Dr. Babasaheb Ambedkar Technological University
(Established as a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra Telephone and Fax: 02140 - 275142
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Curriculum (As per NEP)

UNDER GRADUATE PROGRAMME
(B. Tech. Information Technology)

FINAL YEAR ENGINEERING

WITH EFFECT FROM THE ACADEMIC YEAR 2026-2027



Vision of the University

"The University is committed to become a leading 'Center of Excellence' in the field of Engineering, Technology, and Science as a seat of learning with a national character and international outlook."

Mission of the University

"The University is committed to provide quality technical education, research, and development services to meet the needs of industry, business, service sector, and society, at large."

Vision of the Department

"To achieve excellence in teaching, learning, and research to develop quality engineers to meet the current trends in the emerging world of Information Technology."

Mission of the Department

M1: The department constantly aims at providing quality technical education.

M2: The department works in pace with modern scientific and technological development.

M3: The department strives to meet the needs of industry, business, the service sector, and society at large."

Semester VII

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme – Hours per week				Examination Scheme - Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR/ OR	
1	Mobile Computing	26UD1246PC701	PCC	3	0	0	3	20	20	60	-	-	100
2	Introduction to Large Language Models	26UD1246PC702	PCC	3	0	0	3	20	20	60	-	-	100
	PEC-III (Any One)												
3	A. Cryptography and Network Security	26UD1246PEC703A	PEC-III	2	0	0	2	20	20	60	-	-	100
	B. Big Data Analytics	26UD1246PEC703B		2	0	0	2	20	20	60	-	-	100
	C. Hyperspectral Remote Sensing Applications	26UD1246PEC703C		2	0	0	2	20	20	60	-	-	100
	D. Softwares for Embedded Systems	26UD1246PEC703D		2	0	0	2	20	20	60	-	-	100
	E. Generative AI and Agentic Systems	26UD1246PEC703E		2	0	0	2	20	20	60	-	-	100
	F. Blockchain in Supply Chain Management	26UD1246PEC703F		2	0	0	2	20	20	60	-	-	100
	G. Cloud Storage and Security	26UD1246PEC703G		2	0	0	2	20	20	60	-	-	100
	H. Infrastructure as Code	26UD1246PEC703H		2	0	0	2	20	20	60	-	-	100
	I. Quantum Machine Learning	26UD1246PEC703I		2	0	0	2	20	20	60	-	-	100
	J. Usability Engineering	26UD1246PEC703J		2	0	0	2	20	20	60	-	-	100
	K. Quality Control and Quality Assurance	26UD1246PEC703K		2	0	0	2	20	20	60	-	-	100
	L. Network Security and Administration	26UD1246PEC703L		2	0	0	2	20	20	60	-	-	100
	M. Modern Computational Finance	26UD1246PEC703M		2	0	0	2	20	20	60	-	-	100
4	Introduction to Large Language Models Lab	26UD1246PCL704	PCC	0	0	2	1	-	-	-	60	40	100
5	Major Project	26UD1246PROJ705	Project	0	0	8	4	-	-	-	50	50	100
6	Multi-Disciplinary Minor #	26UD1246MD706	MD M#	2	0	0	2	20	20	60	-	-	100
Total				**10**	**0**	**10**	**15**	**80**	**80**	**240**	**110**	**90**	**600**

 # 2 Credits based on the choice of MD-M from another department.

Semester VIII

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	PEC-IV (Any One)												
1	A. Cyber Forensics and Incident Response	26UD1246PEC801A	PEC-IV	2	0	0	2	20	20	60	-	-	100
	B. Social Media Analytics	26UD1246PEC801B		2	0	0	2	20	20	60	-	-	100
	C. Spectral Signature Analysis & Classification	26UD1246PEC801C		2	0	0	2	20	20	60	-	-	100
	D. IoT Protocols and Architecture	26UD1246PEC801D		2	0	0	2	20	20	60	-	-	100
	E. Applied Accelerated Artificial Intelligence	26UD1246PEC801E		2	0	0	2	20	20	60	-	-	100
	F. Enterprise Blockchain and Implementation	26UD1246PEC801F		2	0	0	2	20	20	60	-	-	100
	G. Cloud Application and Development	26UD1246PEC801G		2	0	0	2	20	20	60	-	-	100
	H. DevOps with Docker and Kubernetes	26UD1246PEC801H		2	0	0	2	20	20	60	-	-	100
	I. Quantum Hardware and Error Correction	26UD1246PEC801I		2	0	0	2	20	20	60	-	-	100
	J. Advanced HCI & Emerging Interfaces	26UD1246PEC801J		2	0	0	2	20	20	60	-	-	100
	K. Software Design and Architecture	26UD1246PEC801K		2	0	0	2	20	20	60	-	-	100
	L. Network Programming	26UD1246PEC801L		2	0	0	2	20	20	60	-	-	100
	M. Advanced Financial Analytics	26UD1246PEC801M		2	0	0	2	20	20	60	-	-	100
2	Research Methodology	26UD1246RM802	RM	3	1	-	4	20	20	60	-	-	100
3	Internship / Major Project	26UD1246ITRNP803	Intern-ship/Project	-	-	24	12	-	-	-	100	50	150
4	Multi-Disciplinary Minor #	26UD1246MD806	MD M#	2	0	0	2	20	20	60	-	-	100
Total				**07**	**1**	**24**	**20**	**60**	**60**	**180**	**100**	**50**	**450**

 # 2 Credits based on the choice of MD-M from another department.

Multidisciplinary Minor [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme – Hours per week				Examination Scheme - Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR/ OR	
Any One													
1	Mobile Computing	26UD1246MD706A	MD-M	**2**	**0**	**0**	**2**	**20**	**20**	**60**	**-**	**-**	**100**
2	Introduction to Large Language Models	26UD1246MD706B											
3	Cryptography and Network Security	26UD1246MD706C											
4	Big Data Analytics	26UD1246MD706D											
5	Spectral Signature Analysis & Classification	26UD1246MD706E											
6	Softwares for Embedded Systems	26UD1246MD706F											
7	Generative AI and Agentic Systems	26UD1246MD706G											
8	Blockchain in Supply Chain Management	26UD1246MD706H											
9	Cloud Storage and Security	26UD1246MD706I											
10	Infrastructure as Code	26UD1246MD706J											
11	Quantum Machine Learning	26UD1246MD706K											
12	Usability Engineering	26UD1246MD706L											
13	Quality Control and Quality Assurance	26UD1246MD706M											
14	Network Security and Administration	26UD1246MD706N											
15	Modern Computational Finance	26UD1246MD706O											

*** Please select one course from the options listed above for the Multidisciplinary Minor.**

Multidisciplinary Minor [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme – Hours per week				Examination Scheme - Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR/ OR	
Any One													
1	Cyber Forensics and Incident Response	26UD1246MD806A	MD-M	**2**	**0**	**0**	**2**	**20**	**20**	**60**	**-**	**-**	**100**
2	Social Media Analytics	26UD1246MD806B											
3	Spectral Signature Analysis & Classification	26UD1246MD806C											
4	IoT Protocols and Architecture	26UD1246MD806D											
5	Applied Accelerated Artificial Intelligence	26UD1246MD806E											
6	Enterprise Blockchain and Implementation	26UD1246MD806F											
7	Cloud Application and Development	26UD1246MD806G											
8	DevOps with Docker and Kubernetes	26UD1246MD806H											
9	Quantum Hardware and Error Correction	26UD1246MD806I											
10	Advanced HCI & Emerging Interfaces	26UD1246MD806J											
11	Software Design and Architecture	26UD1246MD806K											
12	Network Programming	26UD1246MD806L											
13	Advanced Financial Analytics	26UD1246MD806M											

*** Please choose any one course from the Multidisciplinary Minor options listed above.**

B. Tech. IT (Honors) [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Decision Support Systems	26UD1246HR701											
2	Agile Development Methodologies	26UD1246HR702	Honors	03	00	00	03	20	20	60	-	-	100
3	AI in Robotics	26UD1246HR703											

B. Tech. IT (Honors) [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Edge and Fog Computing	26UD1246HR801											
2	Smart Agriculture using IoT	26UD1246HR802	Honors	03	00	00	03	20	20	60	-	-	100
3	AI for Cybersecurity	26UD1246HR803											

B. Tech. IT (By Research) [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Qualitative Data Analysis Software	26UD1246RS701	Research	03	00	00	03	20	20	60	-	-	100
2	Research Design and Proposal Writing	26UD1246RS702											

B. Tech. IT (By Research) [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Meta-analysis	26UD1246RS801	Research	03	00	00	03	20	20	60	-	-	100
2	Research Methodology in Health Sciences	26UD1246RS802											

Course Title : Mobile Computing | **Semester : VII**

Prerequisite : Computer Networks | **L–T–P : 3-0-0**

Course Code : 26UD1246PC701 | **Credits : 3**

Course Type : PCC

Course Objectives:

1. To understand the fundamentals of mobile computing and wireless communication.
2. To learn GSM architecture and the evolution of mobile networks from 2G to 5G.
3. To study Mobile IP, MANETs, and their security challenges.
4. To understand TCP protocols, congestion control, and mobility management.
5. To explore emerging technologies in mobile computing, including IoT, AI, cloud computing, and blockchain.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the fundamentals of mobile computing and wireless communication.
2. Describe GSM architecture and modern mobile network technologies.
3. Analyze Mobile IP and Mobile Ad Hoc Networks (MANETs).
4. Explain TCP variants and congestion control in wireless networks.
5. Evaluate emerging trends and technologies in mobile computing.

Course Contents:

UNIT I

Fundamentals of Mobile Computing and Wireless Communication: **[08 Hours]**

Introduction to Mobile Computing, Wireless Communication block diagram, Communication Methods, Wired network Vs Wireless Network, Applications , Characteristics and Challenges of Mobile Computing, Signals and its types, Antenna and types, Signal propagation, Multiplexing and types , Modulation and Demodulation, ASK, PSK and FSK, Cellular Wireless Network.

UNIT II

GSM and other architectures: **[08 Hours]**

Introduction to GSM, GSM Architecture, CDMA Technology, General Packet Radio Service (GPRS), Enhanced Data Rates for GSM Evolution (EDGE), Third Generation (3G) Network Architecture, Long-Term Evolution (LTE – 4G) and 5G overview.

UNIT III

Mobile IP and Mobile Ad Hoc Networks: **[08 Hours]**

Mobile IP, Components of Mobile IP, Mobile IP working, Dynamic Host Configuration Protocol DHCP, Adhoc Wireless network or Simple Wireless adhoc network WANET or MANET, Characteristics, Properties, Challenges and Application of MANETS, Security in ad-hoc networks.

UNIT IV

TCP in Mobile and Wireless Networks: **[08 Hours]**

Traditional TCP and TCP Congestion Control, Slow Start, Fast Retransmit and Fast Recovery, TCP Variants for Mobile Networks: Indirect TCP (I-TCP), Snooping TCP and Mobile TCP (M-TCP), Mobile Management.

UNIT V

Emerging Trends in Mobile Computing : **[08 Hours]**

Introduction to Emerging Trends in Mobile Computing, Internet of Things (IoT) and Mobile Computing, Mobile Cloud Computing (MCC), Edge Computing and Fog Computing, Artificial Intelligence (AI) and Machine Learning (ML) in Mobile Computing, Mobile Security and Privacy, Blockchain in Mobile Computing, Wearable and Smart Mobile Devices, Future Trends in Mobile Computing.

Text Books:

1. Jochen Schiller,***"Mobile Communications"***, Pearson Education, 2nd edition, 2009.
2. Asoke K. Talukder, Hasan Ahmed, Roopa R. Yavagal,***"Mobile Computing: Technology, Applications and Service Creation"***, McGraw Hill Education, 2nd edition, 2017.
3. Raj Kamal, ***"Mobile Computing"***, Oxford University Press, 3rd edition, 2019.
4. Prasant Kumar Pattnaik and Rajib Mall, ***"Fundamentals of Mobile Computing"***,2nd Edition, PHI Learning, 2019.
5. William Stallings, ***"Wireless Communications and Networks"***,2nd Edition, Pearson Education, 2005.

Reference Books:

1. C. Siva Ram Murthy and B. S. Manoj,***"Ad Hoc Wireless Networks: Architectures and Protocols"***, 2nd Edition, Pearson Education, 2007.
2. Theodore S. Rappaport,***"Wireless Communications: Principles and Practice"***, 2nd Edition, Pearson Education, 2002.
3. Charles E. Perkins,***"Mobile IP: Design Principles and Practices"***, Addison-Wesley, 1998.
4. Dharma Prakash Agrawal and Qing-An Zeng,***"Introduction to Wireless and Mobile Systems"***, 4th Edition, Cengage Learning, 2016.
5. Andreas F. Molisch,***"Wireless Communications"***, 3rd Edition, Wiley, 2023.

Course Title : Introduction to Large Language Models | **Semester : VII**

Prerequisite : Deep Learning | **L–T–P : 3-0-0**

Course Code : 26UD1246PC702 | **Credits : 3**

Course Type : PCC

Course Objectives:

1. To introduce the fundamentals of Natural Language Processing, statistical language modeling, and deep learning techniques relevant to Large Language Models (LLMs).
2. To develop understanding of word representations, neural language models, sequence modeling techniques, and decoding strategies used in modern NLP systems.
3. To explain the architecture and working principles of Transformers, attention mechanisms, pre-training strategies, and implementation frameworks such as PyTorch and HuggingFace.
4. To familiarize students with advanced concepts including prompt engineering, instruction tuning, retrieval-augmented generation, knowledge graphs, and parameter-efficient fine-tuning techniques.
5. To analyze recent advancements, interpretability methods, ethical concerns, and real-world applications of modern Large Language Models such as GPT, Llama, Gemini, Claude, and Mistral.

Course Outcomes:

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

1. Explain the concepts of NLP pipelines, statistical language models, and deep learning foundations used in language processing applications.
2. Apply word embedding techniques, neural sequence models, and decoding algorithms for solving NLP tasks.
3. Design and implement Transformer-based architectures using PyTorch and utilize pre-trained models through HuggingFace libraries.
4. Demonstrate understanding of prompt engineering, retrieval-augmented generation, knowledge graphs, and parameter-efficient adaptation methods for LLMs.
5. Evaluate modern Large Language Models with respect to interpretability, alignment, ethical issues, bias, toxicity, and emerging research trends.

Course Contents:

UNIT I

NLP Fundamentals and Deep Learning : **[08 Hours]**

Introduction to NLP (NLP Pipeline, Applications of NLP), Introduction to Statistical Language Models, Statistical Language Models: Advanced Smoothing and Evaluation, Introduction to Deep Learning (Perceptron, ANN, Backpropagation, CNN), Introduction to PyTorch.

UNIT II

Word Embeddings and Sequence Models : **[08 Hours]**

Word Representation, Word2Vec, fastText, GloVe, Tokenization Strategies, Neural Language Models, CNN, RNN, 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.

UNIT III

Transformers and Pre-trained Models : **[08 Hours]**

Introduction to Transformers, Self and Multi-Head Attention, Positional Encoding and Layer Normalization, Implementation of Transformers using PyTorch,Pre-Training Strategies: ELMo, BERT (Encoder-only Model), Pre-Training Strategies: Encoder-decoder and Decoder-only Models, Introduction to HuggingFace.

UNIT IV

Prompting, RLHF and RAG : **[08 Hours]**

Instruction Tuning, Prompt-based Learning, Advanced Prompting Techniques and Prompt Sensitivity, Alignment of Language Models with Human Feedback (RLHF), The case for retrieving from structured and unstructured sources;retrieval-augmented inference and generation Retrieval augmentation techniques,Key-value memory networks in QA for simple paths in KGs,Early HotPotQA solvers, pointer networks, reading comprehension,REALM, RAG, FiD, Unlimiformer,KGQA (e.g., EmbedKGQA, GrailQA).

UNIT V

Knowledge Graphs and Ethical NLP : **[08 Hours]**

Knowledge graphs (Kgs), Representation, completion, Tasks: Alignment and isomorphism, Distinction between graph neural networks and neural KG inference Parameter-efficient Adaptation (Prompt Tuning, Prefix Tuning, LoRA), An Alternate Formulation of Transformers: Residual Stream Perspective, Interpretability Techniques, Overview of recently popular models such as GPT-4, Llama-3, Claude-3,Mistral, and Gemini Ethical NLP – Bias and Toxicity.

Text Books:

1. Daniel Jurafsky, James H. Martin,***"Speech and Language Processing"***, Pearson Education / Prentice Hall.
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf,***"Natural Language Processing with Transformers"***, O'Reilly Media.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville,***"Deep Learning"***,MIT Press.
2. Denis Rothman, ***"Transformers for Natural Language Processing"*** , Packt Publishing.

Course Title : Cryptography and Network Security | **Semester : VII**

Prerequisite: Computer Networks | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703A | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the basic concepts and importance of cryptography in network security.
2. To provide knowledge of classical and modern encryption techniques.
3. To develop an understanding of the mathematical foundations used in cryptographic systems.
4. To familiarize with public key cryptography and key exchange mechanisms.
5. To study authentication methods, hash functions, and digital signatures.
6. To explore cryptanalysis techniques and common security attacks.
7. To introduce advanced topics such as blockchain, quantum cryptography, and secure communication.

Course Outcomes:

After learning the course, the students will be able to:

1. Understand the fundamentals of cryptography, classical techniques, and symmetric key encryption methods.
2. Gain knowledge of number theory concepts and public key cryptographic algorithms.
3. Understand authentication techniques, digital signatures, and cryptographic protocols.
4. Study hash functions and various cryptanalysis methods used in security analysis.
5. Explore advanced cryptographic concepts and their applications in modern security systems.

Course Contents:

UNIT I

Fundamentals of Cryptography and Classical Techniques: **[06 Hours]**

Introduction to cryptography, Classical Cryptosystem, Block Cipher. Data Encryption Standard (DES), Triple DES, Modes of Operation, Stream Cipher. LFSR based Stream Cipher, Mathematical background, Abstract algebra, Number Theory.

UNIT II

Public Key Cryptography and Number Theory : **[06 Hours]**

Modular Inverse, Extended Euclid Algorithm, Fermat's Little Theorem, Euler Phi-Function, Euler's theorem. Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem. Primarily Testing, ElGamal Cryptosystem, Elliptic Curve over the Reals, Elliptic curve Modulo a Prime.

UNIT III

Authentication and Cryptographic Protocols: **[06 Hours]**

Generalized ElGamal Public Key Cryptosystem, Rabin Cryptosystem. Message Authentication, Digital Signature, Key Management, Key Exchange, Hash Function.

UNIT IV

Hashing and Cryptanalysis: **[06 Hours]**

Cryptographic Hash Function, Secure Hash Algorithm (SHA), Digital Signature Standard (DSS). Cryptanalysis, Time-Memory Trade-off Attack, Differential and Linear Cryptanalysis.

UNIT V

Advanced Topics in Cryptography and Security: **[06 Hours]**

Cryptanalysis on Stream Cipher, Modern Stream Ciphers, Shamir's secret sharing and BE, Identity-based Encryption (IBE), Attribute-based Encryption (ABE). Side-channel attack, The Secure Sockets Layer (SSL), Pretty Good Privacy (PGP), Introduction to Quantum Cryptography, Blockchain, Bitcoin and Cryptocurrency.

Text Books:

1. William Stallings, ***"Cryptography and Network Security: Principles and Practice"***, Pearson, 7th Edition.
2. Behrouz A. Forouzan, ***"Cryptography and Network Security"***, McGraw-Hill.
3. Atul Kahate, ***"Cryptography and Network Security"***, Tata McGraw-Hill.

