databricks.com
2. University of California, San Diego. (n.d.). *Big Data Specialization* [Online course]. Coursera. Retrieved June 6, 2025, from https://www.coursera.org/specializations/big-data

Course Name: Big Data Analytics Lab

Course Code: HMCE11P

Category: Honors in Data Science

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: Advance Databases

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:

Learner will be able to:

1. Recall fundamental concepts: Big Data characteristics (5Vs), HDFS components, NoSQL database types, stream mining algorithms, and Spark architecture.
2. Explain the working of HDFS, MapReduce model, NoSQL types, and Big Data stream algorithms with examples.
3. Implement MapReduce algorithms (Word Count, Join), streaming algorithms (like Bloom filters, DGIM, and Flajolet-Martin), similarity metrics, and Spark transformations.
4. Analyze trade-offs between traditional vs. Big Data systems, CAP theorem applications, stream algorithm efficiency, and clustering performance (CURE)
5. 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	-	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. 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

Course Name: Text, Web and Social Media Analytics

Course Code: HMCE12T

Category: Honors in Data Science

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	6

		Console, and SEMrush.	
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: HMCE12P

Category: Honors in Data Science

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: Cryptography & Network Security

Course Code: HMCE13T

Category: Honours/ Minor in Cyber Security

Preamble:

Most today's computing devices support network connectivity, from your laptops and desktops to web servers, to Internet-of-Things devices. This connectivity is essential for enhancing the capabilities of computer technology. However, it has also fostered an environment rampant with network security and privacy concerns. This course aims to provide a thorough grounding in network security suitable for those interested in working in or conducting research in the area, as well as students more generally interested in either security or networking. We will examine core network protocols and their security, as well as broader issues relating to Internet security for which networking plays a role. Through this course, you should learn the fundamentals of how computer networks should operate, and what can and does go wrong.

Pre-requisites:

Operating system

Course Objectives:

- Basic concepts computer networks and security
- Various cryptography algorithms including secret key management and different authentication techniques.
- Different types of malicious software's and its effect on security
- Various secure communication standards including IPSEC, SSL/TLS and email.
- Network management security and network access control techniques in computer security.
- Different attacks on network and infer the use of firewalls and security protocol.

Course Outcomes:

Learner will be able to:
CO1: Explain the fundamentals concepts of computer security and network security.
CO2: Identify the basic cryptographic techniques using classical and block encryption methods.
CO3: Study and describe the system security malicious software.
CO4: Describe the Network layer security, Transport layer security and application layer security.
CO5: Explain the need of network management security and illustrate the need for NAC.
CO6: Identify the function of an IDS and firewall for system security.

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 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 Network Security & cryptography**	Computer security and Network Security(Definition), CIA, Services, Mechanisms and attacks, The OSI security architecture, Network security model. Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, transposition techniques: keyed and keyless transposition ciphers). Introduction to steganography	4
2	**Cryptography: Key management, distribution and user authentication**	Cryptography: Key management, distribution and user authentication Block cipher modes of operation, Data Encryption Standard, Advanced Encryption Standard (AES). RC5 algorithm. Public key cryptography: RSA algorithm. Hashing Techniques: SHA256, SHA-512, HMAC and CMAC, Digital Signature Schemes – RSA, DSS. Remote user Authentication Protocols, Kerberos, Digital Certificate: X.509, PKI	8
3	**Malicious Software**	Malicious Software: SPAM, Trojan horse, Viruses, Worms, System Corruption, Attack Agents, Information Theft, Trapdoor, Keyloggers, Phishing, Backdoors, Rootkits, Denial of Service Attacks, Zombie	4
4	**IP Security**	IP Security, Transport level security and Email Security: IP level Security: Introduction to IPSec, IPSec Architecture, Protection Mechanism (AH and ESP), Transport level security: VPN. Need Web Security considerations, Secure Sockets Layer (SSL)Architecture, Transport Layer Security (TLS), HTTPS, Secure Shell (SSH) Protocol Stack. Email Security: Secure Email S/MIME Screen reader support enabled.	8
5	**Network Management Security and Network Access Control**	Network Management Security and Network Access Control: Network Management Security:SNMPv3, NAC: Principle elements of NAC, Principle NAC enforcement methods, How to implement NAC Solutions, Use cases for network access control	4

Module No.	Module Name	Content	No of Hours
6	**System Security**	System Security: IDS, Firewall Design Principles, Characteristics of Firewalls, Types of Firewalls	2
Total			**30**

Textbooks:

1. Cryptography and Network Security: Principles and Practice by William Stallings, 6th edition Pearson publication
2. Cryptography and Network security by Behrouz A. Forouzan, Tata Mc Graw Hill
3. Information Security Principles and Practice, Mark Stamp, Wiley publication

Reference Books:

1. Security in Computing by Charles P. Pfleeger, Pearson publication
2. Computer Security Art and Science by Matt Bishop, Addison- Wesley publication

Course Name: Cryptography & Network Security Lab

Course Code: HMCE13P

Category: Honours/ Minor in Cyber Security

Preamble:

The purpose of this security lab is to provide hands-on experience and practical knowledge in understanding various aspects of cybersecurity and information security practices. Through this lab, students will explore different security mechanisms, tools, techniques, and methodologies to safeguard digital assets, mitigate risks, and respond effectively to security incidents. Security lab provides a valuable opportunity for participants to gain practical skills, insights, and hands-on experience in the field of cybersecurity. By actively engaging in lab activities and embracing security best practices, students will be better equipped to address the evolving challenges and complexities of today's cybersecurity landscape.

