Jharkhand University of Technology, Ranchi
NEP-2020 based Syllabus w.e.f – 2025-26 batch
B.Tech in CSE

Semester- VIIth

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
		PROGRAMME CORE COURSES (PCC)										
01		PCC-I (Data Science)	3	0	0		3					
		PROGRAMME ELECTIVES V, VI & VII										
02		PE-V (Any One FromThe Given Basket of PE-V)										
03		PE-VI (Any One FromThe Given Basket of PE-VI)										
04		PE-VII (Any One FromThe Given Basket of PE-VII)										
		OPEN ELECTIVE-II & III										
05		OE-II (Any one From The Given Basket of OE-II)										
06		OE-III (Any one FromThe Given Basket of OE-III)										
Total												
Practical			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**

06		**Lab-I (Data Science LAB)**	**0**	**0**	**3**		**1**					
07		**Lab-II (Digital Project Management LAB)**	**0**	**1**	**2**		**2**					
Total												
Audit Course			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
10		**(THROUGH NPTEL/SWAYAM)** Exploring Human Values: Visions of Happiness and Perfect Society										
11		Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance										
Project			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
12		Minor Research Project										
Total												
Grand Total												

Basket of Professional Elective-V

S. No.	Course Code	Subject
01		Cloud Computing
02		Deep Learning
03		Design of Secure Protocols

Basket of Professional Elective-VI

S. No.	Course Code	Subject
01		AR/VR Systems for Real-World Applications
02		Software Reliability Techniques
03		Pattern Recognition

04		Internet of Things		**04**		Soft Computing
05		Intrusion Detection Systems		**05**		Multimedia Technology
06		Quantum Computing		**06**		Time Series Analysis and Forecasting (TSAF)
07		Real Time Systems		**07**		Image Processing
08		Secure Software Engineering		**08**		Digital Signal Processing
09		Security and Privacy		**09**		Video Analytics
10		Robotic Process Automation		**10**		Social Network Analysis

Basket of Professional Elective-VII

S. No.	Course Code	Subject		S. No.	Course Code	Subject
01		Big Data Analytics		06		Optimization Techniques
02		Information Storage and Retrieval		07		Information and Coding Theory
03		Programming Environment and User Interface Design		08		Cryptography
04		Advanced Numerical Computation		09		Information Security
05				10		Approximation Algorithms

Basket of Open Elective-II

S. No.	Course Code	Subject
01		Advanced Numerical Methods
02		Random Processes
03		Queuing and Reliability Modelling
04		Production and Operations Management for Entrepreneurs
05		Multivariate Data Analysis
06		Additive Manufacturing
07		New Product Development
08		Industrial Design & Rapid Prototyping

Basket of Open Elective-III

S. No.	Course Code	Subject
01		Reverse Engineering
02		Sustainable Manufacturing
03		Electric and Hybrid Vehicles
04		Space Engineering
05		Industrial Management
06		Quality Engineering
07		Fire Safety Engineering
08		Introduction to Non-destructive Testing

		Techniques				
09		Micro and Precision Engineering		09		Mechatronics
10		Cost Management of Engineering Projects		10		Foundation of Robotics

Abbreviations:- *AU- Audit Course; L: Lecture, T: Tutorial, P: Practice.
J- Self learning hours shall not be reflected in the Time table. Self-learning includes micro project/ assignment/ other activities as mentioned in earlier semester.
***Passing in Audit Course shall be mandatory.**
Note:- Student may choose their two Professional Electives (PE-V, VI & PE-VII) & Open Elective-II & III from NPTEL/SWAYAM also on the advice of departmental academic council if the subject is not mentioned in the above basket.
Students will complete the Elective Papers (Professional or Open) of 12 weeks duration from NPTEL/SWAYAM. Student may register on NPTEL/SWAYAM at any time from 1st to 7th semester but the passing marks and credits will be reflected only in the 7th semester.
The secured percentage of marks and passing certificate of the subject shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.

Jharkhand University of Technology, Ranchi
NEP-2020 based Syllabus w.e.f – 2025-26 batch
B.Tech, Branch-

VIIIth –Semester

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
01		Major Project/ Research Project	36 Hours per week / week Total 12-16 Weeks			6	20					
02		Industrial Internship										
Total												
Grand Total												

L: Lecture, T: Tutorial, P: Practical.
J- Self learning hours shall not be reflected in the Time table. Self-learning includes micro project/ assignment/ other activities as mentioned in earlier semester.