Reference Books:

1. Douglas R. Stinson, ***"Cryptography: Theory and Practice"***, CRC Press.
2. Jonathan Katz and Yehuda Lindell, ***"Introduction to Modern Cryptography"***, CRC Press.
3. Bruce Schneier, ***"Applied Cryptography"***, Wiley.
4. Christof Paar and Jan Pelzl, ***"Understanding Cryptography"***, Springer.
5. Wenbo Mao, ***"Modern Cryptography: Theory and Practice"***, Pearson.

Course Title : Big Data Analytics | **Semester : VII**

Prerequisite : Databases, Data mining | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703B | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce fundamental concepts of Big Data and the Hadoop ecosystem.
2. To understand distributed storage and processing using HDFS and MapReduce.
3. To explore NoSQL databases and their role in handling large-scale data.
4. To study stream mining techniques and real-time big data analytics models.
5. To develop basic data analytics and visualization skills using R.

Course Outcomes:

After learning the course, the students should be able :

1. To explain Big Data concepts, characteristics, and Hadoop architecture.
2. To apply HDFS and MapReduce techniques for distributed data processing.
3. To analyze and compare different NoSQL database models and architectures.
4. To interpret data stream processing methods and real-time analytics models.
5. To perform basic data analysis and visualization using R.

Course Contents:

UNIT I

Introduction to Big Data and Hadoop **[06 Hours]**

Introduction to Big Data - Big Data characteristics and Types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions, Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem.

UNIT II

Hadoop HDFS and MapReduce **[08 Hours]**

Distributed File Systems & Architecture, HDFS: Block storage, replication, architecture, MapReduce: Map, Shuffle, Reduce phases, Combiners and execution flow, Handling failures, Basic MapReduce Algorithms: Selection & Projection, Union & Intersection, Hadoop Limitations.

UNIT III

NoSQL **[06 Hours]**

Introduction to NoSQL & Business Drivers, Types of NoSQL: Key-Value Stores, Document Stores, Column-Family Stores, Graph Databases, Architecture Concepts: Master-Slave vs Peer-to-Peer, Shared-Nothing Architecture, NoSQL Case Study.

UNIT IV

Stream Mining and Real-Time Big Data Models: **[06 Hours]**

Stream data model, DSMS, sources and challenges, Sampling and filtering in streams (Bloom Filter), Counting distinct elements (Flajolet–Martin Algorithm), Sliding window model (DGIM Algorithm), Recommendation systems: Content-based & Collaborative filtering, Applications: Product recommendation and social network analysis.

UNIT V

Data Analytics with R: **[04 Hours]**

Introduction to R and RStudio; data types, variables, vectors, and basic operations, Data handling: reading, writing, preprocessing, and use of built-in and user-defined functions, Data visualization and basic statistical analysis (plots, mean, median, summary functions).

Text Books:

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

Reference Books:

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

Course Title : Hyperspectral Remote Sensing Applications | **Semester : VII**

Prerequisite : Remote Sensing, Image Processing | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703C | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand hyperspectral imaging concepts and data characteristics.
2. To learn preprocessing and analysis techniques for hyperspectral data.
3. To explore application-oriented classification and interpretation methods.
4. To analyze hyperspectral data for real-world problem solving.
5. To study domain-specific applications of hyperspectral remote sensing.

Course Outcomes:

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

1. To explain hyperspectral imaging and spectral data properties.
2. To apply preprocessing and analysis techniques on hyperspectral datasets.
3. To use classification methods for extracting meaningful information.
4. To evaluate hyperspectral data for different domain applications.
5. To implement hyperspectral techniques in real-world scenarios.

Course Contents:

UNIT I

Fundamentals of Hyperspectral Remote Sensing : **[06 Hours]**

Basics of remote sensing, Electromagnetic spectrum and spectral signatures, Multispectral vs hyperspectral imaging, Hyperspectral sensors and data characteristics, Challenges in hyperspectral data, Overview of applications.

Case Study: Overview of hyperspectral imaging in agriculture and environmental monitoring.

UNIT II

Hyperspectral Data Processing Techniques : **[06 Hours]**

Data acquisition and formats, Radiometric and atmospheric correction, Noise removal and normalization, Dimensionality reduction (PCA), Feature extraction, Endmember identification basics.

Case Study: Preprocessing of hyperspectral data for crop analysis and mineral detection.

UNIT III

Agricultural and Environmental Applications : **[08 Hours]**

Crop health monitoring and disease detection, Soil property analysis, Precision agriculture, Vegetation analysis (NDVI and spectral indices), Water quality monitoring, Forest and biodiversity assessment.

Case Studies: Precision agriculture: crop disease detection and yield prediction,Water pollution and algae bloom detection in lakes and rivers.

UNIT IV

Geological, Urban and Industrial Applications : **[06 Hours]**

Mineral exploration and mapping, Geological feature detection, Urban land use and land cover classification, Infrastructure monitoring, Pollution detection, Disaster management applications.

Case Studies: Mineral identification and geological mapping using hyperspectral data Urban growth and land use classification using satellite imagery Disaster management: forest fire detection and flood impact assessment.

UNIT V

Advanced and Emerging Applications : **[04 Hours]**

Defense and surveillance applications, Medical and biomedical imaging basics, Climate change studies, Integration with AI and machine learning, Future trends in hyperspectral remote sensing.

Case Studies: Camouflage detection and surveillance using hyperspectral imaging, Tumor detection using hyperspectral biomedical imaging.

Text Books:

1. Prasad S. Thenkabail, ***"Hyperspectral Remote Sensing of Vegetation"***, CRC Press.
2. Chein-I Chang, ***"Hyperspectral Imaging: Techniques for Spectral Detection and Classification"***, Springer.
3. John A. Richards, ***"Remote Sensing Digital Image Analysis"***, Springer.

Reference Books:

1. James B. Campbell and Randolph H. Wynne, ***"Introduction to Remote Sensing"***, Guilford Press.
2. George Joseph, ***"Fundamentals of Remote Sensing"***, Universities Press.
3. Chein-I Chang, ***"Hyperspectral Data Processing: Algorithm Design and Analysis"***, Wiley.
4. Rafael C. Gonzalez and Richard Woods,***"Digital Image Processing"***, Pearson.
5. Lillesand, Kiefer, Chipman, ***"Remote Sensing and Image Interpretation"***,Wiley.

Course Title : Softwares for Embedded Systems | **Semester : VII**

Prerequisite : NIL | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703D | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To expose the students to the fundamentals of embedded Programming
2. To Introduce the GNU C Programming Tool Chain in Linux.
3. To study the basic concepts of embedded C.
4. To teach the basics of Python Programming
5. To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts
6. Acquired over the 5 Units of the subject for improved employability skills.

Course Outcomes:

At the end of this course, the students will demonstrate the ability to :

1. Demonstrate C programming and its salient features for embedded systems
2. Deliver insight into various programming languages/software compatible to embedded process development with improved design & programming skills.
3. Develop knowledge on C programming in Linux environment.
4. Possess ability to write python programming for Embedded applications.
5. Have improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.

Course Contents:

UNIT I

Basic of C Programming : **[06 Hours]**

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II

Embedded C : **[06 Hours]**

Adding Structure to ‘C’ Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT III

C Programming Tool-Chain in Linux : **[06 Hours]**

C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library.

UNIT IV

Python Programming : **[06 Hours]**

Introduction - Parts of Python Programming Language - Control Flow Statements - Functions – Strings - Lists - Dictionaries - Tuples and Sets.

UNIT V

Modules, Packages and Libraries in Python : **[06 Hours]**

Python Modules and Packages - Creating Modules and Packages - Practical Example - Libraries for Python - Library for Mathematical functionalities and Tools - Numerical Plotting Library - GUI Libraries for Python - Imaging Libraries for Python - Netoworking Libraries.

Text Books:

1. Paul Deitel and Harvey Deitel, ***"C How to Program"***, 8th Edition, Pearson Education Limited, 2016.
2. Michael J Pont, ***"Embedded C"***, Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, ***"The Definitive Guide to GCC"***, 2nd Edition, Apress Inc., 2006.
4. Gowrishankar S and Veena A, ***"Introduction to Python Programming"***, CRC Press, Taylor & Francis Group, 2019.

Reference Books:

1. Noel Kalicharan, ***"Learn to Program with C"***, Apress Inc., 2015.
2. Steve Oualline, ***"Practical C programming"***, O'Reilly Media, 1997.
3. Fabrizio Romano, ***"Learn Python Programming"***, Second Edition, Packt Publishing, 2018.
4. John Paul Mueller, ***"Beginning Programming with Python for Dummies"***, 2nd Edition, John Wiley & Sons Inc., 2018.
5. Mark Lutz, ***"Programming Python"***, 4th Edition, O'Reilly Media Inc., 2010.

Course Title : Generative AI and Agentic Systems | **Semester : VII**

Prerequisite : Artificial Intelligence, Machine Learning | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703E | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the fundamentals of Artificial Intelligence, Generative AI, Large Language Models (LLMs), and the principles of Agentic AI systems.
2. To develop skills in prompt engineering, Retrieval-Augmented Generation (RAG), and tool integration for intelligent AI applications.
3. To design and develop autonomous AI agents with reasoning, planning, memory, and decision-making capabilities.
4. To explore modern agent development frameworks and build enterprise-grade AI solutions for real-world applications.
5. To evaluate ethical, security, governance, and societal challenges associated with Generative AI and Agentic Systems.

Course outcomes:

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

1. Explain the concepts, architectures, and working principles of Generative AI, Large Language Models, and Agentic AI systems.
2. Design AI-powered workflows using prompt engineering, Retrieval-Augmented Generation (RAG), and external tool integration.
3. Develop autonomous AI agents capable of reasoning, planning, memory management, and multi-step task execution.
4. Build intelligent applications using modern agent frameworks for enterprise automation, software development, research, and business decision support.
5. Analyze ethical, security, governance, and deployment issues related to Generative AI and Agentic Systems while adopting responsible AI practices.

Course Contents:

UNIT I

Foundations of Generative AI and Agentic Systems : **[06 Hours]**

Introduction to Artificial Intelligence, Machine Learning and Deep Learning, Introduction to Generative AI, Foundation Models and Large Language Models (LLMs), Transformer Architecture Basics, Tokenization and Embeddings, Prompt Engineering Fundamentals, Generative AI Applications and Limitations, Introduction to Agentic AI, Generative AI vs Agentic AI.

UNIT II

Agent Design, Reasoning and Planning : **[06 Hours]**

Fundamentals of Intelligent Agents, Agent Architecture, Types of Intelligent Agents, Autonomous Decision Making, Goal-Oriented Reasoning, Planning and Task Decomposition, ReAct Framework, Reflection and Self-Correction, Short-Term and Long-Term Memory, Memory-Augmented Agents, Human-in-the-Loop Systems, Agent Evaluation Metrics.

UNIT III

Agent Development and Multi-Agent Systems : **[06 Hours]**

System Prompts, Function Calling, Tool Calling, Retrieval-Augmented Generation (RAG), Agent Workflows, AI Copilots, Multi-Agent Systems, Agent Communication Protocols, Agent Collaboration, Agent Orchestration, Workflow Automation, Model Context Protocol (MCP), Agent Security, Prompt Injection Attacks.

UNIT IV

Agent Frameworks and Enterprise Applications : **[06 Hours]**

LangChain, LangGraph, CrewAI, AutoGen, OpenAI Agents SDK, Semantic Kernel, AI Coding Agents, Research Agents, Business Agents, Customer Support Agents, Enterprise AI Agents, AI for Software Development, AI in Finance, AI in Healthcare, AI in Education, AI for Business Process Automation, Industry Case Studies.

UNIT V

Enterprise Agentic AI, Governance and Future Trends : **[06 Hours]**

Responsible AI, AI Ethics, Explainable AI (XAI), AI Safety and Alignment, Privacy and Security, Agent Governance, AgentOps, AI Monitoring and Evaluation, Autonomous AI Systems, Enterprise Deployment Strategies, Scalability of AI Agents, Future Trends in Agentic AI, Artificial General Intelligence (AGI), Mini Project and Practical Implementation.

Text Books:

1. Chip Huyen , ***"AI Engineering: Building Applications with Foundation Models"***, O'Reilly Media , 2025.

2. Jay Alammar, Maarten Grootendorst ,***"Hands-On Large Language Models"***, O'Reilly Media , 2024.

Reference Books:

1. James Phoenix, Mike Taylor , ***"Prompt Engineering for Generative AI"***,O'Reilly Media , 2024.

2. Stuart Russell, Peter Norvig ,***"Artificial Intelligence: A Modern Approach"***, Pearson Education , 4th Edition.

Course Title : Blockchain in Supply Chain Management | **Semester : VII**

Prerequisite : Introduction to Blockchain | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703F | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the fundamentals of blockchain technology and supply chain management.
2. To analyze the role of blockchain in improving transparency, traceability, and security in .
3. To study smart contracts, distributed ledger systems, and blockchain architectures used in SCM.
4. To explore real-world applications and case studies of blockchain-enabled supply chains.
5. To evaluate emerging trends, challenges, and future research directions in blockchain-based supply chain systems.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the concepts and working principles of blockchain and supply chain management systems.
2. Analyze blockchain architectures, consensus mechanisms, and smart contract applications in SCM.
3. Apply blockchain concepts to improve supply chain transparency, security, and efficiency.
4. Evaluate industrial use cases and integration of blockchain with IoT, AI, and cloud technologies.
5. Assess challenges, governance issues, and future opportunities in blockchain-enabled supply chains.

Course Contents:

UNIT I

Fundamentals of Supply Chain and Blockchain : **[06 Hours]**

Introduction to Supply Chain Management, Components of Supply Chain, Challenges in Traditional Supply Chains, Digital Transformation in SCM, Introduction to Blockchain Technology, Characteristics of Blockchain, Types of Blockchain, Distributed Ledger Technology, Cryptography Basics in Blockchain, Consensus Mechanisms

UNIT II

Blockchain Architecture and Smart Contracts : **[06 Hours]**

Blockchain Network Architecture, Blocks Hashing and Merkle Trees, Transactions and Validation Process, Peer-to-Peer Networks, Smart Contracts Concepts and Working, Smart Contract Platforms, Tokenization in Supply Chains, Digital Identity and Authentication, Security and Privacy Issues, Blockchain Scalability and Interoperability.

UNIT III

Applications of Blockchain in Supply Chain Management : **[06 Hours]**

Traceability and Transparency, Product Provenance Tracking, Inventory and Warehouse Management, Logistics and Transportation Monitoring, Supplier Relationship Management, Counterfeit Product Detection, Food Supply Chain Applications, Pharmaceutical Supply Chain Applications, Cold Chain Monitoring using IoT and Blockchain, Real-Time Data Sharing and Visibility

UNIT IV

Integration Technologies and Case Studies : **[06 Hours]**

Integration of IoT with Blockchain, AI and Blockchain in SCM, Cloud Computing and Blockchain, RFID and Sensor Technologies, Big Data Analytics in Supply Chains, Blockchain Platforms for SCM, Case Study on IBM Food Trust, Case Study on Walmart Blockchain Supply Chain, Case Study on Maersk TradeLens, Industry Adoption Challenges

UNIT V

Future Trends Governance and Research Directions : **[06 Hours]**

Blockchain Governance Models, Legal and Regulatory Issues, Ethical Issues in Blockchain SCM, Sustainability and Green Supply

Chains, Cybersecurity in Blockchain Networks, Cost Benefit Analysis of Blockchain Adoption, Emerging Trends in Blockchain SCM, Decentralized Finance in Supply Chains, Future Research Opportunities, Mini Project and Practical Implementation

Text Books:

1. Nir Kshetri, ***"Blockchain and Supply Chain Management"***, Elsevier Publications.
2. Chandramouli Subramanian, Asha A George, Abhillash A Vadakkepat, ***"Blockchain Technology"***, Universities Press.

Reference Books:

1. Imran Bashir, ***"Mastering Blockchain"***, Packt Publishing.
2. Don Tapscott and Alex Tapscott, ***"Blockchain Revolution"***, Portfolio/Penguin Publications.

Course Title : Cloud Storage and Security | **Semester : VII**

Prerequisite : Fundamentals of Cloud Computing | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703G | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the fundamental concepts, architecture, and service models of cloud computing and cloud storage systems.
2. To develop an understanding of virtualization, distributed storage technologies, and cloud infrastructure management.
3. To provide knowledge of cloud security principles, threats, vulnerabilities, and protection mechanisms.
4. To explain identity management, data security, privacy preservation, and compliance issues in cloud environments.
5. To study emerging trends, secure cloud applications, disaster recovery, and modern cloud security solutions.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the architecture, characteristics, and deployment models of cloud computing and cloud storage systems.
2. Analyze cloud service models, virtualization technologies, and distributed storage mechanisms.
3. Apply cloud security techniques to protect data, applications, and infrastructure in cloud environments.
4. Evaluate security challenges related to authentication, access control, privacy, and compliance in cloud systems.
5. Understand recent advancements in cloud storage, disaster recovery, and secure cloud-based applications.

Course Contents:

UNIT I

Introduction to Cloud Computing and Cloud Storage : **[06 Hours]**

Basic concepts of cloud computing, Characteristics and advantages of cloud computing, Cloud storage architecture and components, Distributed file systems, Object storage, block storage and file storage — models and use cases.

UNIT II

Virtualization, Containers and Infrastructure Security : **[06 Hours]**

Concept of virtualization, Containerization concepts, Container networking basics, Kubernetes security fundamentals — RBAC and network policies, Container image security — scanning and signing, Secrets management in containerized environments.

UNIT III

Cloud Data Management : **[06 Hours]**

Data replication and consistency models, Distributed databases in cloud, Data migration and synchronization, Backup and disaster recovery mechanisms, Storage security challenges, Data availability and fault tolerance techniques

UNIT IV

Cloud Security and Privacy : **[06 Hours]**

Security issues in cloud computing, Threats and vulnerabilities in cloud environments, Identity and access management, Authentication and authorization mechanisms, Encryption techniques for cloud data security, Secure data transmission, Risk management, Intrusion detection and prevention systems in cloud environments.

UNIT V

Emerging Trends in Cloud Security : **[06 Hours]**

Secure cloud application development, Multi-cloud and hybrid cloud security, Cloud forensics, Blockchain in cloud security, Mobile cloud computing security, Internet of Things (IoT) and cloud integration, Edge and fog computing security, Artificial Intelligence in cloud security, Future trends in cloud storage and security technologies.

Text Books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, ***"Mastering Cloud Computing"***,McGraw Hill Education, 2nd edition, 2020.
2. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra,***"Distributed and Cloud Computing: From Parallel Processing to the Internet of Things"***, Morgan Kaufmann, 1st edition, 2012.
3. Ronald L. Krutz, Russell Dean Vines, ***"Cloud Security: A Comprehensive Guide to Secure Cloud Computing"***, Wiley India, 1st edition, 2010.

Reference Books:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif,***"Cloud Security and Privacy"***, O'Reilly Media, 1st edition, 2009.
2. Barrie Sosinsky, ***"Cloud Computing Bible"***,Wiley India, 2nd edition, 2011.

Course Title : Infrastructure as Code (IaC) | **Semester : VII**

Prerequisite: Version Control with Git | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703H | **Credits : 2**

Course Type : PEC

Course Objectives:

1. Shift from manual hardware/cloud configuration to a software-driven approach for consistency and speed.
2. Gain proficiency in HashiCorp Configuration Language (HCL) to define complex cloud architectures.
3. Understand the complete lifecycle of infrastructure from initial provisioning to versioned updates and decommissioning.
4. Learn to manage, secure, and lock infrastructure state files in a collaborative team environment.
5. Develop the ability to create modular, reusable infrastructure components to standardize deployments across environments.