Pre-requisites:

Operating system

Course Objectives:

- To apply the knowledge of symmetric cryptography to implement classical ciphers
- To analyze and implement public key encryption algorithms, hashing and digital signature algorithms
- To explore the different network reconnaissance tools to gather information about networks
- To explore the tools like sniffers, port scanners and other related tools for analyzing
- To Scan the network for vulnerabilities and simulate attacks
- To set up intrusion detection systems using open source technologies and to explore email security

Course Outcomes:

Learner will be able to:
LO1: Illustrate symmetric cryptography by implementing classical ciphers.
LO2: Demonstrate Key management, distribution and user authentication.
LO3: Explore the different network reconnaissance tools to gather information about networks.
LO4: Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
LO5: Use open-source tools to scan the network for vulnerabilities and simulate attacks
LO6: Demonstrate the network security system using open-source tools.

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 Practicals:

Sr No.	Title of Practicals
1	Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher)
2	1)Block cipher modes of operation using a) Data Encryption Standard b)Advanced Encryption Standard (AES). 2)Public key cryptography: RSA algorithm. 3)Hashing Techniques: HMAC using SHA 4)Digital Signature Schemes – RSA, DSS
3	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
4	1) Download and install nmap. 2) Use it with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.
5	a) Keylogger attack using a keylogger tool. b) Simulate DOS attack using Hping or other tools c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities
6	1) Set up IPSec under Linux. 2) Set up Snort and study the logs. 3) Explore the GPG tool to implement email security
7	Design a network and demonstrate. 1) Path the network follows before implementing VPN 2) Path the network follows after implementing VPN
8	Demonstrate Phishing attack over LAN and WAN network using Kali Linux
9	Demonstrate SQL Injection attack using Kali Linux
10	Demonstrate Fake Email attack using Kali Linux

Textbooks:

1. Build your own Security Lab, Michael Gregg, Wiley India.
2. CCNA Security, Study Guide, TIm Boyles, Sybex.
3. Hands-On Information Security Lab Manual, 4th edition, Andrew Green, Michael Whitman, Herbert Mattord.
4. The Network Security Test Lab: A Step-by-Step Guide Kindle Edition, Michael Gregg.

Reference Books:

1. Network Security Bible, Eric Cole, Wiley India.

2. Network Defense and Countermeasures, William (Chuck) Easttom.
3. Principles of Information Security + Hands-on Information Security Lab Manual, 4th Ed. , Michael Whitman , Herbert Mattord.

Course Name: Web Application Security

Course Code: HMCE14T

Category: Honors/ Minor in Cyber Security

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	-	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: HMCE14P

Category: Honors/ Minor in Cyber Security

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.)

Prepare a Security Assessment Report

Course Name: Digital Forensics

Course Code: PEIT32T

Category: PEC (Cyber Security)

Preamble:

This course introduces students to the principles, techniques, and methodologies of digital forensics. It covers the investigation and analysis of digital evidence, including file systems, network traffic, and digital devices. Emphasis is placed on legal and ethical considerations, as well as practical hands-on experience with forensic tools and techniques.

Pre-requisites:

Cryptography and Network Security

Course Objectives:

- To explore the fundamentals of digital forensics, digital evidence and incident response
- To learn the tools and techniques required for computer forensics.
- To understand the network attacks and tools and techniques required to perform network forensics.
- To learn how to investigate attacks on mobile platforms.
- To generate a forensics, report after investigation.

Course Outcomes:

Learner will be able to:
CO1: Recognize the need of digital forensics and define the concept of digital evidence and incident response
CO2: Apply the knowledge of computer forensics using different tools and techniques.
CO3: Detect the network attacks and analyse the evidence.
CO4: Apply the knowledge of computer forensics using different tools and techniques.
CO5: List the method to generate legal evidence and supporting investigation reports
CO6: Understand the legal framework in Digital forensics

Course Scheme:

Contact Hours		Credit 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 Digital Forensics	Introduction to Digital Forensics, Need and Objectives of Digital Forensics, Types of Digital Forensics, Process of Digital Forensics, Benefits of Digital Forensics, Chain of Custody, Anti Forensics. Digital Evidence and its Types, Rules of Digital Evidence. Incident Response, Methodology of Incident Response, Roles of CSIRT in handling incident.	4
2	Computer Forensics	Introduction to Computer Forensics, Evidence collection (Disk, Memory, Registry, Logs etc), Evidence Acquisition, Analysis and Examination (Window, Linux, Email, Web, Malware) , Challenges in Computer Forensics, Tools used in Computer Forensics.	6
3	Network Forensics	Introduction, Evidence Collection and Acquisition (Wired and Wireless), Analysis of network evidence (IDS, Router,), Challenges in network forensics, Tools used in network forensics	6
4	Mobile Forensics	Introduction, Evidence Collection and Acquisition, Analysis of Evidence, Challenges in mobile forensics, Tools used in mobile forensics	4
5	Report Generation	Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report.	4
6	Introduction to Legal Frameworks	Overview of legal principles in digital forensics Sources of law relevant to digital evidence (statutory, case law, regulations), Jurisdictional considerations in digital investigations, Admissibility of digital evidence in court Rules of evidence (e.g., hearsay, authentication, best evidence rule) Chain of custody requirements and documentation, GDPR (General Data Protection Regulation) and its implications for digital forensics, HIPAA (Health Insurance Portability and Accountability Act) considerations, Other relevant privacy laws and their impact on digital investigations, Challenges with encryption and decryption Anti-forensic techniques and legal implications	6
Total			**30**

Textbooks:

1. John Sammons, "The Basics of Digital Forensics: The Premier for Getting Started in Digital Forensics", 2nd Edition, Syngress, 2015.

2. Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic: The fascinating world of Digital Evidences" Wiley India Pvt Ltd 2017.

3. Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.

Reference Books:

1. Sangita Chaudhuri, Madhumita Chatterjee, "Digital Forensics", Staredu, 2019.

2. Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" Cengage Learning, 2014.

3. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.

Course Name: Digital Forensics Lab
Course Code: PEIT32P
Category: Program Elective Course (PEC)
Preamble:
This lab course facilitates rigorous and impartial digital investigations through the application of scientific methods and best practices in forensic analysis. Aim is to provide reliable evidence to support legal proceedings, internal investigations, and proactive security measures.
Pre-requisites:
Computer Networks Lab- IT06P
Operating system Lab- IT05P
Computer & Network Security Lab- IT24P
Course Objectives:
1. Conduct thorough examinations of digital devices, networks, and storage media to uncover relevant evidence while maintaining chain of custody and integrity.
2. Utilize state-of-the-art forensic tools and methodologies to extract, analyze, and interpret digital evidence effectively and efficiently.
3. Foster collaboration with law enforcement agencies, legal teams, and internal stakeholders to ensure the accuracy and relevance of forensic findings.
4. Uphold ethical principles and legal guidelines in all investigative processes, respecting privacy rights and confidentiality.

Course Outcomes:
Learner will be able to:
CO1: Understanding of Digital Forensics Principles
CO2: Proficiency in Forensic Tools and Techniques
CO3: Ability to Conduct Forensic Examinations
CO4: Evidence Handling and Chain of Custody
CO5: Report Writing and Presentation Skills
CO6: Ethical and Legal Considerations

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 Practicals:

Sr No.	Title of Practicals
1	Use tools like Nmap to scan a network for active hosts and services. Enumerate services to gather information about versions and configurations.
2	Identify common vulnerabilities (e.g., using CVE database) in a target system. Use vulnerability scanners like OpenVAS or Nessus to detect vulnerabilities.
3	Exploit common vulnerabilities such as buffer overflows, SQL injection, or XSS attacks. Use frameworks like Metasploit to automate exploitation.

4	Use tools like John the Ripper or Hashcat to crack passwords from hashed files. Experiment with different password cracking techniques (dictionary attacks, brute force, etc.).
5	Perform SQL injection attacks on vulnerable web applications. Cross-Site Scripting (XSS) attacks to inject malicious scripts into web pages. Directory traversal and file inclusion attacks.
6	Crack Wi-Fi passwords using tools like Aircrack-ng or Wifite. Perform rogue access point attacks and man-in-the-middle (MITM) attacks on Wi-Fi networks.
7	Use tools like Autopsy or Sleuth Kit to analyze disk images for evidence of security breaches. Investigate system logs and network traffic to reconstruct security incidents.
8	Configure firewalls and intrusion detection/prevention systems (IDS/IPS).
9	Conduct physical penetration tests to gain unauthorized access to facilities or systems.
10	Mini project

Textbooks:

1. "Computer Forensics: Investigating Network Intrusions and Cybercrime" by EC-Council
2. "Digital Forensics with Open Source Tools" by Cory Altheide and Harlan Carvey
3. "The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory" by Michael Hale Ligh, Andrew Case, Jamie Levy, and AAron Walters
4. "Practical Forensic Imaging: Securing Digital Evidence with Linux Tools" by Bruce Nikkel

Reference Books:

1. "Handbook of Digital Forensics and Investigation" edited by Eoghan Casey
2. "Windows Forensic Analysis Toolkit: Advanced Analysis Techniques for Windows 10" by Harlan Carvey
3. "Network Forensics: Tracking Hackers through Cyberspace" by Sherri Davidoff and Jonathan Ham
4. "Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation" by Lee Reiber