Jharkhand University of Technology, Ranchi

B.Tech
Computer Science and Engineering

NEP-2020 based Syllabus w.e.f – 2025-26 Batch

Semester- VIIth

PROGRAMME CORE COURSES (PCC)

(Data Science)

Course code: **L:T:P:3:0:0**

Rationale:

1. To understand the fundamentals of data science
2. To learn various data pre-processing and data collection techniques
3. To understand the process of data analytics and model building
4. To understand different tools and techniques of data visualization

Course Outcomes:

CO1: To understand the concept of data science and data science life cycle
CO2: To apply the pre-processing techniques for generating quality data inputs
CO3: To analyse the concept and parameters of exploratory data analytics
CO4: To develop the regression models using data science and analytics process
CO5: To analyse various tools and techniques of data visualization
CO6: handling data, encoding, tools apply, and types of data visualization.

Unit I

Introduction to data science, data science life cycle, data science process, roles, tools, and technologies, data collection, data wrangling, focusing on techniques for data collection, cleaning, pre-processing, and transformation. Overview of Random variables and probability distributions.

Unit II

Statistical learning: Assessing model accuracy, Bias-Variance Trade-Off, Descriptive Statistics, Dependent and Independent events; Linear Regression: Simple and multiple linear regressions, regularization, Lasso, Ridge, and Elastic-Net Regression. Comparison of Linear regression with K-nearest neighbours. Logistic Regression, LDA, QDA. PCA and SVD.

Unit III

Hypothesis Testing, Student's’t-test, paired t and U test, correlation and covariance, tests for association; association rules and correlations; hypothesis testing, correlation and causation, ANOVA, and statistical significance.

Unit IV

Exploratory data analysis (EDA), descriptive statistics, data visualization techniques, and identifying patterns and trends, Histograms and frequency polygons, Box-plots, Quartiles, Scatter Plots, Heat Maps. Matrix visualization, Scientific Design Choices in Data Visualization, Higher-dimensional Displays and Special Structures, Visual data mining.

Unit V

Data Wrangling: Data Acquisition, Data Formats, Imputation, split-apply-combine paradigm. Descriptive Analytics: Data Warehousing and OLAP, Data Summarization, Data de-duplication, Data Visualization using CUBEs.

Learning Resources:

Text Books

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, February 11, 2013. Web link: www.statlearning.com (Chapters 1 to 4).
2. Mark Gardener, *Beginning R: The Statistical Programming Language*, Wiley, 2015.

Reference Books

1. Jiawei Han, Micheline Kamber, and Jian Pei, *Data Mining: Concepts and Techniques*, 3rd Edition, Morgan Kaufmann, 2012. (Chapter 2 and Chapter 4).
2. C. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.

PROGRAMME ELECTIVES V, VI & VII

PE-V (Any One FromThe Given of PE-V)

Cloud Computing

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to provide a clear understanding of cloud computing concepts and services such as SaaS, PaaS, and IaaS. It aims to help students understand how business agility in an organization can be created and to evaluate the deployment of web services from cloud architecture. The course also helps to compare the economic benefits delivered by various cloud models and to study the best practices for developing and deploying cloud-based applications.

Course Outcomes:

- Understand the concept of virtualization and how it has enabled the development of cloud computing.
- Know the fundamentals of cloud, cloud architectures, and types of services in the cloud.
- Understand scaling, cloud security, and disaster management.
- Design different applications in the cloud.
- Explore some important commercial systems driven by cloud computing.

UNIT I – Introduction **(9 Hours)**

Evolution: Clustering – Grid Computing – Virtualization – Basic Concepts – Benefits and Risks – Roles and Boundaries – Characteristics – IaaS based Service Offerings – Basic Deployment Models.

UNIT II – Enabling Technologies **(9 Hours)**

Networks: ISPs – Connectionless Packet Switching – Router-based Interconnectivity – Technical and Business Considerations – Data Center: Standardization and Modularity – Automation – Remote Operation – High Availability – Hardware Virtualization: Hardware Independence – Server Consolidation – Resource Replication – OS and Hardware-based Virtualization – Web Technology – Multitenant Technology – Service Technology.

UNIT III – Computing Mechanisms **(9 Hours)**

Infrastructure: Logical Network Perimeter – Virtual Server – Storage Device – Usage Monitor – Resource Replication – Specialized: Automated Scaling Listener – Load Balancer – Monitors – Failover System – Hypervisor – Resource Cluster – Multi-Device Broker – State Management Database – Management: Resource – SLA – Billing – Remote Administration – Security.