Course Outcomes:

After learning the course, the students will be able to:

1. Successfully deploy virtual networks, servers, and storage using Terraform across major cloud providers.
2. Apply Git workflows to infrastructure code to track changes, perform rollbacks, and manage peer reviews.
3. Design and implement Terraform Modules to reduce code duplication and enforce organizational standards.
4. Identify and resolve ”configuration drift” between the actual cloud state and the defined code.
5. Automate the execution of infrastructure changes within a CI/CD pipeline using automated plan and apply triggers.

Course Contents:

UNIT I

Introduction to IaC & Provisioning: **[05 Hours]**

The evolution of infrastructure: Manual vs. Automated. Benefits of IaC: Consistency, speed, and documentation. Declarative vs. Imperative automation. Introduction to the IaC ecosystem (Terraform, Ansible, CloudFormation). Installing and configuring the Terraform CLI.

UNIT II

Terraform Core Concepts & Syntax : **[06 Hours]**

Introduction to HCL (HashiCorp Configuration Language). Blocks: Providers, Resources, and Data Sources. The Terraform Workflow: init, plan, apply, and destroy. Managing local and remote providers (AWS/Azure/GCP).

UNIT III

State Management & Variables : **[06 Hours]**

Understanding terraform.tfstate : Purpose and security risks. Remote backends (S3/Azure Blob) and State Locking. Using Variables (vars), Locals, and Outputs to create dynamic configurations. Sensitive data handling.

UNIT IV

Modularity & Advanced Logic : **[06 Hours]**

Creating reusable Modules: Input/Output patterns. Advanced expressions : count, for_each, and conditional logic. Managing multiple environments (Dev, Staging, Prod) using Workspaces or directory structures.

UNIT V

IaC in the DevOps Pipeline : **[07 Hours]**

Integrating Terraform with Git for ”GitOps” workflows. Automating IaC with CI/CD (GitHub Actions/Jenkins). Best practices: Immutable infrastructure, drift detection, and security linting.

Text Books:

1. Yevgeniy Brikman, ***"Terraform: Up & Running: Writing Infrastructure as Code"***, O'Reilly Media, ISBN: 9781098116743, 3rd edition, 2022.
2. Kief Morris, ***"Infrastructure as Code: Dynamic Systems for the Cloud Age""***, O'Reilly Media, ISBN: 9781492040521, 2nd edition, 2021.
3. Robert Hafner, ***"Terraform in Depth: Infrastructure as Code with Terraform and OpenTofu"***, Manning Publications, ISBN: 9781633438385, 1st edition, 2025.

Reference Books:

1. Rosemary Wang, ***"Infrastructure as Code, Patterns and Practices"***, Manning Publications, ISBN: 9781617298295, 1st edition, 2022.
2. Gene Kim, Jez Humble, Patrick Debois and John Willis, ***"The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations"***, IT Revolution Press, ISBN: 9781950508402, 2nd edition, 2021.
3. Muneeb Shaikh, ***"Continuous Deployment with GitOps and Kubernetes"***, Packt Publishing, ISBN: 9781803248677, 1st edition, 2024.

Course Title : Quantum Machine Learning | **Semester : VII**

Prerequisite : Introduction to Quantum Computing, Machine Learning | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703I | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the fundamentals of quantum computing and machine learning concepts.
2. To study quantum algorithms, quantum circuits, and computational models used in quantum machine learning.
3. To explore quantum machine learning techniques such as quantum neural networks, quantum kernels, and hybrid models.
4. To develop skills in using quantum computing frameworks and tools for implementing QML applications.
5. To analyze advanced topics, challenges, and future research directions in quantum machine learning.

Course Outcomes:

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

1. Explain the principles of quantum computing and their relevance to machine learning.
2. Analyze quantum algorithms and computational models used in quantum machine learning systems.
3. Implement basic quantum machine learning models using quantum programming frameworks.
4. Evaluate applications of quantum machine learning in optimization, finance, healthcare, and cybersecurity.
5. Assess challenges, scalability issues, and emerging trends in quantum machine learning technologies.

Course Contents:

UNIT I

Fundamentals of Quantum Computing and Machine Learning : **[05 Hours]**

Introduction to Quantum Computing, Classical vs Quantum Computing, Qubits and Quantum States, Quantum Gates and Circuits, Quantum Measurement, Superposition and Entanglement, Basics of Linear Algebra for Quantum Computing, Introduction to Machine Learning, Supervised and Unsupervised Learning, Challenges in Classical Machine Learning.

UNIT II

Quantum Algorithms and Computational Models : **[06 Hours]**

Quantum Circuit Model, Quantum Fourier Transform, Quantum Search Algorithms, Grover's Algorithm, Shor's Algorithm, Variational Quantum Circuits, Quantum Complexity Theory, Hybrid Quantum-Classical Computing, Noisy Intermediate-Scale Quantum Devices, Quantum Programming Frameworks.

UNIT III

Quantum Machine Learning Techniques : **[06 Hours]**

Quantum Data Encoding Methods, Quantum Feature Maps, Quantum Neural Networks, Variational Quantum Classifiers, Quantum Support Vector Machines, Quantum Kernel Methods, Quantum Clustering Algorithms, Quantum Reinforcement Learning, Quantum Generative Models, Hybrid Quantum Machine Learning Models.

UNIT IV

Quantum Computing Frameworks and Applications : **[05 Hours]**

Quantum Computing with Qiskit, Quantum Machine Learning Libraries, PennyLane for Quantum ML, TensorFlow Quantum, Quantum Circuit Simulation, Quantum Optimization Problems, Applications in Finance, Healthcare and Cybersecurity, Quantum Recommendation Systems, Quantum Image Processing, Real-World Case Studies.

UNIT V

Advanced Topics and Future Trends in Quantum Machine Learning : **[05 Hours]**

Noise and Error Mitigation, Quantum Error Correction Basics, Scalability Challenges in QML, Explainable Quantum AI, Ethical

Issues in Quantum AI, Quantum Advantage in Machine Learning, Research Trends in QML, Quantum Deep Learning, Future Quantum Hardware Developments, Mini Project and Practical Implementation.

Text Books:

1. Peter Wittek, ***"Quantum Machine Learning"*** , Academic Press (Elsevier).
2. Noson S. Yanofsky, Mirco A. Mannucci, ***"Quantum Computing for Computer Scientists"*** ,Cambridge University Press.

Reference Books:

1. Maria Schuld, Francesco Petruccione, ***"Machine Learning with Quantum Computers"***, Springer Publications.
2. Eric Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, ***"Programming Quantum Computers"*** , O'Reilly Media.

Course Title : Usability Engineering | **Semester : VII**

Prerequisite : HCI Basics, UI Design | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703J | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand fundamental concepts, principles, and importance of usability engineering.
2. To learn user-centered design approaches for developing interactive systems.
3. To develop skills in usability testing and evaluation methods.
4. To apply design guidelines for creating effective and user-friendly interfaces.
5. To analyze usability issues and incorporate accessibility and ethical considerations in design.

Course Outcomes:

After learning the course, the students should be able to:

1. Explain usability principles and human factors influencing interface design.
2. Apply user-centered design techniques to develop interactive systems.
3. Conduct usability testing and evaluate systems using standard methods.
4. Design user interfaces that are efficient, effective, and accessible.
5. Assess usability challenges and propose improvements considering ethical and user needs.

Course Contents:

UNIT I

Introduction to Usability Engineering **[06 Hours]**

Introduction to usability – definition, goals, and importance, Usability engineering lifecycle, Human factors in usability: cognition, perception, memory, Principles of usability: learnability, efficiency, memorability, errors, satisfaction, Overview of Human-Computer Interaction (HCI), Case studies of usability successes and failures.

UNIT II

User-Centered Design Process **[08 Hours]**

User-centered design (UCD) lifecycle, Requirement gathering techniques: interviews, surveys, observation, Personas and scenarios, Task analysis and user workflows, Information architecture and interaction design basics, Wireframing and prototyping techniques.

UNIT III

Usability Evaluation Methods **[06 Hours]**

Types of usability testing: formative and summative evaluation, Heuristic evaluation and Nielsen's principles, Cognitive walkthrough, Usability testing methods: lab testing and remote testing, Data collection techniques: logs, questionnaires, feedback analysis, Metrics for usability evaluation.

UNIT IV

Designing for Usability **[06 Hours]**

User interface design principles and guidelines, Visual design and layout, Navigation design and consistency, Accessibility and inclusive design (WCAG guidelines), Mobile and web usability considerations, Error handling and user support systems.

UNIT V

Advanced Topics and Trends in Usability Engineering **[04 Hours]**

Usability in emerging technologies (AR/VR, IoT), UX design and emotional usability, A/B testing and analytics, Ethical issues in usability and user data privacy, Future trends in usability engineering.

Text Books:

1. Jakob Nielsen , ***"Usability Engineering"***, Morgan Kaufmann.

2. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale , ***"Human-Computer Interaction"***, Pearson Education.

3. Ben Shneiderman, Catherine Plaisant, ***"Designing the User Interface: Strategies for Effective Human-Computer Interaction"***, Pearson Education.

Reference Books:

1. Donald A. Norman , ***"The Design of Everyday Things"***, Basic Books.

2. Steve Krug , ***"Don't Make Me Think"***, New Riders.

3. Alan Cooper, Robert Reimann, David Cronin, ***"About Face: The Essentials of Interaction Design"***, Wiley.

4. Jeff Johnson, ***"Designing with the Mind in Mind"***, Morgan Kaufmann.

5. Jeffrey Rubin and Dana Chisnell, ***"Handbook of Usability Testing"***, Wiley.

Course Title : Quality Control and Quality Assurance | **Semester : VII**

Prerequisite : Software Testing | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703K | **Credits : 2**

Course Type : PEC

Course Objectives:

After completing this course, students will be able :

1. To understand the fundamental concepts of quality, quality control, and quality assurance.
2. To study statistical techniques and tools used in quality improvement.
3. To develop knowledge of quality management systems and standards.
4. To learn methods for process control, inspection, and reliability analysis.
5. To understand modern quality improvement approaches such as TQM and Six Sigma.

Course Outcomes:

Students will be able to:

1. Explain the concepts and importance of quality control and quality assurance in industries.
2. Apply statistical quality control techniques for process monitoring and improvement.
3. Analyze quality management systems and standards such as ISO.
4. Evaluate process capability, reliability, and inspection methods.
5. Implement modern quality improvement methodologies for organizational excellence.

Course Contents:

UNIT I

Introduction to Quality Concepts **[06 Hours]**

Definition of Quality, Quality Control (QC), and Quality Assurance (QA), Evolution of quality management, Dimensions of quality, Quality planning and quality costs, Quality philosophies: Deming, Juran, Crosby, Feigenbaum, Quality circles and continuous improvement.

UNIT II

Statistical Quality Control (SQC) **[06 Hours]**

Introduction to Statistical Quality Control, Measures of central tendency and dispersion, Probability distributions in quality control, Control charts for variables and attributes, Process capability analysis, Acceptance sampling techniques.

UNIT III

Quality Assurance Systems and Standards **[06 Hours]**

Concepts of Quality Assurance, Documentation and quality manuals, ISO 9000 series standards, ISO 14000 and environmental management systems, Auditing and certification process, Total Quality Management (TQM) principles.

UNIT IV

Inspection, Reliability, and Process Improvement **[06 Hours]**

Types of inspection and inspection planning, Measurement systems and calibration, Reliability concepts and reliability testing, Failure modes and effects analysis (FMEA), Root cause analysis, Corrective and preventive actions (CAPA).

UNIT V

Modern Quality Improvement Techniques **[06 Hours]**

Six Sigma methodology (DMAIC), Lean manufacturing concepts, Kaizen and continuous improvement, Benchmarking and quality function deployment (QFD), 5S methodology, Case studies in quality improvement.

Text Books:

1. Douglas C. Montgomery, ***"Introduction to Statistical Quality Control"***, 8th Edition, Wiley, 2019.

2. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary Besterfield-Sacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, ***"Total Quality Management"***, 3rd Edition, Pearson Education, 2011.

3. J.M. Juran, Frank M. Gryna, ***"Quality Planning and Analysis"***, 5th Edition, McGraw Hill, 2007.

Reference Books:

1. Acheson J. Duncan, ***"Quality Control and Industrial Statistics"***, 5th Edition, Irwin Publications, 1986.

2. James R. Evans, William M. Lindsay, ***"The Management and Control of Quality"***, 9th Edition, Cengage Learning, 2014.

3. Armand V. Feigenbaum, ***"Total Quality Control"***, 3rd Edition, McGraw Hill, 1991.

4. Mikel Harry, Richard Schroeder, ***"Six Sigma: The Breakthrough Management Strategy"***, 1st Edition, Currency Publications, 2000.

Course Title : Network Security and Administration | **Semester : VII**

Prerequisite :Computer Network Fundamentals | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703L | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the fundamental concepts of computer networks, network administration, and network security principles.
2. To develop an understanding of network architectures, protocols, routing, switching, and network management techniques.
3. To provide knowledge of various network threats, vulnerabilities, cryptographic techniques, and security mechanisms.
4. To explain system administration tasks including user management, server configuration, monitoring, and maintenance.
5. To study modern network security technologies, intrusion detection systems, firewalls, and secure network design practices.

Course Outcomes:

After learning the course, the students should be able to:

1. Explain network architectures, communication protocols, and the role of network administration in organizational environments.
2. Configure and manage network devices, servers, and network services using administration tools and techniques.
3. Analyze network security threats and apply suitable security mechanisms to protect systems and networks.
4. Evaluate cryptographic methods, firewalls, intrusion detection systems, and access control techniques for secure communication.
5. Understand recent advancements in network security, cloud network management, and secure enterprise networking solutions.

Course Contents:

UNIT I

Introduction to Network Security and Administration : **[06 Hours]**

Basic concepts of computer networks, Network topologies and architectures, OSI and TCP/IP models, Network devices and components, IP addressing and subnetting, Network operating systems, Roles and responsibilities of network administrators, Network configuration and troubleshooting basics, Introduction to network security concepts, Security goals: confidentiality, integrity and availability.

UNIT II

Network Protocols and Administration : **[06 Hours]**

Routing and switching concepts, Routing protocols and switching techniques, VLANs and network segmentation, DNS, DHCP, FTP, HTTP and email services, Wireless networking concepts, Network monitoring and management tools, Server administration, User and group management, File systems and permissions, Backup and recovery management, Remote administration techniques.

UNIT III

Cryptography and Network Security Mechanisms : **[06 Hours]**

Introduction to cryptography, Symmetric and asymmetric encryption, Hashing and digital signatures, Public Key Infrastructure (PKI), SSL/TLS protocols, Virtual Private Networks (VPNs), Authentication and authorization techniques, Access control models, Security policies and procedures, Secure communication mechanisms, Wireless network security protocols.

UNIT IV

Network Threats and Protection Mechanisms : **[06 Hours]**

Types of network attacks: malware, phishing, spoofing, denial-of-service attacks, Session hijacking and packet sniffing, Firewall concepts and configurations, Intrusion Detection and Prevention Systems (IDS/IPS), Network scanning and vulnerability assessment, Security auditing, Incident response and disaster recovery planning, Ethical hacking basics and penetration testing concepts.

UNIT V

Emerging Trends in Network Security and Administration : **[06 Hours]**

Cloud network security, Software Defined Networking (SDN), Network Function Virtualization (NFV), Internet of Things (IoT) security, Mobile and wireless security, Zero Trust architecture, Artificial Intelligence in cybersecurity, Security Information and Event Management (SIEM), Blockchain in network security, Future trends in secure networking and administration technologies.

Text Books:

1. Jochen Schiller, ***"Mobile Communications"***, 2nd Edition, Pearson Education, 2003.
2. Asoke K. Talukder and Roopa R. Yavagal, ***"Mobile Computing: Technology, Applications and Service Creation"***, 2nd Edition, McGraw Hill Education, 2017.
3. Raj Kamal, ***"Mobile Computing"***, 3rd Edition, Oxford University Press, 2017.
4. Prasant Kumar Pattnaik and Rajib Mall, ***"Fundamentals of Mobile Computing"***, 2nd Edition, PHI Learning, 2019.
5. William Stallings, ***"Wireless Communications and Networks"***, 2nd Edition, Pearson Education, 2005.

Reference Books:

1. C. Siva Ram Murthy and B. S. Manoj, ***"Ad Hoc Wireless Networks: Architectures and Protocols"***, 2nd Edition, Pearson Education, 2007.
2. Theodore S. Rappaport, ***"Wireless Communications: Principles and Practice"***, 2nd Edition, Pearson Education, 2002.
3. Charles E. Perkins, ***"Mobile IP: Design Principles and Practices"***, Addison-Wesley, 1998.
4. Dharma Prakash Agrawal and Qing-An Zeng, ***"Introduction to Wireless and Mobile Systems"***, 4th Edition, Cengage Learning, 2016.
5. Andreas F. Molisch, ***"Wireless Communications"***, 3rd Edition, Wiley, 2023.

Course Title : Modern Computational Finance | **Semester : VII**

Prerequisite : Finance Engineering | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC703M | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce advanced machine learning and artificial intelligence techniques used in modern computational finance and portfolio optimization.
2. To develop understanding of financial risk management concepts including Value at Risk (VaR), Conditional Value at Risk (CVaR), and statistical foundations of risk analysis.
3. To apply machine learning methods such as LSTM, XGBoost, GARCH, and anomaly detection techniques for financial forecasting and risk assessment.
4. To provide foundational knowledge of quantum computing concepts, quantum circuits, and QUBO formulations relevant to financial optimization problems.
5. To explore quantum algorithms and computational frameworks such as QAOA, VQE, Qiskit, and D-Wave for solving portfolio optimization and financial decision-making problems.

Course Outcomes:

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

1. Explain the role of machine learning, reinforcement learning, and explainable AI techniques in modern financial systems and portfolio management.
2. Analyze financial risk using VaR, CVaR, volatility modeling, and statistical risk assessment methods.
3. Implement machine learning models such as LSTM, XGBoost, GARCH, and anomaly detection techniques for financial prediction and risk management applications.
4. Demonstrate understanding of quantum computing principles, quantum gates, quantum circuits, and QUBO-based optimization formulations.
5. Apply quantum algorithms including Quantum Annealing, VQE, and QAOA using frameworks such as Qiskit and D-Wave Ocean SDK for computational finance problems.

Course Contents:

UNIT I

Advanced ML for Finance: **[05 Hours]**

Role of ML in Finance, Attention-Based Models (Transformers) for Portfolio Allocation, Graph Neural Networks (GNN) for Portfolio Optimization, Explainable AI for Portfolio Decisions, Reinforcement Learning for Dynamic Portfolio Allocation.

UNIT II

Risk Management in Finance: **[07 Hours]**

Meaning and Importance of Risk Management, Risk vs Return Trade-off, Role of Risk Management in Portfolio Construction, Statistical Foundations of Risk, Value at Risk (VaR) Definition and Interpretation of VaR, Methods of VaR Calculation, Limitations of VaR, Conditional VaR (CVaR) Concept and Need, Difference between VaR and CvaR.

UNIT III

Machine Learning in Risk Management : **[05 Hours]**

Volatility Prediction using LSTM, XGBoost, GARCH, VaR using ML, Anomaly Detection (Isolation Forest), Correlation Modeling (PCA, Graphical Lasso)

UNIT IV

Basics of Quantum Computing for Finance : **[05 Hours]**

Basics of Quantum Mechanics for Computing, Principles of quantum computing, Quantum Gates, Quantum Circuits, Bloch Sphere Representation, Mapping Portfolio Optimization to Quantum Problems using QUBO, Constraint Handling in QUBO

UNIT V

Quantum Algorithms for Finance : **[05 Hours]**

Quantum Annealing, Variational Quantum Eigensolver (VQE), Quantum Approximate Optimization Algorithm (QAOA), Variational Circuits, Parameter Optimization using Classical Optimizers, Cost Function Design for Portfolio Problems, Tools and Frameworks (Qiskit, D-Wave Ocean SDK, Cirq)

Text Books:

1. Marcos López de Prado, ***"Machine Learning for Asset Managers"***, Cambridge University Press.
2. Mughees Ahmed, Abdul Rafey Khan, ***"Hands-On Quantum Machine Learning with Python"***, Packt Publishing.

Reference Books:

1. Marcos López de Prado, ***"Advances in Financial Machine Learning***, Wiley.
2. Oswaldo Zapata, ***"Quantum Computing for Finance"***, Packt Publishing.

Course Title :Introduction to Large Language Models Lab	**Semester : VII**
Prerequisite : Deep Learning	**L–T–P : 0-0-2**
Course Code : 26UD1246PCL704	**Credits : 1**
Course Type : PCC	

List of Experiments:

1. **Implementation of Basic NLP Pipeline**
   Perform tokenization, stop-word removal, stemming, lemmatization, and text preprocessing using Python NLP libraries.

2. **Statistical Language Modeling and Smoothing Techniques**
   Build unigram, bigram, and trigram language models and implement smoothing techniques such as Laplace and Good-Turing smoothing.

3. **Implementation of Neural Networks using PyTorch**
   Design and train simple Perceptron, ANN, and CNN models using PyTorch for text classification tasks.

4. **Word Embedding Techniques using Word2Vec, GloVe, and fastText**
   Train and visualize word embeddings and analyze semantic similarity between words.

5. **Sequence Modeling using RNN, LSTM, and GRU**
   Implement sequence models for sentiment analysis or next-word prediction using PyTorch.

6. **Implementation of Sequence-to-Sequence Models with Attention**
   Develop Seq2Seq models with attention mechanisms for machine translation or text summarization.

7. **Implementation of Decoding Strategies in Language Generation**
   Compare Greedy Search, Beam Search, Top-k Sampling, Temperature Sampling, and Nucleus Sampling for text generation tasks.

8. **Implementation of Transformer Architecture using PyTorch**
   Build and train a basic Transformer model including self-attention and positional encoding components.

9. **Working with Pre-trained Models using HuggingFace Transformers**
   Fine-tune pre-trained models such as BERT for text classification, question answering, or sentiment analysis.

10. **Prompt Engineering and Instruction Tuning Experiments** Design and evaluate prompts using zero-shot, few-shot, chain-of-thought, and role-based prompting techniques.

11. **Implementation of Retrieval-Augmented Generation (RAG)**
    Build a simple RAG pipeline using vector databases and document retrieval for question answering applications.

12. **Parameter-Efficient Fine-Tuning and Bias Analysis in LLMs**
    Implement LoRA/Prompt Tuning methods and analyze ethical issues such as bias and toxicity in generated text.

Course Title : Major Project	**Semester : VII**
Prerequisite : Community Project/Field Project	**L–T–P : 0-0-8**
Course Code : 26UD1246PROJ705	**Credits : 4**
Course Type : Project	

Course Objectives:
Major Project aims to:

1. Identify a real-world industrial, societal, or research problem.
2. Perform an extensive literature survey and requirement analysis.
3. Design and develop working software during Semester VII.
4. Implement the core modules demonstrating significant technical contribution.
5. Prepare complete technical documentation including SRS, system architecture, design documents, implementation report, and project presentation.

Course Outcomes:
After successful completion of Project Phase I, students will be able to:

1. Identify, analyze, and formulate a real-world industrial, societal, or research problem and define appropriate project objectives.
2. Conduct a comprehensive literature survey, analyze existing solutions, and identify research or technology gaps to justify the proposed solution.
3. Perform requirement analysis, prepare the Software Requirement Specification (SRS), and design the system architecture, database, and UML models.
4. Develop and implement a functional software prototype with measurable technical contributions by integrating appropriate tools, technologies, and programming practices.
5. Test, evaluate, document, and effectively present the project through technical reports, demonstrations, and viva voce, demonstrating professional communication and teamwork skills.

Course Contents:

Step 1: Project Identification and Literature Survey

- Selection of project domain
- Problem identification and statement
- Industrial, societal, or research problem analysis
- Literature survey and review of existing solutions
- Identification of research/technology gaps
- Definition of project objectives and scope

Step 2: Project Planning and Requirement Analysis

- Requirement gathering
- Functional and non-functional requirements
- Software Requirement Specification (SRS)
- Feasibility study (Technical, Economic, Operational)
- Work Breakdown Structure (WBS)
- Gantt Chart and project scheduling
- Risk assessment and mitigation plan
- Team roles and responsibilities

Step 3: System Design

- System architecture design
- Module identification and decomposition
- UML diagrams (Use Case, Class, Sequence, Activity, etc.)
- Flowcharts and algorithms
- Database design (ER Diagram and Schema)
- User Interface (UI/UX) design
- Security and privacy considerations

Step 4: Working Software Development

- Selection and justification of programming language(s), framework(s), database, APIs, and development tools
- Module-wise software development
- Source code development using coding standards
- Version control using Git/GitHub or equivalent
- Integration of software modules
- Initial testing (Unit and Integration Testing)
- Development of a functional working software demonstrating measurable technical contribution

Step 5: Documentation, Demonstration, and Evaluation

Preparation of:

- Project Synopsis
- Literature Review Report
- Software Requirement Specification (SRS)
- System Design Document
- Source Code Repository
- Working software
- Test Report
- Project Report
- Project Presentation (PPT)
- Demonstration
- Review, feedback, and improvement plan for the Project for VIII semester

Expected Outcome of Project

By the end of Semester VII, each student/group shall deliver functional software that demonstrates significant implementation of the proposed solution. The software should include the core functionalities of the project and provide a measurable technical contribution. The Major Project in the VIII semester may subsequently involve enhancing the developed software with additional features, preparing a research paper based on the Project work of the VII semester, developing a new problem statement, or completing an industry internship. This progression ensures continuity while providing flexibility in Semester VIII.

Suggested Areas

- Artificial Intelligence
- Machine Learning
- Cyber Security
- Cloud Computing
- Blockchain
- IoT
- Data Analytics
- Mobile Applications
- Web Applications
- Digital Forensics
- SCADA Security
- Quantum-safe Security
- Privacy Engineering
- Zero Trust Architecture

Deliverables

Students shall submit

- Problem Statement
- Literature Review
- SRS
- Architecture Design
- Database Design
- UML Diagrams
- Working Prototype
- Source Code
- Experimental Results
- Project Report
- Synopsis
- PPT
- Demonstration

Evaluation Scheme

Component	**Marks**
Project Proposal	10
Literature Survey	10
Requirement Analysis and SRS	10
Design and Documentation	30
Presentation and Viva	40
Total	**100**

General Guidelines

- Students may work individually or in groups of 3–4.
- Every group shall be assigned a faculty guide.
- Industry-sponsored and interdisciplinary projects are encouraged.
- Weekly progress reviews and maintenance of a project diary/logbook are mandatory.
- Proper citations and references must be included in the report.
- Plagiarism is strictly prohibited.
- Ethical practices, cybersecurity considerations, and intellectual property rights must be followed.
- The final project should demonstrate innovation, practical implementation, technical competency, and societal or industrial relevance.

Note: Major Project is not merely a proposal or design course. Students are expected to complete functional software during Semester VII.

Multidisciplinary Minor [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme – Hours per week				Examination Scheme - Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR/ OR	
Any One													
1	Mobile Computing	26UD1246MD706A	MD-M	**2**	**0**	**0**	**2**	**20**	**20**	**60**	**-**	**-**	**100**
2	Introduction to Large Language Models	26UD1246MD706B											
3	Cryptography and Network Security	26UD1246MD706C											
4	Big Data Analytics	26UD1246MD706D											
5	Spectral Signature Analysis & Classification	26UD1246MD706E											
6	Softwares for Embedded Systems	26UD1246MD706F											
7	Generative AI and Agentic Systems	26UD1246MD706G											
8	Blockchain in Supply Management	26UD1246MD706H											
9	Cloud Storage and Security	26UD1246MD706I											
10	Infrastructure as Code	26UD1246MD706J											
11	Quantum Machine Learning	26UD1246MD706K											
12	Usability Engineering	26UD1246MD706L											
13	Quality Control and Quality Assurance	26UD1246MD706M											
14	Network Security and Administration	26UD1246MD706N											
15	Modern Computational Finance	26UD1246MD706O											

*** Please select one course from the options listed above for the Multidisciplinary Minor.**

Course Title : Mobile Computing | **Semester : VII**

Prerequisite : Computer Networks | **L–T–P : 2-0-0**

Course Code : 26UD1246MD706A | **Credits : 2**

Course Type : MD-M

Course Objectives:

1. To understand the fundamentals of mobile computing and wireless communication.
2. To learn GSM architecture and the evolution of mobile networks from 2G to 5G.
3. To study Mobile IP, MANETs, and their security challenges.
4. To understand TCP protocols, congestion control, and mobility management.
5. To explore emerging technologies in mobile computing, including IoT, AI, cloud computing, and blockchain.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the fundamentals of mobile computing and wireless communication.
2. Describe GSM architecture and modern mobile network technologies.
3. Analyze Mobile IP and Mobile Ad Hoc Networks (MANETs).
4. Explain TCP variants and congestion control in wireless networks.
5. Evaluate emerging trends and technologies in mobile computing.

Course Contents:

UNIT I

Fundamentals of Mobile Computing and Wireless Communication: **[06 Hours]**

Introduction to Mobile Computing, Wireless Communication block diagram, Communication Methods, Wired network Vs Wireless Network, Applications , Characteristics and Challenges of Mobile Computing, Signals and its types, Antenna and types, Signal propagation, Multiplexing and types , Modulation and Demodulation.

UNIT II

GSM and other architectures: **[06 Hours]**

Introduction to GSM, GSM Architecture, CDMA Technology, General Packet Radio Service (GPRS), Enhanced Data Rates for GSM Evolution (EDGE), Third Generation (3G) Network Architecture, Long- Term Evolution (LTE – 4G) and 5G overview.

UNIT III

Mobile IP and Mobile Ad Hoc Networks: **[06 Hours]**

Mobile IP, Components of Mobile IP, Mobile IP working, Dynamic Host Configuration Protocol DHCP, Adhoc Wireless network or Simple Wireless adhoc network WANET or MANET.

UNIT IV

TCP in Mobile and Wireless Networks: **[06 Hours]**

Traditional TCP and TCP Congestion Control, Slow Start, Fast Retransmit and Fast Recovery, TCP Variants for Mobile Networks: Indirect TCP (I-TCP), Snooping TCP and Mobile TCP (M-TCP), Mobile Management.

UNIT V

Emerging Trends in Mobile Computing : **[06 Hours]**

Introduction to Emerging Trends in Mobile Computing, Internet of Things (IoT) and Mobile Computing, Mobile Cloud Computing (MCC), Edge Computing and Fog Computing, Artificial Intelligence (AI) and Machine Learning (ML) in Mobile Computing.

Text Books:

1. Jochen Schiller,***"Mobile Communications"***, Pearson Education, 2nd edition, 2009.
2. Asoke K. Talukder, Hasan Ahmed, Roopa R. Yavagal,***"Mobile Computing: Technology, Applications and Service Creation"***, McGraw Hill Education, 2nd edition, 2017.
3. Raj Kamal, ***"Mobile Computing"***, Oxford University Press, 3rd edition, 2019.
4. Prasant Kumar Pattnaik and Rajib Mall, ***"Fundamentals of Mobile Computing"***,2nd Edition, PHI Learning, 2019.
5. William Stallings, ***"Wireless Communications and Networks"***,2nd Edition, Pearson Education, 2005.

Reference Books:

1. C. Siva Ram Murthy and B. S. Manoj,***"Ad Hoc Wireless Networks: Architectures and Protocols"***, 2nd Edition, Pearson Education, 2007.
2. Theodore S. Rappaport,***"Wireless Communications: Principles and Practice"***, 2nd Edition, Pearson Education, 2002.
3. Charles E. Perkins,***"Mobile IP: Design Principles and Practices"***, Addison-Wesley, 1998.
4. Dharma Prakash Agrawal and Qing-An Zeng,***"Introduction to Wireless and Mobile Systems"***, 4th Edition, Cengage Learning, 2016.
5. Andreas F. Molisch,***"Wireless Communications"***, 3rd Edition, Wiley, 2023.

Course Title : Introduction to Large Language Models | **Semester : VII**

Prerequisite : Deep Learning | **L–T–P : 2-0-0**

Course Code : 26UD1246MD706B | **Credits : 2**

Course Type : MD-M

Course Objectives:

1. To introduce the fundamentals of Natural Language Processing, statistical language modeling, and deep learning techniques relevant to Large Language Models (LLMs).
2. To develop understanding of word representations, neural language models, sequence modeling techniques, and decoding strategies used in modern NLP systems.
3. To explain the architecture and working principles of Transformers, attention mechanisms, pre-training strategies.
4. To familiarize students with advanced concepts including prompt engineering, instruction tuning, retrieval-augmented generation, knowledge graphs, and parameter-efficient fine-tuning techniques.
5. To analyze recent advancements, interpretability methods, ethical concerns, and real-world applications of modern Large Language Models such as GPT, Llama, Gemini, Claude, and Mistral.

Course Outcomes:

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

1. Explain the concepts of NLP pipelines, statistical language models, and deep learning foundations used in language processing applications.
2. Apply word embedding techniques, neural sequence models, and decoding algorithms for solving NLP tasks.
3. Design and implement Transformer-based architectures.
4. Demonstrate understanding of prompt engineering, retrieval-augmented generation, knowledge graphs, and parameter-efficient adaptation methods for LLMs.
5. Evaluate modern Large Language Models with respect to interpretability, alignment, ethical issues, bias, toxicity, and emerging research trends.

Course Contents:

UNIT I

NLP Fundamentals and Deep Learning : **[06 Hours]**

Introduction to NLP (NLP Pipeline, Applications of NLP), Introduction to Statistical Language Models, Statistical Language Models: Advanced Smoothing and Evaluation, Introduction to Deep Learning (Perceptron, ANN, Backpropagation, CNN).

UNIT II

Word Embeddings and Sequence Models : **[06 Hours]**

Word Representation, Word2Vec, fastText, GloVe, Tokenization Strategies, Neural Language Models, CNN, RNN, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Attention in Sequence-to-Sequence Models.

UNIT III

Transformers and Pre-trained Models : **[06 Hours]**

Introduction to Transformers, Self and Multi-Head Attention, Positional Encoding and Layer Normalization, Pre-Training Strategies: ELMo, BERT (Encoder-only Model), Pre-Training Strategies: Encoder-decoder and Decoder-only Models.

UNIT IV

Prompting, RLHF and RAG : **[06 Hours]**

Instruction Tuning, Prompt-based Learning, Advanced Prompting Techniques and Prompt Sensitivity, Alignment of Language Models with Human Feedback (RLHF), The case for retrieving from structured and unstructured sources;retrieval-augmented inference and generation Retrieval augmentation techniques,Key-value memory networks in QA for simple paths in KGs , Early HotPotQA solvers.

UNIT V

Knowledge Graphs and Ethical NLP : **[06 Hours]**

Knowledge graphs (Kgs), Representation, completion, Tasks: Alignment and isomorphism, Distinction between graph neural networks and neural KG inference Parameter-efficient Adaptation (Prompt Tuning, Prefix Tuning, LoRA), Overview of recently popular models such as GPT-4, Llama-3, Claude-3,Mistral, and Gemini.

Text Books:

1. Daniel Jurafsky, James H. Martin,***"Speech and Language Processing"***, Pearson Education / Prentice Hall.
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf,***"Natural Language Processing with Transformers"***, O'Reilly Media.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville,***"Deep Learning"***,MIT Press.
2. Denis Rothman, ***"Transformers for Natural Language Processing"*** , Packt Publishing.

B. Tech. IT (Honors) [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Decision Support Systems	26UD1246HR701											
2	Agile Development Methodologies	26UD1246HR702	Honors	03	00	00	03	20	20	60	-	-	100
3	AI in Robotics	26UD1246HR703											

Course Title : Decision Support Systems | **Semester : VII**

Course Code : 26UD1246HR701 | **L–T–P : 3-0-0**

Prerequisite : Database Systems | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand the concepts and components of Decision Support Systems.
2. To study data-driven and model-driven decision-making techniques.
3. To explore DSS tools, architectures, and development approaches.
4. To analyze business problems using DSS and analytical models.
5. To understand modern trends like AI-based and group decision support systems.

Course Outcomes:

After learning the course, the students should be able :

1. To explain DSS concepts, components, and architecture.
2. To apply data-driven and model-driven approaches for decision-making.
3. To develop simple DSS models for real-world problems.
4. To evaluate DSS tools and techniques for business applications.
5. To analyze advanced DSS concepts such as GDSS and intelligent DSS.

Course Contents:

UNIT I

Introduction to Decision Support Systems: **[08 Hours]**

Definition and evolution of DSS, Characteristics and capabilities of DSS, Components of DSS: data, model, and user interface, Types of DSS: data-driven, model-driven, knowledge-driven, communication-driven, Role of DSS in organizations.

Case Study: Use of DSS in business decision-making (e.g., sales forecasting and inventory management).

UNIT II

Data Management and Data-Driven DSS: **[08 Hours]**

Data warehouse concepts, Data marts and ETL process, OLAP operations, Data mining basics in DSS, Business Intelligence (BI) tools and dashboards, Data visualization techniques.

Case Study: Retail decision support using data warehouse and BI dashboards.

UNIT III

Model Management and Analytical DSS: **[08 Hours]**

Model-based DSS, Types of models: statistical, optimization, simulation models, What-if analysis and sensitivity analysis, Decision trees and forecasting models, Spreadsheet-based DSS.

Case Studies: Financial decision-making using forecasting models, What-if analysis for production planning

UNIT IV

Knowledge-Based and Group Decision Support Systems: **[08 Hours]**

Knowledge-based DSS and expert systems, Artificial Intelligence in DSS, Group Decision Support Systems (GDSS), Collaboration tools and technologies, Decision-making in groups and conflict resolution.

Case Studies: Expert system for medical diagnosis, GDSS for team-based project decision-making

UNIT V

Advanced DSS and Applications: **[08 Hours]**

Web-based DSS, Mobile DSS, Intelligent DSS and AI integration, Big Data and DSS, DSS applications in healthcare, finance,

supply chain, and e-governance, Ethical and security issues in DSS.
Case Studies: Healthcare decision support for disease prediction, Supply chain optimization using DSS

Text Books:

1. Efraim Turban, Jay E. Aronson, Ting-Peng Liang, ***"Decision Support Systems and Intelligent Systems"***, Pearson.
2. Efraim Turban, Ramesh Sharda, Dursun Delen, ***"Decision Support and Business Intelligence Systems"***, Pearson.
3. Rick Sherman, ***"Business Intelligence Guidebook: From Data Integration to Analytics"***, Morgan Kaufmann.

Reference Books:

1. Daniel J. Power, ***"Decision Support Systems: Concepts and Resources for Managers"***, Quorum Books.
2. Ramesh Sharda, Dursun Delen, ***"Business Intelligence and Analytics: Systems for Decision Support"***,Efraim Turban, Pearson.
3. Jiawei Han, Micheline Kamber, ***"Data Mining: Concepts and Techniques"***, Morgan Kaufmann.
4. Thomas H. Davenport, ***"Competing on Analytics"***, Harvard Business Review Press.
5. Kenneth C. Laudon and Jane P. Laudon, ***"Management Information Systems"***, Pearson.

Course Title : Agile Development Methodologies | **Semester : VII**

Course Code : 26UD1246HR702 | **L–T–P : 3-0-0**

Prerequisite : Software Engineering, Programming Basics | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand the principles and values of Agile software development.
2. To learn different Agile methodologies and frameworks.
3. To develop skills in Agile planning, estimation, and execution.
4. To apply Agile practices in real-world software development.
5. To analyze challenges and best practices in Agile environments.