UNIT IV – Cloud Providers & Software Platforms **(9 Hours)**

Globally Available Public Clouds (Microsoft Azure – Amazon Web Services – Google Cloud Platform): Overview and Comparison – Instances – Images – Networking and Security – Storage – Monitoring and Automation – Introduction to Open-source Software: Eucalyptus – OpenNebula – OpenStack – Apache CloudStack.

UNIT V – Programming Models & Advances (9 Hours)

Introduction to MapReduce – Apache Spark – TensorFlow – Intercloud: Architecture – Resource Provisioning – Billing – Security – Mobile Cloud Computing: Resource Allocation – Security – Business Aspects – Application – Future Scope – Introduction to Edge and Fog Computing.

Learning Resources:

Text Book

1. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, *Distributed and Cloud Computing from Parallel Processing to the Internet of Things*, Morgan Kaufmann, Elsevier, 2012.

Reference Books

1. Barrie Sosinsky, *Cloud Computing Bible*, John Wiley & Sons, 2010.
2. Tim Mather, Subra Kumaraswamy, Shahed Latif, *Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance*, O'R'illy, 2009.
3. James Turnbull, *The Docker Book: Containerization is the New Virtualization*, E-Book, 2015.

<u>Deep Learning</u>

Course code: **L:T:P:3:0:0**

Rationale:

- To understand the basic concepts and techniques of Deep Learning and the need for these techniques in real-world problems.
- To understand CNN algorithms and how to evaluate the performance of CNN architectures.
- To apply RNN and LSTM to learn, predict, and classify real-world problems in the paradigms of Deep Learning.
- To understand, learn, and design GANs for selected problems.
- To understand the concept of Auto-encoders and enhancing GANs using auto-encoders.

Course Outcomes:

CO1: Understand the basic concepts and techniques of Deep Learning and the need for them in real-world problems.
CO2: Understand CNN algorithms and the way to evaluate the performance of the CNN architectures.
CO3: Apply RNN and LSTM to learn, predict, and classify real-world problems in the paradigms of Deep Learning.
CO4: Understand, learn, and design GANs for the selected problems.
CO5: Understand the concept of Auto-encoders and enhancing GANs using auto-encoders.

UNIT I – Introduction to Deep Learning **(9 Hours)**
Artificial Intelligence – Machine Learning – Learning Representations from Data – Understanding How Deep Learning Works – Mathematical Building Blocks of Neural Networks – Data Representations for Neural Networks – Scalars – Vectors – Matrices – 3D Tensors and Higher-Dimensional Tensors – Key Attributes – Vector Data – The Gears of Neural Networks: Tensor Operations – Element-wise Operations – Tensor Dot

UNIT II – Foundations of Neural Network and Deep Learning **(9 Hours)**
Neural Networks – The Biological Neuron – The Perceptron – Multilayer Feed Forward Networks – Training Neural Networks – Backpropagation Learning – Activation Functions: Linear – Sigmoid – Tanh – SoftMax – Loss Functions – Hyperparameters: Learning Rate – Regularization – Momentum – Sparsity

UNIT III – Fundamentals of Deep Networks **(9 Hours)**
Architectural Principles of Deep Networks – Parameters – Layers – Activation Functions – Loss Functions – Optimization Algorithms – Hyperparameters – Building Blocks of Deep Networks – RBMs – Autoencoders – Variational Autoencoders – Major Architectures of Deep Networks: Deep Belief Networks – Generative Adversarial Networks – Convolutional Neural Networks – Recursive Neural Networks

UNIT IV – Deep Learning for Computer Vision **(9 Hours)**
Introduction to ConvNets – The Convolution Operation – The Max-Pooling Operation – Training a ConvNet from Scratch on a Small Dataset – The Relevance of Deep Learning for Small-Data Problems – Downloading the Data – Building Your Network – Data Preprocessing – Using Data Augmentation – Using a Pre-trained ConvNet – Feature Extraction – Fine-Tuning – Visualizing

What ConvNets Learn – Visualizing Intermediate Activations – Visualizing ConvNet Filters – Visualizing Heatmaps of Class Activation

UNIT V – Deep Learning for Text and Sequences (9 Hours)

Working with Text Data – One-Hot Encoding of Words and Characters – Using Word Embeddings – Putting It All Together: From Raw Text to Word Embeddings – Understanding Recurrent Neural Networks – A Recurrent Layer in Keras – Understanding the LSTM and GRU Layers – A Concrete LSTM Example in Keras – Advanced Use of Recurrent Neural Networks – A Temperature-Forecasting Problem – Preparing the Data – First Recurrent Baseline – Using Recurrent Dropout to Fight Overfitting – Stacking Recurrent Layers – Using Bidirectional RNNs – Sequence Processing with ConvNets – Understanding 1D Convolution for Sequence Data – 1D Pooling for Sequence Data – Implementing a 1D ConvNet – Combining CNNs and RNNs to Process Long Sequences

Learning Resources:

Text Books

1. Josh Patterson, Adam Gibson, *Deep Learning: A Practitioner's Approach*, First Edition, O'Reilly Media, Inc., 2017.
2. François Chollet, *Deep Learning with Python*, Manning Publications Co., 2018.

Reference Books

1. Jason Brownlee, *Better Deep Learning: Train Faster, Reduce Overfitting and Make Better Predictions*, Machine Learning Mastery, 2019.
2. Dr. Pablo Rivas, Laura Montoya, *Deep Learning for Beginners: A Beginner's'Guide to Getting Up and Running with Deep Learning from Scratch Using Python*, Packt Publishing, 2020.

Design of Secure Protocols

Course code: **L:T:P:3:0:0**

Rationale:

- To understand basic network security issues, types of attacks, and mechanisms to combat them.
- To understand authentication challenges and requirements, as well as authentication algorithms.
- To comprehend public and private key management issues.
- To understand and apply algorithms for secure transactions and protocols at the network, transport, and web levels.

Course Outcomes:

Course Contents:

UNIT I

Needham-Schroeder public-key protocol. Introduction to finite-state checking, SSL/TLS case study, IP security. Internet Key Exchange (IKE) protocol, Introduction to process algebra, Just Fast Keying (JFK) protocol, Security as observational equivalence.

UNIT II

JFK protocol in applied pi calculus, Protocols for anonymity, Probabilistic model checking, Probabilistic contract signing protocols, Floyd-Hoare logic. Compositional protocol logic, Paulson's'inductive method, Analyzing SET with the inductive method, Symbolic constraint solving.

UNIT III

Formal definitions of security for symmetric ciphers, Formal model for secure key exchange, Simulatability-based proofs of protocol security, Probabilistic polynomial-time process calculus, Formal analysis of denial of service, Formal verification of routing protocols, Computational soundness of formal models.

UNIT IV

Multicast security, Spoofing and identity theft, Fair exchange and contract signing protocols, Trusted computing, Privacy preserving data mining, Automatic proofs of strong secrecy, Game-based verification of contract signing protocols.

UNIT V

Wireless security, Game-based analysis of denial-of-service protection, Analysis of Internet voting protocols, Privacy-preserving graph algorithms, Universal composability framework, Analysis of Group Diffie-Hellman protocols

Learning Resources:

Text Books

1. Oded Goldreich, *Foundations of Cryptography, Vol. I and II*, Cambridge University Press, 2007.
2. Jonathan Katz and Yahuda Lindell, *Introduction to Modern Cryptography*, CRC Press, 2008.

Reference Books

1. Van Oorschot, Paul Scott, A. Vanstone, A. J. Menezes, *Handbook of Applied Cryptography*, CRC Press, 2004.

Internet of Things

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to understand the basic characteristics of IoT, identify new models for market strategic interaction, and review various communication components of IoT. The course also aims to help students understand IoT architecture, protocols, privacy, and security issues. It also identifies future trends of IoT in business.

Course Outcomes:

CO1: Understand the key components, architectures, and design principles of an IoT system.
CO2: Analyze the different communication protocols used for IoT devices.
CO3: Apply various sensor technologies and embedded systems for building IoT applications.
CO4: Evaluate the security, privacy, and ethical issues related to IoT deployments.
CO5: Develop a simple end-to-end IoT application using a microcontroller and cloud services.

Course Contents:

Unit I

Introduction to IoT – IoT Definition – Characteristics – Things in IoT – IoT Complete Architectural Stack – IoT Enabling Technologies – IoT Challenges – IoT Levels – Case Study to Realize the Stack.
Sensors and Hardware for IoT – Accelerometer, Proximity Sensor, IR Sensor, Gas Sensor, Temperature Sensor, Chemical Sensor, Motion Detection Sensor.
Hardware Kits – Arduino, Raspberry Pi, NodeMCU.
A Case Study with Any One of the Boards and Data Acquisition from Sensors.