Course Outcomes:

After learning the course, the students should be able :

1. To explain Agile principles, values, and lifecycle models.
2. To apply Agile methodologies like Scrum, XP, and Kanban.
3. To perform Agile planning, estimation, and tracking.
4. To collaborate effectively in Agile teams and manage projects.
5. To evaluate Agile practices and adapt them to different scenarios.

Course Contents:

UNIT I

Introduction to Agile Development: **[08 Hours]**

Software development challenges with traditional models, Agile manifesto and principles, Agile lifecycle, Comparison with Waterfall model, Benefits and limitations of Agile.

Case Study: Transition from Waterfall to Agile in a software development company.

UNIT II

Agile Methodologies and Frameworks: **[08 Hours]**

Scrum framework: roles (Product Owner, Scrum Master, Team), events (Sprint, Daily Scrum, Review, Retrospective), artifacts (Product backlog, Sprint backlog), Extreme Programming (XP) practices, Kanban methodology and workflow.

Case Study: Implementation of Scrum in a product development team.

UNIT III

Agile Planning and Estimation: **[08 Hours]**

User stories and story writing, Backlog management and prioritization, Estimation techniques: story points, planning poker, Velocity and sprint planning, Release planning and tracking progress.

Case Studies: Sprint planning and estimation using planning poker, Backlog prioritization for a real-world project

UNIT IV

Agile Development Practices: **[08 Hours]**

Test-driven development (TDD), Continuous integration and delivery (CI/CD), Refactoring and pair programming, Agile testing strategies, DevOps and Agile integration.

Case Studies: Implementation of TDD in software development, Continuous integration using modern tools

UNIT V

Scaling Agile and Emerging Trends: **[08 Hours]**

Scaling Agile frameworks (SAFe, LeSS), Agile project management tools (JIRA, Trello), Distributed Agile teams, Challenges in

Agile adoption, Future trends in Agile and DevOps.
Case Studies: Scaling Agile in large organizations, Agile implementation in distributed/global teams

Text Books:

1. Robert C. Martin, ***"Agile Software Development: Principles, Patterns, and Practices"***, Pearson.
2. Jeff Sutherland, ***"Scrum: The Art of Doing Twice the Work in Half the Time"***, Crown Business.
3. Ken Schwaber, ***"Agile Project Management with Scrum"***,Microsoft Press.

Reference Books:

1. Kent Beck, ***"Extreme Programming Explained: Embrace Change"***, Addison-Wesley.
2. Mike Cohn, ***"User Stories Applied: For Agile Software Development"***, Addison-Wesley.
3. Mary and Tom Poppendieck, ***"Lean Software Development: An Agile Toolkit"***, Addison-Wesley.
4. David J. Anderson, ***"Kanban: Successful Evolutionary Change for Your Technology Business"***, Blue Hole Press.
5. Gene Kim, Jez Humble, Patrick Debois, John Willis, ***"The DevOps Handbook"***, IT Revolution Press.

Course Title : AI in Robotics | **Semester : VII**

Course Code : 26UD1246HR703 | **L–T–P : 3-0-0**

Prerequisite : Artificial Intelligence, Programming Basics | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand the fundamentals of robotics and artificial intelligence integration.
2. To learn perception, sensing, and environment modeling techniques.
3. To explore planning, reasoning, and decision-making in robots.
4. To study machine learning and control techniques in robotics.
5. To analyze real-world applications of AI in robotic systems.

Course Outcomes:

After learning the course, the students should be able :

1. To explain concepts of robotics and AI integration.
2. To apply perception and sensing techniques in robotic systems.
3. To implement planning and decision-making algorithms.
4. To use AI and machine learning methods in robotics applications.
5. To evaluate robotic systems in real-world scenarios.

Course Contents:

UNIT I

Introduction to Robotics and AI: **[08 Hours]**

Basics of robotics: components, types of robots, Robot kinematics overview, Introduction to Artificial Intelligence in robotics, Intelligent agents and environments, Applications of AI in robotics.

Case Study: Industrial robots in manufacturing and automation.

UNIT II

Perception and Sensing in Robotics: **[08 Hours]**

Sensors in robotics: vision, ultrasonic, infrared, LIDAR, Computer vision basics for robots, Image processing techniques, Environment modeling and representation.

Case Study: Autonomous vehicles using sensors and perception systems.

UNIT III

Planning and Navigation: **[08 Hours]**

Path planning algorithms: A*, Dijkstra, Motion planning and obstacle avoidance, Localization and mapping (SLAM basics), Decision-making under uncertainty, Reinforcement learning basics.

Case Studies: Robot navigation in dynamic environments, Warehouse robots for automated logistics.

UNIT IV

Machine Learning and Control in Robotics: **[08 Hours]**

Supervised and unsupervised learning in robotics, Neural networks for perception and control, Reinforcement learning in robotics, Robot control systems and feedback mechanisms.

Case Studies: Robotic arm control using machine learning, Learning-based object recognition.

UNIT V

Applications and Emerging Trends in AI Robotics: **[08 Hours]**

Humanoid robots, Service and healthcare robots, Swarm robotics, Human-robot interaction, Ethical issues and safety in robotics,

Future trends in AI robotics.
Case Studies: Healthcare robots for patient assistance, Swarm robotics for search and rescue.

Text Books:

1. Stuart Russell and Peter Norvig, ***"Artificial Intelligence: A Modern Approach"***, Pearson.
2. John J. Craig, ***"Introduction to Robotics: Mechanics and Control"***, Pearson.
3. Bruno Siciliano et al., ***"Robotics: Modelling, Planning and Control"***, Springer.

Reference Books:

1. Sebastian Thrun, Wolfram Burgard, Dieter Fox,***"Probabilistic Robotics"***, MIT Press.
2. Lentin Joseph, ***"Robot Operating System (ROS) for Absolute Beginners"***, Apress.
3. Richard S. Sutton and Andrew G. Barto, ***"Reinforcement Learning: An Introduction"***, MIT Press.
4. Richard Szeliski, ***"Computer Vision: Algorithms and Applications"***, Springer.
5. Thomas R. Kurfess, ***"Robotics and Automation Handbook"***, CRC Press.

B. Tech. IT (By Research) [Semester VII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Qualitative Data Analysis Software	26UD1246RS701	Research	03	00	00	03	20	20	60	-	-	100
2	Research Design and Proposal Writing	26UD1246RS702											

Course Title : Qualitative Data Analysis Software | **Semester : VII**

Course Code : 26UD1246RS701 | **L–T–P : 3-0-0**

Prerequisite : Basic Statistics | **Credits : 3**

Course Type : Research

Course Objectives:

1. To understand qualitative research methods and data analysis concepts.
2. To learn the use of QDAS tools for organizing and analyzing qualitative data.
3. To explore coding, categorization, and thematic analysis techniques.
4. To apply qualitative analysis methods using software tools.
5. To interpret and present qualitative findings effectively.

Course Outcomes:

After learning the course, the students should be able :

1. To explain qualitative data analysis concepts and methodologies.
2. To use QDAS tools for managing and analyzing qualitative data.
3. To perform coding and thematic analysis on textual data.
4. To interpret qualitative results and generate meaningful insights.
5. To present qualitative findings using appropriate visualization tools.

Course Contents:

UNIT I

Introduction to Qualitative Research and QDAS: **[08 Hours]**

Qualitative vs quantitative research, Types of qualitative data (text, audio, video), Introduction to QDAS tools, Overview of software (NVivo, ATLAS.ti, MAXQDA), Research design in qualitative studies.

Case Study: Analysis of interview data using qualitative research methods.

UNIT II

Data Preparation and Management: **[08 Hours]**

Data collection methods: interviews, focus groups, surveys, Data transcription and cleaning, Importing and organizing data in QDAS tools, Document management and project setup.

Case Study: Organizing and managing survey and interview datasets in QDAS.

UNIT III

Coding and Thematic Analysis: **[08 Hours]**

Coding techniques: open, axial, and selective coding, Creating categories and themes, Codebook development, Thematic analysis methods, Inter-coder reliability.

Case Studies: Thematic analysis of social media data, Coding interview responses for research studies.

UNIT IV

Advanced Analysis and Visualization: **[08 Hours]**

Content analysis and discourse analysis, Query tools and data exploration, Visualization techniques: word clouds, charts, relationship maps, Mixed-methods integration.

Case Studies: Sentiment analysis of online reviews, Visualization of qualitative research findings.

UNIT V

Reporting, Interpretation and Applications: **[08 Hours]**

Interpretation of qualitative results, Report writing and presentation, Ethical considerations in qualitative research, Applications in

social sciences, business, healthcare, and education.
Case Studies: Market research analysis using QDAS, Healthcare feedback analysis using qualitative data.

Text Books:

1. Matthew B. Miles, A. Michael Huberman, Johnny Saldaña, ***"Qualitative Data Analysis: A Methods Sourcebook"***, Sage Publications.

2. Susanne Friese, ***"Doing Qualitative Data Analysis with Software"***, Sage Publications.

3. Ann Lewins and Christina Silver, ***"Using Software in Qualitative Research: A Step-by-Step Guide"***, Sage Publications.

Reference Books:

1. Johnny Saldaña,***"The Coding Manual for Qualitative Researchers"***, Sage Publications.

2. John W. Creswell, ***"Qualitative Inquiry and Research Design"***, Sage Publications.

3. Juliet Corbin and Anselm Strauss,***"Basics of Qualitative Research"***, Sage Publications.

4. Carla Willig, ***"Introducing Qualitative Research in Psychology"***, McGraw-Hill.

5. Trena M. Paulus, Jessica N. Lester, Paul Dempster, ***"Digital Tools for Qualitative Research"***, Sage Publications.

Course Title : Research Design and Proposal Writing | **Semester : VII**

Course Code : 26UD1246RS702 | **L–T–P : 3-0-0**

Prerequisite : Basic Statistics | **Credits : 3**

Course Type : Research

Course Objectives:

1. To understand the principles and concepts of research design.
2. To learn techniques for identifying and formulating research problems.
3. To develop skills in literature review and hypothesis formulation.
4. To understand methods of data collection and analysis.
5. To prepare and present a structured research proposal.

Course Outcomes:

After learning the course, the students should be able :

1. To explain research design concepts and methodologies.
2. To formulate research problems and objectives effectively.
3. To conduct literature reviews and identify research gaps.
4. To design appropriate research methodologies and data collection strategies.
5. To develop and present a comprehensive research proposal.

Course Contents:

UNIT I

Introduction to Research Design: **[08 Hours]**

Meaning and importance of research design, Types of research: exploratory, descriptive, experimental, Qualitative vs quantitative research, Components of research design, Criteria for good research.

Case Study: Analysis of a published research paper to understand research design structure.

UNIT II

Problem Formulation and Literature Review: **[08 Hours]**

Identification of research problem, Defining research objectives and questions, Literature review techniques, Sources of literature (journals, conferences, databases), Research gap identification, Referencing and citation styles.

Case Study: Literature review and gap identification for a selected research topic.

UNIT III

Research Methodology and Data Collection: **[08 Hours]**

Research approaches and methods, Sampling techniques, Data collection methods: surveys, interviews, experiments, Questionnaire design, Validity and reliability, Ethical considerations in research.

Case Studies: Designing a questionnaire for survey-based research, Sampling strategy for a real-world research problem.

UNIT IV

Data Analysis and Interpretation: **[08 Hours]**

Qualitative and quantitative data analysis, Statistical tools and techniques, Use of software tools (Excel/SPSS/R), Interpretation of results, Hypothesis testing basics.

Case Studies: Data analysis and interpretation of survey results, Hypothesis testing for a sample dataset.

UNIT V

Research Proposal Writing and Presentation: **[08 Hours]**

Structure of a research proposal: title, abstract, objectives, methodology, timeline, budgeting, Writing techniques and formatting,

Presentation skills, Peer review and revision.
Case Studies: Preparation and evaluation of a complete research proposal, Proposal presentation and feedback session.

Text Books:

1. C.R. Kothari, ***"Research Methodology: Methods and Techniques"***, New Age International.
2. John W. Creswell, ***"Research Design: Qualitative, Quantitative, and Mixed Methods Approaches"***, Sage Publications.
3. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, ***"The Craft of Research"***, University of Chicago Press.

Reference Books:

1. Paul D. Leedy and Jeanne Ellis Ormrod, ***"Practical Research: Planning and Design"***, Pearson.
2. Donald R. Cooper and Pamela S. Schindler, ***"Business Research Methods"***, McGraw-Hill.
3. Joan Bolker, ***"Writing Your Dissertation in Fifteen Minutes a Day"***, Holt Paperbacks.
4. Robert A. Day and Barbara Gastel,***"How to Write and Publish a Scientific Paper"***,Cambridge University Press.
5. John W. Creswell, ***"Qualitative Inquiry and Research Design"***, Sage Publications.

Course Title : Cyber Forensics and Incident Response | **Semester : VIII**

Prerequisite: Computer Networks | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801A | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the fundamental concepts of digital forensics and incident response.
2. To provide knowledge of forensic tools and techniques for evidence acquisition and analysis.
3. To develop an understanding of file systems and network forensics.
4. To familiarize with incident detection, response, and recovery processes.
5. To explore malware analysis and investigation techniques.
6. To understand legal, ethical, and documentation aspects in cyber forensics.

Course Outcomes:

After learning the course, the students will be able to:

1. Understand digital forensics fundamentals, evidence handling, and forensic investigation process.
2. Analyze file systems and perform data recovery and metadata analysis.
3. Examine network traffic and logs for forensic investigation.
4. Understand and implement incident response procedures and reporting.
5. Investigate malware using static and dynamic analysis techniques.

Course Contents:

UNIT I

Digital Forensics Fundamentals: **[06 Hours]**

Chain of custody, Evidence handling, Forensic imaging tools, Write blockers, Hash verification, File carving, Disk imaging techniques, Memory forensics, Volatile data collection, Forensic analysis process.

UNIT II

File System Forensics: **[06 Hours]**

FAT file system analysis, NTFS file system analysis, Ext file systems, HFS+ analysis, File recovery techniques, Deleted file recovery, Metadata analysis, Timeline analysis, Orphan file recovery, Slack space analysis.

UNIT III

Network Forensics: **[06 Hours]**

Packet capture and analysis, TCPdump usage, Wireshark analysis, Network traffic reconstruction, Flow analysis, Log aggregation, Syslog analysis, DNS query analysis, Lateral movement detection, Command and control analysis.

UNIT IV

Incident Response Process: **[06 Hours]**

Preparation phase, Detection and analysis, Containment strategies, Eradication procedures, Recovery process, Post-incident activities, Incident classification, Severity assessment, Stakeholder communication, Documentation and reporting.

UNIT V

Malware Investigation: **[06 Hours]**

Static malware analysis, Dynamic malware analysis, Sandboxing techniques, API monitoring, System call analysis, Decompiling malware, Reverse engineering basics, Behavioral analysis, IOC generation, Threat intelligence sharing.

Text Books:

1. Kevin Mandia, Matthew Pepe, and Jason Luttgens, ***"Incident Response and Computer Forensics"***, McGraw-Hill.
2. Eoghan Casey, ***"Digital Evidence and Computer Crime"***, Academic Press.
3. Bill Nelson, Amelia Phillips, and Christopher Steuart, ***"Guide to Computer Forensics and Investigations"***, Cengage Learning.

Reference Books:

1. Jason Luttgens, Matthew Pepe, Kevin Mandia, ***"Incident Response & Computer Forensics"***, McGraw-Hill.
2. Chris Prosise and Kevin Mandia, ***"Incident Response and Computer Forensics"***, McGraw-Hill.
3. Brian Carrier, ***"File System Forensic Analysis"***, Addison-Wesley.
4. Michael Sikorski and Andrew Honig, ***"Practical Malware Analysis"***, No Starch Press.
5. Richard Bejtlich, ***"The Practice of Network Security Monitoring"***, No Starch Press.

Course Title : Social Media Analytics | **Semester : VIII**

Prerequisite : Data mining | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801B | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce fundamental concepts of Social Media Analytics and its significance in decision-making.
2. To understand techniques for collecting, preprocessing, and managing social media data.
3. To explore text analytics and sentiment analysis for extracting insights from user-generated content.
4. To study social network analysis methods for understanding relationships and influence patterns.
5. To develop skills in applying analytics tools for trend analysis, prediction, and visualization.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain social media analytics concepts, metrics, and applications.
2. To apply data collection and preprocessing techniques on social media datasets.
3. To analyze text data using sentiment analysis and topic modeling techniques.
4. To interpret social network structures and perform influence and community analysis.
5. To perform advanced analytics, visualization, and derive insights using analytical tools.

Course Contents:

UNIT I

Introduction to Social Media Analytics **[06 Hours]**

Overview of Social Media Platforms, Evolution and importance of Social Media Analytics, Types of Social Media Data (structured, unstructured, semi-structured), Social Media Metrics: Reach, Engagement, Impressions, CTR, Challenges in Social Media Data Analysis, Applications of Social Media Analytics in business, healthcare, governance.

UNIT II

Data Collection and Preprocessing **[06 Hours]**

Data Sources: APIs, Web Scraping, Third-party tools, Data Extraction using APIs, Data Cleaning and Preprocessing Techniques, Text preprocessing: Tokenization, Stop-word removal, Stemming, Lemmatization, Handling noisy, missing, and duplicate data, Introduction to data storage (NoSQL databases), Data integration and transformation.

UNIT III

Text Analytics and Sentiment Analysis **[06 Hours]**

Basics of Natural Language Processing (NLP), Sentiment Analysis: positive, negative, neutral, Lexicon-based and Machine Learning approaches, Opinion Mining and Emotion Detection, Topic Modeling (LDA basics), Case Study: Brand sentiment analysis.

UNIT IV

Social Network Analysis: **[06 Hours]**

Introduction to Social Network Analysis, Graph theory basics: Nodes, edges, degree, centrality measures, Network metrics: Betweenness, Closeness, Eigenvector centrality, Community detection algorithms, Influence analysis and viral marketing, Visualization of social networks.

UNIT V

Advanced Analytics and Applications **[06 Hours]**

Trend Analysis and Hashtag Analytics, Predictive Analytics using social media data, Recommender Systems: Content-based and

Collaborative filtering, Fake News Detection and Misinformation Analysis, Ethical issues and privacy concerns, Tools: Python (NLTK, Tweepy), R, Tableau.

Text Books:

1. Matthew A. Russell, ***"Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More"***, O'Reilly Media.
2. Jimmy Lin and Chris Dyer, ***"Data-Intensive Text Processing with MapReduce"***, Morgan & Claypool Publishers.
3. Bing Liu, ***"Sentiment Analysis and Opinion Mining"***, Morgan & Claypool Publishers.
4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, ***"Social Media Mining: An Introduction"***, Cambridge University Press.
5. IBM, ***"Introduction to Social Media Analytics"***, IBM Press.

Reference Books:

1. Jake VanderPlas, ***"Python Data Science Handbook"***, O'Reilly Media.
2. Wes McKinney, ***"Python for Data Analysis"***, O'Reilly Media.
3. Foster Provost and Tom Fawcett, ***"Data Science for Business"***, O'Reilly Media.
4. Albert-László Barabási, ***"Network Science"***, Cambridge University Press.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman,***"The Elements of Statistical Learning"***, Springer.
6. Jurafsky and James H. Martin, ***"Speech and Language Processing"***, Pearson.
7. David Easley and Jon Kleinberg , ***"Networks, Crowds, and Markets"***, Cambridge University Press.

Course Title : Spectral Signature Analysis & Classification **Semester : VIII**

Prerequisite : Remote Sensing, Image Processing **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801C **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand spectral signatures and their role in remote sensing.
2. To learn preprocessing and feature extraction techniques for spectral data.
3. To explore classification methods for hyperspectral and multispectral data.
4. To analyze spectral data for accurate identification of materials.
5. To apply spectral analysis and classification in real-world applications.