Unit II

Protocols for IoT – Infrastructure Protocol (IPv4/IPv6, RPL), Identification (URLs), Transport (WiFi, LiFi, BLE), Discovery, Data Protocols, Device Management Protocols.
A Case Study with MQTT/CoAP Usage.
Cloud and Data Analytics – Types of Cloud – IoT with Cloud Challenges – Selection of Cloud for IoT Applications – Fog Computing for IoT – Edge Computing for IoT – Cloud Security Aspects for IoT Applications – FDM for Data Analytics – Case Study with AWS / Azure / Adafruit / IBM Bluemix.

Unit III

Case Studies with Architectural Analysis: IoT Applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart Waste Management.

Learning Resources:

Text Book:

1. Bahga A, Madisetti V. *Internet of Things: A Hands-on Approach*. 2014.

Reference Books:

1. Shriram K Vasudevan, Abhishek SN and Sundaram RMD. *Internet of Things*. First Edition, Wiley India, 2019.
2. Raj P, Raman AC. *The Internet of Things: Enabling Technologies, Platforms, and Use-cases*. Auerbach Publications, 2017.

3. Adrian McEwen. *Designing the Internet of Things*. Wiley, 2013.

Intrusion Detection Systems

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce basic concepts of intrusion detection systems (IDS) and intrusion prevention systems (IPS). Students learn to apply knowledge of IDS history and fundamentals to avoid common pitfalls in creating and evaluating new IDS. The curriculum also aims to teach when, where, how, and why to apply IDS tools and techniques to improve an organization's security posture. It also covers topics on agent development for intrusion detection and architectural models for both IDS and IPS.

Course Outcomes:

CO1: Understand the basic concepts of intrusion detection systems.
CO2: Understand Intrusion Prevention Systems, Network IDS protocols, and models for intrusion analysis.
CO3: Apply knowledge of IDS history and fundamentals to avoid common pitfalls in developing new IDS.
CO4: Analyze intrusion alerts and logs to distinguish attack types from false alarms using tools like Snort.
CO5: Learn agent development for intrusion detection and understand the architectural models of IDS and IPS.

Course Contents:

Unit I
Firewall Planning and Design, Developing a Security Policy, System Configuration Strategies, Working with Proxy Servers and Application-Level Firewalls, Authenticating Users, Encryption and Firewalls.

Unit II
Intrusion detection, Audit, Internal and external threats to data, attacks, Information sources - –ost based information sources, and Network based information sources; Types and classification of IDS.

Unit III
Intrusion Prevention Systems, Network Systems, Network IDs protocol based IDs, Hybrid IDs, Analysis schemes, models for intrusion analysis, techniques, mapping responses to policy vulnerability analysis, credential analysis non-credential analysis.

Unit IV
IDS using SNORT, NIDS, NNID and HIDS.

Unit V
Discovery and Detection: Identify IDS signatures such as anomaly detection, pattern matching and statistical analysis; Machine Learning models for IDS, Distributed IDS models; Architecture models of Intrusion Detection and intrusion prevention.

Learning Resources:

Text Books

1. Rafeeq Rehman, *Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID*, Prentice Hall, 2003.
2. Carl Endorf, Eugene Schultz, Jim Mellander, *Intrusion Detection & Prevention*, Tata McGraw-Hill, 2004.

Reference Books

1. Christopher Kruegel, Fredrik Valeur, Giovanni Vigna, *Intrusion Detection and Correlation: Challenges and Solutions*, Springer, 2005.
2. Stephen Northcutt, Judy Novak, *Network Intrusion Detection*, New Riders Publishing, 2002.

<u>Quantum Computing</u>

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce students to quantum computation, including the foundational algebra of complex vector spaces and quantum mechanics. It aims to provide a strong foundation in quantum computing theory and its practical applications. The course also introduces quantum algorithms and their applications in various sectors.

Course Outcomes:

CO1: Understand the fundamentals of qubits and their various representations.
CO2: Identify operators and their matrix representations.
CO3: Demonstrate the implementation of quantum gates, circuits, and elementary quantum algorithms.
CO4: Understand quantum measurement and error correction.
CO5: Understand quantum entanglement.

Course Contents:

Unit 1
Mathematics: Complex Numbers; Complex Vector Spaces

Unit 2
Leap from Classical to Quantum: Classical Deterministic Systems; Probabilistic Systems, Quantum Systems, Assembling Systems

Unit 3
Basic Quantum Theory: Quantum States, Observables; Measuring; Dynamics; Assembling Quantum Systems

Unit 4
Architecture: Bits and Qubits; Classical Gates; Reversible Gates; Quantum Gates

Unit 5
lgorithms: Deutsch's Algorithm; Deutsch–Jozsa Algorithm; Simon's Periodicity Algorithm; Grover's Search Algorithm; Shor's Factoring Algorithm

Unit 6
Programming Languages: Programming in a Quantum World; Quantum Assembly Programming; Toward Higher-Level Quantum Programming; Quantum Computation Before Quantum Computers

Learning Resources:

Text Books

1. Noson S. Yanofsky, Mirco A. Mannucci, *Quantum Computing for Computer Scientists*, Cambridge University Press, 1st Edition, 2008.