Course Outcomes:

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

1. To explain spectral signature concepts and characteristics.
2. To apply preprocessing and feature extraction techniques to spectral data.
3. To implement classification algorithms for spectral image analysis.
4. To evaluate classification performance and accuracy.
5. To apply spectral analysis techniques in practical applications.

Course Contents:

UNIT I

Fundamentals of Spectral Signatures : **[06 Hours]**

Electromagnetic spectrum and reflectance properties, Spectral signatures of vegetation, soil, and water, Factors affecting spectral response, Spectral libraries and data sources, Multispectral vs hyperspectral signatures.

Case Study: Analysis of spectral signatures for vegetation, soil, and water bodies.

UNIT II

Spectral Data Preprocessing and Feature Extraction : **[06 Hours]**

Radiometric and atmospheric correction, Noise removal and normalization, Spectral smoothing tion (PCA), Feature extraction, Endmember identification basics.

Case Study: Preprocessing and feature extraction for crop classification and mineral detection.

UNIT III

Supervised Classification Techniques : **[08 Hours]**

Training data selection, Maximum Likelihood Classification, Support Vector Machines (SVM), Decision Trees, Neural Networks basics, Accuracy assessment methods (confusion matrix, kappa coefficient).

Case Studies: Crop classification using supervised learning methods, Land cover classification using SVM and decision trees.

UNIT IV

Unsupervised and Advanced Classification Methods : **[06 Hours]**

Clustering techniques (K-means, ISODATA), Spectral angle mapper (SAM), Spectral unmixing, Object-based classification, Ensemble and hybrid methods.

Case Studies: Mineral identification using spectral angle mapper,Land cover clustering using unsupervised techniques.

UNIT V

Applications of Spectral Analysis & Classification : **[04 Hours]**

Agriculture: crop and soil classification, Environmental monitoring, Urban land use classification, Geological and mineral mapping,

Integration with AI and machine learning, Future trends.
Case Studies: Urban land use classification using spectral data, Environmental monitoring and pollution detection.

Text Books:

1. Chein-I Chang, ***"Hyperspectral Imaging: Techniques for Spectral Detection and Classification"***, Springer.
2. John A. Richards, ***"Remote Sensing Digital Image Analysis"***, Springer.
3. John R. Jensen, ***"Introductory Digital Image Processing: A Remote Sensing Perspective"***, Pearson.

Reference Books:

1. James B. Campbell and Randolph H. Wynne, **"Introduction to Remote Sensing"**, Guilford Press.
2. George Joseph, ***"Fundamentals of Remote Sensing"***, Universities Press.
3. Rafael C. Gonzalez and Richard E. Woods, ***"Digital Image Processing"***, Pearson.
4. Chein-I Chang, ***"Hyperspectral Data Processing: Algorithm Design and Analysis"***, Wiley.
5. Lillesand, Kiefer, Chipman, ***"Remote Sensing and Image Interpretation"***, Wiley.

Course Title : IoT Protocols and Architecture | **Semester : VIII**

Prerequisite : NIL | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801D | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of Internet of Things.
2. To analyze, design and develop solutions for Internet of Things.
3. To explore the real-life aspects of Internet of Things.

Course Outcomes:

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

1. Identify the hardware and software components, challenges of Internet of Things.
2. Assess different Internet of Things technologies and their applications.
3. Design basic circuits using sensors interfacing.
4. Data conversion process and shield libraries to interface with the real world.
5. Build and demonstrate the project successfully by sensor requirements, coding, emulating and testing.

Course Contents:

UNIT I

IoT Fundamentals: **[05 Hours]**

Definition and Characteristics of Internet of Things (IoT) - Challenges and Issues - Physical Design of IoT - Logical Design of IoT - IoT Functional Blocks.

UNIT II

IoT Communication Architectures and Protocols: **[07 Hours]**

Control Units ,Communication modules – Bluetooth , Zigbee ,WiFi , GPS , IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication , Power Sources.

UNIT III

Technologies Behind IoT : **[05 Hours]**

Four pillars of IoT paradigm: RFID, Wireless Sensor Networks, Supervisory Control andData Acquisition (SCADA) - M2M - IoT Enabling Technologies: BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV

Programming the Microcontroller for IoT : **[05 Hours]**

Working principles of sensors – IoT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication: Connecting microcontroller with mobile devices - Communication through Bluetooth - WiFi and USB - Contiki OS - Cooja Simulator.

UNIT V

Resource Management in IoT : **[05 Hours]**

Scalability: Network Configuration Protocol, Open vSwitch Database Management Protocol - Routing and Protocols: Collection Tree, LOADng.

Text Books:

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. ***"Internet of Things: Architectures, Protocols and Standards"***, Wiley Publications, 1st Edition, USA, 2019.

Reference Books:

1. Bahga, Arshdeep, and Vijay Madisetti. ***"Internet of Things: A Hands-on Approach"***, Universities press, 1st Edition, India,2024.

2. Vlasios Tsiatsis, Jan Holler, Catherine Mulligan, Stamatis Karnourskos and David Boyle. ***"Internet of Things: Technologies and Applications for a New Age of Intelligence"***, Academic Press, USA, 2nd Edition, 2018.

Course Title : Applied Accelerated Artificial Intelligence | **Semester : VIII**

Prerequisite : Machine Learning, Deep Learning | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801E | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the architecture and infrastructure required for modern AI computing systems.
2. To learn cloud-native technologies, containerization, and orchestration techniques for AI deployment.
3. To develop skills in deep learning frameworks such as PyTorch and TensorFlow along with model optimization techniques.
4. To explore distributed AI computing, accelerated analytics, and high-performance AI systems.
5. To apply AI concepts in Natural Language Processing, intelligent video analytics, and real-world AI applications.

Course outcomes:

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

1. Explain AI computing infrastructure, accelerators, virtualization, and cloud-based AI environments.
2. Deploy and manage AI applications using containers, Docker, and Kubernetes platforms.
3. Build, optimize, and accelerate deep learning models using PyTorch and TensorFlow.
4. Implement distributed AI computing and accelerated machine learning techniques for scalable AI solutions.
5. Apply NLP and intelligent AI solutions to real-world domains such as smart cities and video analytics.

Course Contents:

UNIT I

AI Computing Infrastructure and System Foundations: **[06 Hours]**

Introduction to AI Systems Hardware, AI Accelerators and GPUs, Operating Systems for AI Computing, Virtualization and Cloud Computing, Containers and Docker, Integrated Development Environments (IDEs) for AI, Scheduling and Resource Management in AI Systems, Fundamentals of AI Infrastructure.

UNIT II

Cloud-Native AI Deployment and High-Performance Computing: **[06 Hours]**

Introduction to Kubernetes, Deployment of AI-Based Services using Kubernetes, DeepOps Concepts and Workflows, Cluster Architecture and Management, Design Principles for High-Performance Computing Clusters, Scalability and Resource Optimization, Distributed Infrastructure for AI Applications, Performance Considerations in AI Systems.

UNIT III

Deep Learning Frameworks and Model Optimization: **[06 Hours]**

Introduction to PyTorch, Profiling and Optimization using DLProf and PyTorch Catalyst, Introduction to TensorFlow, Accelerated TensorFlow and XLA Approach, Automatic Mixed Precision Training, Transfer Learning Techniques, Model Performance Tuning, Best Practices for Deep Learning Training.

UNIT IV

Distributed AI Computing and Accelerated Analytics: **[06 Hours]**

Fundamentals of Distributed AI Computing, Distributed Deep Learning using TensorFlow and Horovod, Challenges in Distributed Training and Convergence, Accelerating AI Model Deployment.

UNIT V

[06 Hours]

Accelerating Neural Network Inference in PyTorch and TensorFlow, Accelerated Data Analytics, Accelerated Machine Learning

Techniques, Deployment Optimization Strategies, Applied AI for Smart Cities, Intelligent Video Analytics, DeepStream-based AI Applications, Real-World AI Deployment Case Studies, Emerging Applications of AI Systems.

Text Books:

1. François Chollet, ***"Deep Learning with Python"***, Manning Publications.

2. Aurélien Géron , ***"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow"***, O'Reilly Media.

Reference Books:

1. Michael Hausenblas, Stefan Schimanski, ***"Programming Kubernetes"***, O'Reilly Media.

2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, ***"Natural Language Processing with Transformers"***, O'Reilly Media.

Web Link:
https://nptel.ac.in/courses/106106238

Course Title : Enterprise Blockchain and Implementation | **Semester : VIII**

Prerequisite : Introduction to Blockchain | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801F | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the fundamentals and architecture of enterprise blockchain systems.
2. To study smart contracts, blockchain platforms, and decentralized application development.
3. To analyze the integration of blockchain with enterprise applications such as ERP, IoT, and cloud systems.
4. To explore real-world enterprise blockchain applications across various industries.
5. To evaluate implementation strategies, security challenges, governance, and future trends in enterprise blockchain.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the concepts, architecture, and working principles of enterprise blockchain systems.
2. Develop and deploy basic smart contracts and blockchain-based enterprise applications.
3. Analyze blockchain integration techniques for enterprise systems and business processes.
4. Evaluate enterprise blockchain use cases in finance, healthcare, supply chain, and governance.
5. Assess security, scalability, governance, and implementation challenges in enterprise blockchain solutions.

Course Contents:

UNIT I

Fundamentals of Enterprise Blockchain : **[05 Hours]**

Introduction to Enterprise Systems, Basics of Blockchain Technology, Distributed Ledger Technology, Public vs Private Blockchain, Consortium Blockchain, Blockchain Architecture, Consensus Mechanisms, Cryptography in Blockchain, Enterprise Blockchain Platforms, Benefits and Challenges of Enterprise Blockchain

UNIT II

Smart Contracts and Blockchain Development : **[06 Hours]**

Smart Contracts Fundamentals, Ethereum Architecture, Hyperledger Fabric Architecture, Chaincode Development, Solidity Programming Basics, Tokenization Concepts, Identity and Access Management, Decentralized Applications, Blockchain APIs and SDKs, Testing and Deployment of Smart Contracts

UNIT III

Enterprise Blockchain Integration and Security : **[05 Hours]**

Blockchain Integration with Enterprise Applications, ERP and Blockchain Integration, Cloud and Blockchain, IoT and Blockchain Integration, Security and Privacy in Blockchain, Digital Signatures and Encryption, Scalability Issues, Interoperability Between Blockchain Networks, Governance Models, Risk Management in Enterprise Blockchain

UNIT IV

Enterprise Blockchain Applications and Case Studies : **[05 Hours]**

Blockchain in Supply Chain Management, Blockchain in Banking and Finance, Healthcare Applications, Digital Identity Management, Trade Finance and Payments, Asset Tracking and Provenance, Blockchain for Government Services, NFT and Enterprise Use Cases, Industry Case Studies, Regulatory and Compliance Issues

UNIT V

Blockchain Implementation and Future Trends : **[05 Hours]**

Enterprise Blockchain Project Lifecycle, Requirement Analysis and Design, Blockchain Deployment Models, Performance Optimization, Blockchain Testing and Maintenance, Cost and ROI Analysis, Legal and Ethical Issues, Emerging Trends in Blockchain, Web3 and Decentralized Ecosystems, Mini Project and Practical Implementation

Text Books:

1. Imran Bashir, ***"Mastering Blockchain"*** , Packt Publishing.
2. Chandramouli Subramanian, Asha A George, Abhillash A Vadakkepat, ***"Blockchain Technology"***, Universities Press.

Reference Books:

1. Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna, ***"Hands-On Blockchain with Hyperledger"***, Packt Publishing.
2. Don Tapscott and Alex Tapscott, ***"Blockchain Revolution"***, Portfolio/Penguin Publications.

Course Title : Cloud Application and Development | **Semester : VIII**

Prerequisite : Web Development | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801G | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the fundamental concepts, architecture, and service models of cloud computing and cloud application development.
2. To develop an understanding of cloud platforms, virtualization, and deployment techniques used for cloud-based applications.
3. To provide knowledge of designing, developing, and deploying scalable cloud applications using modern frameworks and services.
4. To explain cloud data management, security, monitoring, and performance optimization techniques.
5. To study emerging trends in cloud-native development, microservices, containerization, and serverless computing.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain cloud computing models, architectures, and cloud application development environments.
2. Analyze cloud platforms, virtualization technologies, and deployment strategies for cloud applications.
3. Design and develop cloud-based applications using cloud services, APIs, and modern development tools.
4. Evaluate cloud application security, scalability, monitoring, and performance optimization techniques.
5. Understand emerging technologies such as microservices, containerization, DevOps, and serverless computing in cloud environments.

Course Contents:

UNIT I

Introduction to Cloud Computing and Cloud Applications : **[06 Hours]**

Basic concepts of cloud computing, Characteristics and advantages of cloud computing, Evolution of cloud computing, Cloud deployment models: Public, Private, Hybrid and Community cloud, Cloud service models: IaaS, PaaS and SaaS, Cloud application architecture, Distributed computing concepts, Overview of cloud platforms and services, Applications of cloud computing in industry.

UNIT II

Cloud Infrastructure and Virtualization : **[06 Hours]**

Virtualization concepts and types, Hypervisors and virtual machines, Storage and network virtualization, Resource provisioning and load balancing, Data centers and cloud infrastructure, Introduction to containers and container orchestration, Docker and Kubernetes basics, Cloud hosting and deployment models, Overview of AWS, Microsoft Azure and Google Cloud Platform services.

UNIT III

Cloud Application Development : **[06 Hours]**

Cloud application development lifecycle, Cloud programming models, Web services and RESTful APIs, Service-Oriented Architecture (SOA), Microservices architecture, Database services in cloud, Cloud storage integration, Development tools and SDKs for cloud applications, Continuous Integration and Continuous Deployment (CI/CD), DevOps concepts in cloud environments.

UNIT IV

Cloud Security and Performance Management : **[06 Hours]**

Security challenges in cloud applications, Authentication and authorization, Identity and access management, Data security and encryption techniques, Secure API development, Cloud monitoring and logging, Performance optimization techniques, Scalability and fault tolerance, Backup and disaster recovery mechanisms, Compliance and governance in cloud systems.

UNIT V

Emerging Trends in Cloud Application Development : **[06 Hours]**

Serverless computing and Function as a Service (FaaS), Edge and fog computing, Mobile cloud applications, Internet of Things (IoT) integration with cloud, Artificial Intelligence and Machine Learning services in cloud, Multi-cloud and hybrid cloud strategies, Blockchain-based cloud applications, Cloud-native application development, Future trends in cloud technologies.

Text Books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi,***"Mastering Cloud Computing"***, McGraw Hill Education, 2nd edition, 2020.
2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood,***"Cloud Computing: Concepts, Technology and Architecture"***, Pearson Education, 1st edition, 2013.
3. Michael J. Kavis,***"Architecting the Cloud: Design Decisions for Cloud Computing Service Models"***, Wiley India, 1st edition, 2014.

Reference Books:

1. George Reese, ***"Cloud Application Architectures"***, O'Reilly Media, 1st edition, 2009.
2. Barrie Sosinsky,***"Cloud Computing Bible"***, Wiley India, 2nd edition, 2011.

Course Title : DevOps with Docker and Kubernetes | **Semester : VIII**

Prerequisite : Infrastructure as Code | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801H | **Credits : 2**

Course Type : PEC

Course Objectives:

1. Master containerization to ensure applications run identically across development, testing, and production.
2. Learn to build high-performance, secure, and lightweight container images using industry best practices.
3. Understand the architecture and necessity of Kubernetes for managing large-scale distributed systems.
4. Configure automated health checks, restarts, and scaling to ensure high availability of services.
5. Connect containerized workflows with CI/CD pipelines for seamless ”Code-to-Cloud” automation.

Course Outcomes:

After learning the course, the students will be able to:

1. Build multi-stage Dockerfiles that package complex applications with all necessary dependencies.
2. Utilize Docker Compose to orchestrate multi-container applications including databases and networking.
3. Design and apply YAML manifests for Pods, Deployments, and Services to manage application workloads.
4. Implement rolling updates and canary deployments to update software without interrupting users.
5. Manage sensitive data and persistent application state within a dynamic, ephemeral container environment.

Course Contents:

UNIT I

Containerization with Docker : **[06 Hours]**

Virtual Machines vs. Containers. Docker Architecture: Client-Server, Images, and Containers. Docker CLI essentials. Writing high-quality **Dockerfiles**: Layer caching, multi-stage builds, and base image selection.

UNIT II

Docker Networking & Storage : **[05 Hours]**

Persistent Data: Volumes vs. Bind Mounts. Docker Networking: Bridge, Host, and None drivers. Building multi-container applications with **Docker Compose**: Service definitions, dependencies, and environment variables.

UNIT III

Introduction to Kubernetes (K8s) : **[06 Hours]**

The need for Orchestration. Kubernetes Architecture: Control Plane (API Server, etcd, Scheduler) vs. Worker Nodes (Kubelet, Kube-proxy). Core Objects: **Pods, Nodes,** and **Namespaces**. Introduction to kubectl.

UNIT IV

Workload Management & Networking : **[07 Hours]**

Deployments: Scaling applications and managing replicas. **Services**: ClusterIP, NodePort, and LoadBalancer for internal/external communication. Configuration management using **ConfigMaps** and **Secrets**.

UNIT V

Advanced Orchestration & CI/CD : **[06 Hours]**

Self-healing: Liveness and Readiness probes. Deployment strategies: Rolling Updates vs. Blue-Green. Horizontal Pod Autoscaler (HPA). Integrating Docker and K8s into a complete CI/CD pipeline (from code commit to running cluster).

Text Books:

1. Nigel Poulton, ***"The Docker Book: Containerization is the new virtualization"***, James Turnbull, ISBN: 9781984772718, 1st edition, 2023.
2. Brendan Burns, Joe Beda, Kelsey Hightower and Lachlan Evenson, ***"Kubernetes: Up & Running: Dive into the Future of Infrastructure"***, O'Reilly Media, ISBN: 9781098110208, 3rd edition, 2022.
3. Benjamin Muschko, ***"Certified Kubernetes Application Developer (CKAD) Study Guide"***, O'Reilly Media, ISBN: 9781492083733, 2nd edition, 2022.

Reference Books:

1. John Arundel and Justin Domingus, ***"Cloud Native DevOps with Kubernetes: Building, Deploying, and Scaling Modern Applications in the Cloud"***, O'Reilly Media, ISBN: 9781492040767, 2nd edition, 2022.
2. James Turnbull, ***"The Docker Book"***, Turnbull Press, ISBN: 9780988820258, 3rd edition, 2021.
3. Gigi Sayfan, ***"Mastering Kubernetes: Level up your container orchestration skills with Kubernetes to build and manage high-performance applications"***, Packt Publishing, ISBN: 9781803248677, 4th edition, 2022.

Course Title : Quantum Hardware and Error Correction | **Semester : VIII**

Prerequisite : Introduction to Quantum Computing | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801I | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand the fundamentals of quantum computing hardware and qubit technologies.
2. To study different quantum hardware architectures and their operational principles.
3. To analyze quantum noise, decoherence, and error mechanisms in quantum systems.
4. To explore quantum error correction codes and fault-tolerant quantum computation techniques.
5. To evaluate recent advancements, challenges, and future directions in scalable quantum hardware systems.

Course Outcomes:

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

1. Explain the principles and architectures of quantum computing hardware platforms.
2. Analyze the performance and limitations of various qubit technologies and quantum devices.
3. Identify sources of quantum errors and evaluate noise mitigation techniques.
4. Apply quantum error correction methods for reliable quantum computation.
5. Assess emerging trends and research developments in fault-tolerant quantum computing systems.