Reference Books

1. Eleanor G. Rieffel, Wolfgang H. Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.

Real Time Systems

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to familiarize students with the concepts of real-time systems, which require software to meet strict timing constraints. It is achieved by selecting suitable scheduling algorithms. The course aims to teach students how to design and develop real-time systems based on given specifications and requirements, including the use of proper scheduling algorithms for periodic and sporadic tasks. It also covers real-time operating systems (RTOS) and resource sharing protocols to prevent issues like priority inversions.

Course Outcomes:

CO1: Design and develop a real-time system based on given specifications.
CO2: Create task schedules for a set of periodic tasks using appropriate scheduling algorithms.
CO3: Develop real-time systems with sporadic tasks using proper scheduling methods.
CO4: Integrate resource access mechanisms effectively.
CO5: Explain real-time concepts like preemptive multitasking, priorities, and synchronization.

Course Contents:

Unit I
Real-Time Systems, Typical Real-Time Applications, Hard Versus Soft Real-Time Systems, A Reference Model of Real-Time Systems.

Unit II
Commonly Used Approaches to Hard Real-Time Scheduling, Clock-Driven Scheduling, Priority-Driven Scheduling of Periodic Tasks, Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems.

Unit III
Resources and Resource Access Control, Multiprocessor Scheduling and Resource Access Control.

Unit IV
Scheduling Flexible Computations and Tasks with Temporal Distance Constraints.

Unit V
Real-Time Communications, Operating Systems.

Learning Resources:

Text Books

1. Jane Liu, “Real-Time Systems”, Prentice Hall, 2000.

Reference

1. Philip A. Laplante, “Real Time System Design and Analysis”, 3rd Edition, PHI, 2004.

Secure Software Engineering

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to help students understand the concepts of secure software engineering by exploring software security assurance, threats, and insecurities. It also aims to teach how to integrate security assurance effectively into the software development process. Students will learn to design, code, and test software with a focus on security by understanding architectural risk analysis, secure coding practices, and different security testing methods.

Course Outcomes:

CO1: Understand software security relevance, exploring assurance, threats, insecurities, and the benefits of early defect detection.
CO2: Define software security by integrating assurance into the software development lifecycle (SDLC).
CO3: Understand secure requirements, the SQUARE model, and elicitation for secure software.
CO4: Design and code securely by embracing architectural risk analysis, coding best practices, and security testing.
CO5: Analyze failures, attacker behavior, and system complexity.

Course Contents:

Unit-I
Software assurance and software security, threats to software security, sources of software insecurity, benefits of detecting software security, managing secure software development

Unit-II
Defining properties of secure software, how to influence the security properties of software, how to assert and specify desired security properties

Unit-III
Secure software Architecture and Design: Software security practices for architecture and design: Architectural risk analysis, software security knowledge for Architecture and Design: security principles, security guidelines, and attack patterns, secure design through threat modeling, Writing secure software code: Secure coding techniques, Secure Programming: Data validation

Unit-IV
Secure Programming: Using Cryptography Securely, Creating a Software Security Programs

Unit-V
Secure Coding and Testing: code analysis- source code review, coding practices, static analysis, software security testing, security testing consideration through SDLC

Learning Resources:

Text Books

1. Julia H Allen, Sean J Barnum, Robert J Ellison, Gary McGraw, Nancy R Mead, "S“ftware Security Engineering: A Guide for Project Managers",”Addison Wesley, 2008.
2. Ross J Anderson, "S“curity Engineering: A Guide to Building Dependable Distributed Systems",”2nd Edition, Wiley, 2008.

Reference Books

1. Howard, M. and LeBlanc, D., "W“iting Secure Code",”2nd Edition, Microsoft Press, 2003.

Security and Privacy

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce students to the fundamental concepts of cyber security and cybercrime. It aims to provide knowledge of security policies and cyber laws, including the Digital Personal Data Protection Act of 2023. The curriculum is designed to help students understand the tools and methods used in cybercrime, such as phishing, keyloggers, and viruses, as well as the concepts of cyber forensics.

Course Outcomes:

CO1: Understand the basic concepts of cyber security and cybercrimes.
CO2: Understand security policies and cyber laws.
CO3: Understand the tools and methods used in cybercrime.
CO4: Understand the concepts of cyber forensics.
CO5: Understand threats and safety measures for various communication methods like email.

Course Contents:

Unit I

Introduction to Security – risks, threats and vulnerabilities, Cryptography. Symmetric key Cryptography – Encryption, Block ciphers, Chosen plaintext attacks, Stream Ciphers – One-time Pad (OTP), Perfect secrecy, Pseudo-random generators (PRG), Attacks on stream ciphers and OTP, Real world stream ciphers, Semantic security, Case Study- RC4, Salsa 20, CSS in DVD encryption, A5 in GSM, Block ciphers- DES, attacks, AES, Block ciphers from PRG, Modes of operation – one-time key and many-time keys, CBC, CTR modes, Message Integrity – MAC, MAC based on PRF, NMAC, PMAC, Collision resistance – Birthday attack, Merkle-Damgard construction, HMC, Case study:SHA-256, Authenticated encryption, Key exchange algorithms, Public key cryptosystems – Public key tools, Public key encryption, Chosen ciphertext secure public-key encryption, Digital signature, Fast hash based signatures, RSA, ElGamal, Elliptic curve cryptosystems – PKC, key exchange, IBE, Analysis of number theoretic assumptions, Case studies – HTTPS – SSL/TLS, SSH, IPSec, 802.11i WPA.

Unit II

Protocols - –rotocols for identification and login, Identification and signatures from sigma protocols, Proving properties in zero-knowledge, Authenticated key exchange, Key establishment with online trusted third parties, Two-party and multi-party secure computation.

Unit III

Privacy preserving Data analysis - –asis Techniques - –andomized response, the Laplace mechanism, the exponential mechanism, Composition theorems, and sparse vector technique. Releasing Linear Queries with Correlated Error, Mechanisms via α-nets, Iterative construction mechanism, Boosting for queries algorithm, Stability and privacy, Lower bounds for differential privacy.

Unit IV

System design and analysis – Survivable distributed storage system, Electronic voting system, Digital Cash, Bitcoin.

Learning Resources:

Text Books:

1. J. Katz and Y. Lindell, "I“troduction to Modern Cryptography",”CRC Press, 2008.
2. C. Dwork and A. Roth, "T“e Algorithmic Foundations of Differential Privacy",”Now Publishers, 2014.

Reference Books:

1. Van Oorschot, Paul Scott, A Vanstone, A J Menezes, "H“ndbook of Applied Cryptography",”CRC Press, 2004.

Robotic Process Automation

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to help students understand the basic concepts of Robotic Process Automation (RPA) and how it differs from other types of automation. Students will learn to use data tables to store and manipulate data in memory, as well as model the workflow of different data scraping methodologies. The course also covers how to handle exceptions and interpret events that can be used to trigger actions.

Course Outcomes:

CO1: Describe RPA, where it can be applied, and how it is implemented.
CO2: Understand the different types of variables, control flow, and data manipulation techniques in RPA.
CO3: Understand image, text, and data table automation.
CO4: Handle user events and various types of exceptions.
CO5: Understand the deployment of robots and how to maintain the connection with a server.

Course Contents:

UNIT – I
Robotic Process Automation: Introduction, Scope and techniques of automation, Robotic process automation, Components of RPA, RPA platforms, About UiPath UIPath Stack Uipath Studio, Uipath Robot, Types of Robots, UiPath Orchestrator UIPath Studio Projects, User interface The User Interface: Task recorder, Advanced UI interactions: Input methods, Output methods

UNIT – II
Sequence, Flowchart, and Control Flow: Sequencing the workflow, Activities, Control Flow, various types of loops and decision making Data Manipulation: Variables and scope, Collections, Arguments – Purpose and use, Data table usage with examples, File operation with step-by-step example, CSV/Excel to data table and vice versa

UNIT – III
Taking Control of the Controls: Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Handling events, revisit recorder, When to use OCR, Types of OCR available, How to use OCR Plugins and Extensions: Terminal Plugin, SAP Automation, Citrix automation and Credential management

UNIT – IV
Handling User Events and Assistant Bots: Assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event Exception Handling, Debugging, and Logging: Exception handling, Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting

UNIT – V
Managing and Maintaining the Code: Project organization, nesting workflows, Reusability of workflows, Commenting techniques, State Machine, When to use Flowcharts, State Machines, or Sequences, Using config files Deploying and Maintaining the Bot: Publishing using publish utility,

using Orchestration Server to control bots, deploy bots, License Management, Publishing and Managing updates

Learning Resources:

Text Books:

1. *Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots with the leading RPA tool – UiPath*. Kindle Edition.