Course Contents:

UNIT I

Fundamentals of Quantum Computing Hardware : **[05 Hours]**

Introduction to Quantum Computing, Qubits and Quantum States, Quantum Gates and Circuits, Superposition and Entanglement, Quantum Measurement, Physical Realization of Qubits, Quantum Computing Architectures, Classical vs Quantum Hardware, Quantum Coherence and Decoherence, Challenges in Quantum Hardware Development.

UNIT II

Quantum Hardware Technologies : **[06 Hours]**

Superconducting Qubits, Trapped Ion Quantum Computers, Photonic Quantum Computing, Spin Qubits, Neutral Atom Quantum Computing, Topological Quantum Computing, Quantum Processors and Control Systems, Cryogenic Systems, Quantum Interconnects, Comparative Analysis of Quantum Hardware Platforms.

UNIT III

Quantum Noise and Error Mechanisms : **[06 Hours]**

Sources of Quantum Errors, Bit Flip and Phase Flip Errors, Quantum Noise Models, Decoherence Effects, Error Rates and Fidelity, Quantum Channel Models, Measurement Errors, Noise Characterization Techniques, Quantum Error Mitigation, Fault Tolerance Concepts.

UNIT IV

Quantum Error Correction Techniques : **[05 Hours]**

Introduction to Quantum Error Correction, Classical vs Quantum Error Correction, Quantum Redundancy Principles, Shor Code, Steane Code, Surface Codes, Stabilizer Codes, Syndrome Measurement, Fault-Tolerant Quantum Computation, Error Correction in NISQ Devices.

UNIT V

Advanced Topics and Future Directions : **[05 Hours]**

Scalable Quantum Hardware, Quantum Hardware Optimization, Distributed Quantum Computing, Quantum Hardware Benchmarking, Advances in Fault-Tolerant Quantum Computing, Quantum Hardware Security, Applications of Error-Corrected Quantum Systems, Industry Case Studies, Research Trends in Quantum Hardware, Mini Project and Practical Implementation.

Text Books:

1. Michael A. Nielsen, Isaac L. Chuang, ***"Quantum Computation and Quantum Information"***, Cambridge University Press.
2. Daniel A. Lidar, Todd A. Brun, ***"Quantum Error Correction"***, Cambridge University Press.

Reference Books:

1. Lev S. Bishop, ***"Engineering the Quantum"***, O'Reilly Media.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, ***"An Introduction to Quantum Computing"***, Oxford University Press.

Course Title : Advanced HCI & Emerging Interfaces | **Semester : VIII**

Prerequisite : HCI Basics, UI Design | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801J | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To understand advanced concepts and evolution of Human-Computer Interaction.
2. To explore modern interaction techniques and emerging interface technologies.
3. To develop skills in designing and prototyping interactive systems.
4. To learn evaluation methods for usability and user experience.
5. To analyze ethical, social, and future implications of advanced HCI systems.

Course Outcomes:

After learning the course, the students should be able to:

1. Explain advanced HCI concepts, interaction paradigms, and design principles.
2. Design and prototype user interfaces using modern tools and techniques.
3. Apply emerging technologies such as AR/VR, IoT, and multimodal interfaces in HCI solutions.
4. Evaluate interactive systems using usability and UX evaluation methods.
5. Assess ethical, social, and privacy concerns related to emerging interfaces.

Course Contents:

UNIT I

Introduction to Advanced HCI **[06 Hours]**

Introduction to HCI evolution – From GUI to Post-WIMP interfaces, Human factors in interaction design: cognition, perception, memory, Advanced interaction paradigms: ubiquitous computing, context-aware systems, User-centered design vs experience-centered design, Design thinking in HCI, Case studies of modern interactive systems.

UNIT II

Interaction Design & Prototyping **[08 Hours]**

Advanced prototyping techniques: low-fidelity and high-fidelity prototypes, Interaction styles: gesture-based, voice-based, multi-modal interfaces, Design principles and guidelines for advanced interfaces, Usability principles for emerging systems, Tools for UI/UX design and rapid prototyping, Wireframing and interactive design workflows.

UNIT III

Emerging Interaction Technologies **[06 Hours]**

Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), Natural User Interfaces (NUI), Brain-Computer Interfaces (BCI) basics, Wearable computing and smart devices, Internet of Things (IoT) and HCI integration, Case studies of emerging technologies.

UNIT IV

Evaluation Techniques for Advanced Interfaces **[06 Hours]**

Usability evaluation methods: heuristic evaluation and cognitive walkthrough, User experience (UX) metrics and analytics, Experimental design in HCI research, Accessibility and inclusive design evaluation, Performance evaluation of interactive systems, User feedback and testing methods.

UNIT V

Future Trends & Ethical Issues in HCI **[04 Hours]**

AI-driven interfaces and adaptive systems, Conversational interfaces and chatbots, Affective computing and emotion-aware systems, Ethical, social, and privacy issues in HCI, Future trends: human-AI collaboration, metaverse and immersive interfaces.

Text Books:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, ***"Designing the User Interface: Strategies for Effective Human-Computer Interaction"***, Pearson Education.
2. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ***"Human-Computer Interaction"***, Pearson Education.
3. David Benyon, ***"Designing User Experience: A Guide to HCI, UX and Interaction Design"***, Pearson Education.

Reference Books:

1. Donald A. Norman, ***"The Design of Everyday Things"***, Basic Books.
2. Alan Cooper, Robert Reimann, David Cronin, ***"About Face: The Essentials of Interaction Design"***, Wiley.
3. Jeff Johnson, ***"Designing with the Mind in Mind"***, Morgan Kaufmann.
4. Bill Buxton, ***"Sketching User Experiences"***, Morgan Kaufmann.
5. Steve Krug, ***"Don't Make Me Think"***, New Riders.

Course Title : Software Design & Architecture | **Semester : VIII**

Prerequisite : Software Engineering | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801K | **Credits : 2**

Course Type : PEC

Course Objectives:

After completing this course, students will be able :

1. To understand software design principles and methodologies.
2. To apply architectural styles and design patterns.
3. To model software systems using UML diagrams.
4. To evaluate and improve software architecture quality.
5. To design scalable systems using modern architectural approaches (microservices, cloud).

Course Outcomes:

After learning the course, the students should be able :

1. To apply software design principles.
2. To model systems using UML.
3. To design software architecture.
4. To use design patterns for reusability.
5. To evaluate and optimize modern architectures.

Course Contents:

UNIT I

Software Design Fundamentals **[06 Hours]**

Design concepts: abstraction, refinement, modularity, Software design process, Design principles: SOLID principles, Separation of concerns, Coupling & cohesion, Function-oriented vs Object-oriented design, Structured design (DFD, structure charts), UML diagrams (Use case diagram, Class diagram).

UNIT II

Object-Oriented Design & UML Modeling **[06 Hours]**

Object-oriented design concepts: Classes, objects, inheritance, polymorphism, UML diagrams: Sequence diagram, Activity diagram, State diagram, Component diagram, CRC cards (Class-Responsibility-Collaboration), Design class identification and relationships, Package design.

UNIT III

Software Architecture & Architectural Styles **[06 Hours]**

Introduction to software architecture, Architectural views (logical, process, deployment), Architectural styles: Layered architecture, Client-server architecture, MVC architecture, Pipe-and-filter, Event-driven architecture. Architectural patterns: Microservices architecture, Service-Oriented Architecture (SOA), Architecture documentation.

UNIT IV

Design Patterns & Reusability **[06 Hours]**

Introduction to design patterns, Creational patterns: Singleton, Factory Method, Abstract Factory. Structural patterns: Adapter, Decorator, Facade. Behavioral patterns: Observer, Strategy, Command, Pattern selection and application, Frameworks and reuse.

UNIT V

Architecture Evaluation & Modern Trends **[06 Hours]**

Detailed Syllabus: Software architecture evaluation methods: ATAM (Architecture Tradeoff Analysis Method), Quality attributes:

Performance, Scalability, Security, Maintainability, Refactoring and technical debt, Cloud architecture basics, DevOps and continuous architecture, Containerization.

Text Books:

1. Erich Gamma et al., ***"Design Patterns: Elements of Reusable Object-Oriented Software".***
2. Len Bass, ***"Software Architecture in Practice".***
3. Roger S. Pressman, ***"Software Engineering: A Practitioner's Approach".***

Reference Books:

1. Martin Fowler,***"Patterns of Enterprise Application Architecture".***
2. Robert C. Martin, ***"Clean Architecture"***
3. Grady Booch, ***"Object-Oriented Analysis and Design with Applications".***
4. Ian Sommerville, ***"Software Engineering".***
5. Frank Buschmann, ***"Pattern-Oriented Software Architecture".***

Course Title : Network Programming | **Semester : VIII**

Prerequisite : Computer Networks | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801L | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To introduce the fundamental concepts of computer networks and network programming techniques.
2. To develop an understanding of socket programming, communication protocols, and client-server architecture.
3. To provide knowledge of network application development using TCP/IP and UDP protocols.
4. To explain concurrent programming, distributed communication, and security aspects in network applications.
5. To study advanced network programming concepts and modern Internet-based application development techniques.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain networking fundamentals, communication models, and network programming concepts.
2. Develop client-server applications using socket programming and standard network protocols.
3. Apply TCP/IP and UDP programming techniques for reliable and connectionless communication.
4. Analyze concurrent and distributed network applications with appropriate synchronization and security mechanisms.
5. Understand advanced concepts in network programming including web services, remote communication, and modern network application frameworks.

Course Contents:

UNIT I

Introduction to Network Programming : **[06 Hours]**

Basics of computer networks, OSI and TCP/IP reference models, Network protocols and services, IP addressing and port addressing, Client-server architecture, Peer-to-peer communication, Introduction to network programming, Socket concept and types, Connection-oriented and connectionless communication, Overview of network programming environments and tools.

UNIT II

Socket Programming using TCP/IP : **[06 Hours]**

TCP/IP protocol suite, Stream sockets and datagram sockets, TCP socket programming concepts, Client-server communication using TCP, Socket APIs, Connection establishment and termination, Concurrent server design using threads/processes, Error handling in socket programming, File transfer applications, Chat server and client applications.

UNIT III

UDP and Advanced Communication Techniques : **[06 Hours]**

UDP protocol fundamentals, Datagram socket programming, Broadcasting and multicasting concepts, Remote Procedure Calls (RPC), Inter-process communication techniques, Network byte order and data representation, Domain Name System (DNS) programming basics, Email protocols and applications, Introduction to HTTP and web-based communication.

UNIT IV

Distributed and Secure Network Programming : **[06 Hours]**

Distributed application architecture, Multi-threaded network applications, Synchronization issues in distributed systems, Secure socket programming using SSL/TLS, Authentication and authorization mechanisms, Encryption basics in network communication, Firewall and proxy concepts, Network security issues and protection mechanisms, Performance optimization in network applications.

UNIT V

Emerging Trends in Network Programming : **[06 Hours]**

Web services and RESTful APIs, Service-Oriented Architecture (SOA), Cloud-based network applications, Mobile and wireless network programming, Internet of Things (IoT) communication protocols, Software Defined Networking (SDN), Network virtualization concepts, Real-time communication applications, Future trends in network and Internet programming technologies.

Text Books:

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff,***"UNIX Network Programming"***, Pearson Education, 3rd edition, 2003.
2. Douglas E. Comer, David L. Stevens,***"Internetworking with TCP/IP Volume III: Client-Server Programming and Applications"***, Pearson Education, latest edition.
3. Forouzan,***"TCP/IP Protocol Suite"***, McGraw Hill Education, 4th edition, 2010.

Reference Books:

1. Kenneth L. Calvert, Michael J. Donahoo,***"TCP/IP Sockets in C: Practical Guide for Programmers"*** Morgan Kaufmann, 2nd edition, 2008.
2. Charles R. Severance,***"Python Network Programming"***, Wiley India, latest edition.

Course Title : Advanced Financial Analytics | **Semester : VIII**

Prerequisite : Probability Theory | **L–T–P : 2-0-0**

Course Code : 26UD1246PEC801M | **Credits : 2**

Course Type : PEC

Course Objectives:

1. To provide students with a strong foundation in statistical analysis, financial data handling, and programming using R for financial analytics applications.
2. To develop analytical skills in time-series modelling, forecasting, and portfolio optimization techniques used in financial decision-making.
3. To introduce regression-based financial models, volatility modelling, and risk analytics techniques for evaluating financial markets and assets.
4. To enable students to apply advanced econometric techniques such as panel data regression, quantile regression, and Markov regime switching models in finance.
5. To develop practical skills in visualization, interpretation, and implementation of financial analytics models using R programming and GGPLOT tools.

Course Outcomes:

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

1. Apply R programming techniques for data visualization, statistical inference, hypothesis testing, and financial data analysis.
2. Build and evaluate time-series forecasting models including ARIMA, VECM, and cointegration models for financial applications.
3. Analyze portfolio performance, implement asset pricing models, and apply regression techniques to financial datasets using R.
4. Perform financial risk analysis using ARCH/GARCH, VaR/CVaR, logistic regression, and classification techniques.
5. Implement advanced econometric and visualization techniques including panel regression, quantile regression, Markov regime switching, and GGPLOT-based financial data visualization.

Course Contents:

UNIT I

Fundamentals of R Programming and Introduction to Business Statistics: **[05 Hours]**

Data Visualization and Wrangling, working with data frames, processing large data, Statistical Inference, Hypothesis Testing, and Confidence Intervals, Application with R,Time-Series Analytics: Introduction to Stationarity, ARMA/ARIMA Modelling, ACF/PACF, Model Building and Goodness-of-Fit, Modelling Non-stationary process, Cointegration and VECM Models, Time-series forecasting, Implementation in R

UNIT II

Portfolio Analytics: **[07 Hours]**

Portfolio Optimization with two securities and multiple securities, Construction of efficient frontier and market portfolio, Portfolio performance evaluation and construction of market portfolio, Asset Pricing Models, Implementation in R

Application of Regression: Introduction to regression modelling, Simple and Multiple Linear Regression, Assumptions of classical linear regression model and its violations, issues of heteroscedasticity, multicollinearity, autocorrelation, Application with asset pricing models, and implementation with R

UNIT III

Risk Analytics: **[05 Hours]**

Introduction to Volatility Modelling, Historical volatility models, ARCH/GARCH Models, VaR/CvaR models, Implementation in R Logistic Regression: Linear probability models, Logit Model and Probit Models, ROC curve, classification matrix, Maximum Likelihood Estimation, Finance Use case and implementation in R

UNIT IV

Panel Data Regression: **[05 Hours]**

Introduction to Panel Models, Fixed effects, Random effects, First difference, LSDV estimators, Hausman test statistics, Finance Use case and implementation in R Quantile Regression: Introduction to quantile regression, regression quantiles, optimization scheme with quantile regression, theoretical underpinnings, Finance use case with R implementation

UNIT V

Markov Regime Switching Regression: **[05 Hours]**

Introduction to Markov Process, Transient and Recurrent processes, absorption probabilities, Convergence, Finance use case and implementation in R, Financial Markets Data Visualization with GGPLOT: Basics of GGPLOT, Layering, Facet wrap, aesthetics, geometric objects, Use case with R implementation

Text Books:

1. Chris Brooks, ***"Introductory Econometrics for Finance"***, Cambridge University Press.
2. Hadley Wickham, Garrett Grolemund, ***"R for Data Science"***, O'Reilly Media.

Reference Books:

1. Ruey S. Tsay, ***"Analysis of Financial Time Series"***, Wiley.
2. Walter Enders, ***"Applied Econometric Time Series"***, Wiley India / John Wiley & Sons.

Course Title : Research Methodology | **Semester : VIII**

Prerequisite : Basic Statistics | **L–T–P : 3-1-0**

Course Code : 26UD1246RM802 | **Credits : 4**

Course Type : RM

Course Objectives:

1. To understand basic concepts, types, and significance of research.
2. To learn the research process and problem formulation techniques.
3. To develop skills in hypothesis formulation and research design.
4. To apply mathematical modelling and simulation in research.
5. To acquire knowledge of data interpretation and report writing.

Course Outcomes:

After learning the course, the students should be able to:

1. Explain fundamental research concepts and different types of research.
2. Apply appropriate research methodologies for problem solving.
3. Formulate research problems and develop hypotheses.
4. Use modelling and simulation techniques in research analysis.
5. Interpret data and prepare structured research reports.

Course Contents:

UNIT I

Introduction to Research Concepts and Types of Research: **[08 Hours]**

Research Concepts, meaning, objectives, motivation, Types of research –descriptive research, conceptual research, theoretical research, applied research, experimental research.

UNIT II

Research Process and Problem Formulation: **[08 Hours]**

Research process, Criteria for good research, Problems in Indian context, Formulation of Research Task, Literature Review – Importance & Methods – Sources,Quantification of Cause Effect Relations – Discussions– Field Study, Critical Analysis of Facts Generated.

UNIT III

Hypothesis Development and Research Task Selection : **[08 Hours]**

Hypothetical proposals for future development and testing- meaning-types and formulation of hypothesis,identification of research gaps,selection and feasibility analysis of research tasks,research objectives and proposal development.

UNIT IV

Mathematical Modelling and Simulation Techniques: **[08 Hours]**

Mathematical modelling and simulation , Concepts of modelling , Classification of mathematical models , Modelling with – Ordinary differential equations , Difference equations , Partial differential equations , Graphs , Simulation , Process of formulation of model based on simulation.

UNIT V

Interpretation of Data and Research Report Writing: **[08 Hours]**

Interpretation and report writing ,Techniques of interpretation , Precautions in interpretation , Significance of report writing , Different steps in report writing , Layout of research report , Mechanics of writing research report , Layout and format , Style of writing , Typing ,References, Tables, Figures , Conclusion , Appendices.

Text Books:

1. J.W Bames, ***"Statistical Analysis for Engineers and Scientists"***, McGraw Hill, N.York.
2. Schank Fr., ***"Theories of Engineering Experiments"***, Tata Mc Graw Hill Publication.
3. C. R. Kothari, ***"Research Methodology"***, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, ***"Formulation of Hypothesis"***, Himalaya Publication.

Reference Books:

1. Ranjit Kumar, ***"Research Methodology: A Step-by-Step Guide for Beginners"***, SAGE Publications.
2. John W. Creswell, ***"Research Design: Qualitative, Quantitative, and Mixed Methods Approaches"***, SAGE Publications.
3. William M. K. Trochim, ***"The Research Methods Knowledge Base"***, Atomic Dog Publishing.
4. Uwe Flick, ***"An Introduction to Research Methodology"***, SAGE Publications.

Course Title : Internship/ Major Project | **Semester : VIII**

Prerequisite : Web Technology,Community Project, OOP with Java, Advanced Web Technology, Python, Mobile Application Development | **L–T–P : 0-0-24**

Course Code : 26UD1246ITRNP803 | **Credits : 12**

Course Type : Project/Training

Objectives of Internship :

1. Project/ Internship provides students with flexibility to pursue one of the following academic pathways:

Course Outcomes:
After completion , students will be able to:

1. Develop complete software systems using appropriate technologies.
2. Apply industrial practices during internship/project execution.
3. Perform testing, validation, and performance evaluation.
4. Prepare comprehensive technical documentation and reports.
5. Demonstrate project outcomes through presentation, demonstration, and viva voce.

Contents

Option I – Extension of Project developed in VII semester

Students may extend the Semester VII project by implementing 5–6 substantial new features/modules, such as

- AI integration
- Security enhancement
- Cloud deployment
- Mobile application
- Analytics Dashboard
- Performance optimization
- IoT integration
- Blockchain
- Zero Trust implementation
- Quantum-safe security enhancement

The new work should represent a significant technical contribution beyond Project .

Option II – Research Paper

Students may prepare and submit a research paper based on the work carried out in Project developed in VII.
The paper should include

- Literature survey
- Methodology
- Experimental evaluation
- Comparative analysis
- Results
- References

Preference should be given to publication in IEEE, Springer, Elsevier, ACM, Scopus, or UGC CARE-indexed venues.

Option III – New Major Project

Students may undertake an entirely new project based on

- Industrial problem
- Research problem
- Start-up idea
- Societal problem
- Emerging technology

Option IV – Internship

Students may complete an industry internship involving

- Software Development
- Cyber Security
- AI/ML
- Cloud Computing
- Data Analytics
- Mobile Application Development
- Full Stack Development
- DevOps
- IT Infrastructure
- Information Security

The internship should culminate in an internship report, presentation, and evaluation.

Revised Deliverables

Depending upon the selected option, students shall submit

Project Extension :

- Enhanced Software
- Source Code
- Documentation
- Performance Evaluation
- Demonstration

OR

Research Paper :

- Manuscript
- Plagiarism Report
- Submission Proof (if applicable)
- Presentation

OR

New Project :

- Complete Project Report
- Software
- Documentation
- Presentation

OR

Internship :

- Internship Certificate
- Daily Logbook
- Technical Report
- Mentor Evaluation
- PPT
- Viva

General Guidelines

Students may opt for any one of the following:

1. Extension of Major Project developed in VII semester by implementing 5–6 additional features/modules.
2. Preparation and submission of a research paper based on Project Phase I.
3. Development of a new major project on a different problem statement.
4. Completion of an industry internship approved by the department.

The selected option shall be approved by the faculty guide and the Head of the Department. The work must demonstrate originality, measurable technical contribution, and professional standards.

Evaluation Scheme (Internship/Major Project)		
Total Marks: 150		
Sr. No.	**Evaluation Component**	**Marks**
1	Continuous Progress Reviews (Guide Assessment)	20
2	Project Implementation / Internship Performance	35
3	Innovation, Technical Contribution & Problem Solving	20
4	Testing, Validation & Performance Evaluation	15
5	Documentation (Final Report / Research Paper / Internship Report)	20
6	Software Demonstration / Internship Outcome	15
7	Presentation	10
8	Viva-Voce (Internal & External)	15
Total		**150**

Multidisciplinary Minor [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme – Hours per week				Examination Scheme - Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR/ OR	
Any One													
1	Cyber Forensics and Incident Response	26UD1246MD806A	MD-M	**2**	**0**	**0**	**2**	**20**	**20**	**60**	**-**	**-**	**100**
2	Social Media Analytics	26UD1246MD806B											
3	Spectral Signature Analysis & Classification	26UD1246MD806C											
4	IoT Protocols and Architecture	26UD1246MD806D											
5	Applied Accelerated Artificial Intelligence	26UD1246MD806E											
6	Enterprise Blockchain and Implementation	26UD1246MD806F											
7	Cloud Application and Development	26UD1246MD806G											
8	DevOps with Docker and Kubernetes	26UD1246MD806H											
9	Quantum Hardware and Error Correction	26UD1246MD806I											
10	Advanced HCI & Emerging Interfaces	26UD1246MD806J											
11	Software Design and Architecture	26UD1246MD806K											
12	Network Programming	26UD1246MD806L											
13	Advanced Financial Analytics	26UD1246MD806M											

*** Please choose any one course from the Multidisciplinary Minor options listed above.**

B. Tech. IT (Honors) [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Edge and Fog Computing	26UD1246HR801											
2	Smart Agriculture using IoT	26UD1246HR802	Honors	03	00	00	03	20	20	60	-	-	100
3	AI for Cybersecurity	26UD1246HR803											

Course Title : Edge and Fog Computing | **Semester : VIII**

Course Code : 26UD1246HR801 | **L–T–P : 3-0-0**

Prerequisite : Computer Networks, Cloud Computing | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand concepts and architecture of Edge and Fog Computing.
2. To learn data processing and resource management at the edge.
3. To explore communication models and protocols for edge environments.
4. To analyze security and privacy issues in edge and fog systems.
5. To study real-world applications of edge and fog computing.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain Edge and Fog computing concepts and architectures.
2. To apply data processing and resource management techniques at the edge.
3. To analyze communication protocols and system performance.
4. To evaluate security and privacy challenges in distributed environments.
5. To implement edge and fog solutions for real-world applications.

Course Contents:

UNIT I

Introduction to Edge and Fog Computing: **[08 Hours]**

Cloud computing limitations, Need for edge and fog computing, Definitions and characteristics, Edge vs Fog vs Cloud computing, Architecture and components, Role in IoT ecosystems.

Case Study: Smart city architecture using edge and fog computing.

UNIT II

Edge and Fog Architecture & Technologies: **[08 Hours]**

Fog computing architecture (layers and nodes), Edge devices and gateways, Virtualization and containerization (Docker), Microservices architecture, Resource-constrained devices.

Case Study: IoT-based smart home system using edge devices.

UNIT III

Data Processing and Resource Management: **[08 Hours]**

Data processing at the edge, Stream processing and real-time analytics, Task scheduling and load balancing, Resource allocation strategies, Latency optimization techniques.

Case Studies: Real-time traffic monitoring using edge analytics, Industrial IoT (IIoT) predictive maintenance.

UNIT IV

Communication, Security and Privacy: **[08 Hours]**

Communication protocols (MQTT, CoAP, HTTP), Data security and encryption, Privacy issues in distributed systems, Trust management, Fault tolerance and reliability.

Case Studies: Secure data transmission in healthcare IoT systems. Privacy-preserving edge computing in smart surveillance.

UNIT V

Applications and Future Trends: **[08 Hours]**

Applications in smart cities, healthcare, agriculture, autonomous vehicles, Integration with AI and 5G, Challenges and future research directions.

Case Studies: Autonomous vehicle data processing using edge computing. Smart agriculture using IoT and fog computing.

Text Books:

1. Rajkumar Buyya, Satish Narayana Srirama, ***"Fog and Edge Computing: Principles and Paradigms"***, Wiley.
2. Dan C. Marinescu, ***"Edge Computing: A Primer"***, Springer.
3. Thomas Erl, ***"Cloud Computing: Concepts, Technology & Architecture"***, Prentice Hall.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, ***"Internet of Things: A Hands-On Approach"***,Universities Press.
2. George Coulouris et al., ***"Distributed Systems: Concepts and Design"***, Pearson.
3. Maciej Kranz, ***"Building the Internet of Things"***, Wiley.
4. Martin Kleppmann, ***"Designing Data-Intensive Applications"***, O'Reilly.
5. Fei Hu, ***"Security and Privacy in Internet of Things (IoTs)"***, CRC Press.

Course Title : Smart Agriculture using IoT | **Semester : VIII**

Course Code : 26UD1246HR802 | **L–T–P : 3-0-0**

Prerequisite : Computer Networks, IoT Basics | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand the role of IoT in modern agriculture.
2. To learn sensor technologies and data acquisition in farming.
3. To explore data analytics and decision-making for agriculture.
4. To study IoT-based system design for smart farming.
5. To analyze real-world applications of smart agriculture.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain IoT concepts and their application in agriculture.
2. To apply sensor-based data collection and monitoring techniques.
3. To analyze agricultural data using IoT and analytics tools.
4. To design smart agriculture systems for real-world problems.
5. To evaluate IoT-based solutions for improving agricultural productivity.

Course Contents:

UNIT I

Introduction to Smart Agriculture and IoT: **[08 Hours]**

Traditional vs smart agriculture, Role of IoT in agriculture, Components of IoT systems: sensors, actuators, gateways, cloud, Overview of smart farming technologies, Benefits and challenges.

Case Study: Smart farming systems for improving crop productivity.

UNIT II

Sensors and Data Acquisition in Agriculture: **[08 Hours]**

Types of sensors: soil moisture, temperature, humidity, pH, light sensors, Data acquisition systems, Wireless sensor networks (WSN), Data transmission techniques, Integration with IoT platforms.

Case Study: Soil moisture monitoring system for irrigation control.

UNIT III

Data Analytics and Decision Support: **[08 Hours]**

Data collection and storage, Cloud-based data processing, Data analytics techniques, Machine learning for crop prediction, Decision support systems for farmers, Visualization tools.

Case Studies: Crop yield prediction using IoT data, Weather-based irrigation decision system.

UNIT IV

IoT System Design for Smart Agriculture: **[08 Hours]**

Architecture of smart agriculture systems, Automation in irrigation and fertilization, Precision farming techniques, Integration with mobile applications, Security and privacy in IoT systems.

Case Studies: Automated irrigation system using IoT, Smart greenhouse monitoring and control.

UNIT V

Applications and Future Trends: **[08 Hours]**

Applications: crop monitoring, livestock management, greenhouse farming, supply chain management, Integration with AI, drones,

and remote sensing, Challenges and future scope.
Case Studies: Drone-based crop monitoring system, Livestock tracking and health monitoring using IoT.

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, ***"Internet of Things: A Hands-On Approach"***, Universities Press.
2. Various Authors, ***"Smart Agriculture: An Approach Towards Better Agriculture Management"***, Springer.
3. Qin Zhang, ***"Precision Agriculture Technology for Crop Farming"***, CRC Press.

Reference Books:

1. Maciej Kranz, ***"Building the Internet of Things"***, Wiley.
2. Hwaiyu Geng, ***"Internet of Things and Data Analytics Handbook"***, Wiley.
3. Thomas Erl, ***"Cloud Computing: Concepts, Technology & Architecture"***, Pearson.
4. Various Authors, ***"Data Science for Agriculture"***, Academic Press.
5. David Hanes et al., ***"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases"***, Cisco Press.

Course Title : AI for Cybersecurity | **Semester : VIII**

Course Code : 26UD1246HR803 | **L–T–P : 3-0-0**

Prerequisite : Computer Networks, Cybersecurity Basics | **Credits : 3**

Course Type : Honors

Course Objectives:

1. To understand the fundamentals of cybersecurity and AI integration.
2. To learn machine learning techniques for threat detection and prevention.
3. To explore AI-based security analytics and anomaly detection methods.
4. To study applications of AI in network and system security.
5. To analyze challenges and ethical issues in AI-driven cybersecurity.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain cybersecurity concepts and AI-based security approaches.
2. To apply machine learning algorithms for threat detection.
3. To analyze security data for anomaly detection and intrusion prevention.
4. To evaluate AI-based security tools and techniques.
5. To assess ethical, legal, and privacy issues in AI-driven cybersecurity.

Course Contents:

UNIT I

Introduction to Cybersecurity and AI: **[08 Hours]**

Basics of cybersecurity: threats, vulnerabilities, attacks, Introduction to Artificial Intelligence and Machine Learning, Role of AI in cybersecurity, Traditional vs AI-based security approaches.

Case Study: AI-based malware detection in enterprise systems.

UNIT II

Machine Learning for Cybersecurity: **[08 Hours]**

Supervised and unsupervised learning, Classification algorithms (SVM, Decision Trees), Clustering techniques, Feature selection and extraction, Model training and evaluation.

Case Study: Phishing detection using machine learning models.

UNIT III

Anomaly Detection and Intrusion Detection Systems: **[08 Hours]**

Anomaly detection techniques, Signature-based vs anomaly-based IDS, Network intrusion detection systems (NIDS), Host-based intrusion detection systems (HIDS), Deep learning approaches for intrusion detection.

Case Studies: Network intrusion detection using anomaly detection, Detection of insider threats in organizations.

UNIT IV

AI in Network and System Security: **[08 Hours]**

AI for malware analysis, Spam and fraud detection, Behavioral analysis of users, Threat intelligence and security analytics, Automated response systems.

Case Studies: Credit card fraud detection using AI, Spam filtering and email security.

UNIT V

Advanced Topics and Challenges: **[08 Hours]**

Adversarial machine learning, AI model security and attacks, Privacy-preserving AI, Ethical and legal issues, Future trends in AI

for cybersecurity.
Case Studies: Adversarial attacks on AI-based security systems, Privacy-preserving techniques in cybersecurity.

Text Books:

1. Clarence Chio and David Freeman, ***"Machine Learning and Security: Protecting Systems with Data and Algorithms"***, O'Reilly.

2. Various Authors, ***"Artificial Intelligence for Cybersecurity"***, Springer.

3. Soma Halder and Sinan Ozdemir, ***"Hands-On Machine Learning for Cybersecurity"***, Packt.

Reference Books:

1. William Stallings, ***"Network Security Essentials"***, Pearson.

2. Christopher Bishop, ***"Pattern Recognition and Machine Learning"***, Springer.

3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, ***"Deep Learning"***, MIT Press.

4. P.W. Singer, ***"Cybersecurity and Cyberwar: What Everyone Needs to Know"***, Oxford.

5. Jiawei Han, Micheline Kamber, ***"Data Mining: Concepts and Techniques"***, Morgan Kaufmann.

B. Tech. IT (By Research) [Semester VIII]

Sr. No	Course Title	Course Code	Course Type	Teaching Scheme Hours per week				Examination Scheme Marks					Total Marks
				L	T	P	CR	CA	MSE	ESE	TW	PR / OR	
	Any One												
1	Meta-analysis	26UD1246RS801	Research	03	00	00	03	20	20	60	-	-	100
2	Research Methodology in Health Sciences	26UD1246RS802											

Course Title : Meta-Analysis | **Semester : VIII**

Course Code : 26UD1246RS801 | **L–T–P : 3-0-0**

Prerequisite : Research Methodology, Basic Statistics | **Credits : 3**

Course Type : Research

Course Objectives:

1. To understand the principles and importance of meta-analysis in research.
2. To learn techniques for systematic review and data synthesis.
3. To explore statistical methods used in meta-analysis.
4. To analyze heterogeneity and bias in research studies.
5. To apply meta-analysis tools for evidence-based research.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain concepts and methodologies of meta-analysis.
2. To conduct systematic literature reviews and data extraction.
3. To apply statistical techniques for combining study results.
4. To evaluate heterogeneity, bias, and validity of findings.
5. To interpret and report meta-analysis results effectively.

Course Contents:

UNIT I

Introduction to Meta-Analysis and Systematic Review: **[08 Hours]**

Definition and importance of meta-analysis, Systematic review vs narrative review, Steps in meta-analysis, Research question formulation (PICO framework), Protocol development.

Case Study: Overview of a published meta-analysis study in healthcare or social sciences.

UNIT II

Literature Search and Data Extraction: **[08 Hours]**

Search strategies and databases, Inclusion and exclusion criteria, Screening and selection of studies, Data extraction techniques, Coding of study characteristics.

Case Study: Systematic literature review and data extraction for a selected research problem.

UNIT III

Statistical Methods in Meta-Analysis: **[08 Hours]**

Effect size measures (mean difference, odds ratio, risk ratio), Fixed-effect and random-effects models, Weighting of studies, Forest plots, Software tools (R, RevMan).

Case Studies: Calculation of effect size from sample datasets, Forest plot interpretation for combined study results.

UNIT IV

Heterogeneity and Bias Analysis: **[08 Hours]**

Assessment of heterogeneity (Q test, I^2 statistic), Subgroup analysis and meta-regression, Publication bias, Funnel plots, Sensitivity analysis.

Case Studies: Detection of heterogeneity in combined studies, Analysis of publication bias using funnel plots.

UNIT V

Reporting and Applications of Meta-Analysis: **[08 Hours]**

Interpretation of results, Reporting guidelines (PRISMA), Writing meta-analysis reports, Applications in healthcare, social sciences,

engineering, Ethical considerations.
Case Studies: Preparation and evaluation of a meta-analysis report, Application of meta-analysis in evidence-based decision making.

Text Books:

1. Michael Borenstein, Larry V. Hedges, Julian P.T. Higgins, Hannah R. Rothstein, ***"Introduction to Meta-Analysis"***, Wiley.

2. Matthias Egger, George Davey Smith, Douglas G. Altman, ***"Systematic Reviews in Health Care: Meta-Analysis in Context"***, BMJ Books.

3. Mathias Harrer, Pim Cuijpers, Toshi A. Furukawa, David D. Ebert, ***"Doing Meta-Analysis with R: A Hands-On Guide"***, Chapman & Hall/CRC.

Reference Books:

1. Julia Koricheva, Jessica Gurevitch, Kerrie Mengersen, ***"Handbook of Meta-Analysis in Ecology and Evolution"***, Princeton University Press.

2. Mark W. Lipsey and David B. Wilson, ***"Practical Meta-Analysis"***, Sage Publications.

3. Harris Cooper, ***"Research Synthesis and Meta-Analysis: A Step-by-Step Approach"***, Sage Publications.

4. Mike W.-L. Cheung, ***"Meta-Analysis: A Structural Equation Modeling Approach"***, Wiley.

5. ***"The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses"***, Moher et al.

Course Title : Research Methodology in Health Sciences | **Semester : VIII**

Course Code : 26UD1246RS802 | **L–T–P : 3-0-0**

Prerequisite : Research Methodology, Basic Statistics | **Credits : 3**

Course Type : Research

Course Objectives:

1. To understand research concepts and methodologies in health sciences.
2. To learn techniques for designing and conducting health research studies.
3. To explore data collection, analysis, and interpretation in healthcare.
4. To understand ethical issues and regulatory guidelines in health research.
5. To develop skills in scientific writing and reporting in health sciences.

Course Outcomes:

After learning the course, the students should be able to:

1. To explain research methods and designs used in health sciences.
2. To formulate research problems and design appropriate health studies.
3. To apply data collection and statistical analysis techniques in healthcare.
4. To evaluate ethical and regulatory aspects of health research.
5. To prepare and present scientific research reports in health sciences.

Course Contents:

UNIT I

Introduction to Health Research: **[08 Hours]**

Concept and scope of health research, Types of health research: clinical, epidemiological, public health, Qualitative vs quantitative approaches, Research process in health sciences.

Case Study: Analysis of a clinical research study design.

UNIT II

Research Design in Health Sciences: **[08 Hours]**

Observational studies: cohort, case-control, cross-sectional, Experimental studies: randomized controlled trials (RCTs), Study design selection, Bias and confounding factors.

Case Study: Designing a cohort or case-control study for disease analysis.

UNIT III

Data Collection and Sampling Methods: **[08 Hours]**

Sampling techniques in health research, Data collection tools: questionnaires, interviews, clinical measurements, Validity and reliability, Data management and quality control.

Case Studies: Designing a survey for public health research, Sampling strategy for disease prevalence study

UNIT IV

Data Analysis and Interpretation in Health Research: **[08 Hours]**

Descriptive and inferential statistics, Measures of central tendency and dispersion, Hypothesis testing, Use of software tools (SPSS/R), Interpretation of health data.

Case Studies: Analysis of patient data for disease trends, Hypothesis testing for treatment effectiveness.

UNIT V

Ethics, Reporting and Applications: **[08 Hours]**

Ethical principles in health research, Informed consent and confidentiality, Regulatory guidelines (ICMR, WHO), Scientific writing

and publication, Evidence-based medicine and applications.
Case Studies: Ethical issues in clinical trials, Preparation of a health research report.

Text Books:

1. S.K. Sharma, ***"Research Methodology for Health Professionals"***, Jaypee Brothers.
2. Stephen B. Hulley et al., ***"Designing Clinical Research"***, Wolters Kluwer.
3. R. Bonita, R. Beaglehole, T. Kjellström, ***"Basic Epidemiology"***, WHO Press.

Reference Books:

1. Michael J. Campbell et al., ***"Medical Statistics: A Textbook for the Health Sciences"***, Wiley.
2. Kenneth J. Rothman, ***"Epidemiology: An Introduction"***, Oxford University Press.
3. Robert H. Fletcher, Suzanne W. Fletcher, ***"Clinical Epidemiology: The Essentials"***,Wolters Kluwer.
4. Ann Bowling, ***"Research Methods in Health: Investigating Health and Health Services"***, McGraw-Hill.
5. ***"ICMR National Ethical Guidelines for Biomedical and Health Research"***, Government of India.