References:

1. *Robotic Process Automation: A Complete Guide - 2020 Edition*. Kindle Edition.

PE-VI (Any One FromThe Given of PE-VI)

AR/VR Systems for Real-World Applications

Rationale:

1. To introduce students to the basic concepts and framework of Augmented Reality (AR) and Virtual Reality (VR).
2. To familiarize students with technologies for multimodal user interaction and perception in VR, particularly visual, audio, and haptic interfaces.
3. To provide an understanding of technologies for managing large-scale AR/VR environments.

Course Outcomes:

On completion of this course, the learner will be able to:

1. Understand the fundamentals of AR and VR technology.
2. Analyse complex virtual environments, spatial audio, and GPU optimization techniques.
3. Apply spatial mapping in AR and design user interfaces for VR.
4. Discover and use mobile AR development software tools for applications.

Content:

Module 1 (04 Hours)

Introduction to Augmented Reality: Definition and Scope, A Brief History, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Strong vs Weak AR, Challenges in AR, Applications of AR, Role of AI and Machine Learning in AR. Introduction to Virtual Reality: Definition and Scope, Types of VR, Characteristics of VR, Basic VR environments, Limitations of VR environments, Immersion Vs Presence, Key Hardware Requirements for VR.

Module 2 (08 Hours)

Fundamentals of AR and VR Technologies: Input – User Monitoring, Position Tracking, Body Tracking, Physical Input Devices, Speech Recognition and World Monitoring, Bringing the Real World into the Virtual World. Output – Visual Displays: Properties of Visual Displays, Monitor-based or Fishtank VR, Projection-based VR, Head-based VR, See-through Head-based Displays, Handheld VR. Aural Displays: Types, Properties, Stationary Aural Displays-Speakers. Haptic Displays: Types, Properties of Haptic Displays, Vestibular and Other Senses.

Module 3 (06 Hours)

Representing and Rendering the Virtual World: Representation of the Virtual World, Visual Rendering Systems – Methods, Types (Geometrically Based and Non-geometric Based), Complex Visual Scenes. Computer Graphics System Requirements. Aural Rendering Systems: Visual Methods, Complex Sounds. Understanding GPU Architecture, GPU's Role in Rendering and Acceleration, GPU Performance Optimization Techniques.

Module 4 (06 Hours)

Interaction and Experience of Virtual World: User Interface Metaphors, Manipulating a Virtual World – Properties and Operations, Navigating in a Virtual World, Wayfinding and Travelling, Collaborative Interaction, Interacting with the VR System, Rules of the Virtual World.

Module 5 (07 Hours)

Building AR and VR Experiences: Creating AR Applications, Integrating Real-time Camera Feed and Overlaying Digital Content, Environmental Understanding and Spatial Mapping in AR, Designing VR Environments and Interactions, Implementing VR User Interfaces and Navigation Systems, Optimizing Performance for Smooth VR Experiences.

Module 6 (06 Hours)
Augmented Reality Software and Mobile Augmented Reality: Augmented Reality Systems, Software Components, Software Tools for Content Creation, Interaction in Augmented Reality, Augmented Reality Techniques, Mobile Augmented Reality.

Books Recommended

Text Books:

1. *Complete Virtual Reality and Augmented Reality Development with Unity*, Jesse Glover, Jonathan Linowes, Packt Publishing Limited, ISBN-13 978-1838648183, 2019.
2. Alan B. Craig, *Understanding Augmented Reality, Concepts and Applications*, Morgan Kaufmann Publishers, ISBN: 978-0240824086, 2013.
3. Burdea, G. C. and P. Coffet, *Virtual Reality Technology*, Second Edition, Wiley-IEEE Press, 2003/2006.
4. William R. Sherman and Alan B. Craig, *Understanding Virtual Reality: Interface, Application and Design* (The Morgan Kaufmann Series in Computer Graphics), Morgan Kaufmann Publishers, San Francisco, CA, 2002.

Reference Books:

1. David J. Chalmers, *Reality+: Virtual Worlds and the Problems of Philosophy*, W. W. Norton Publisher, ISBN-13 978-1324050346, 2023.
2. Alan Craig, William Sherman and Jeffrey Will, *Developing Virtual Reality Applications, Foundations of Effective Design*, Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, *Augmented Reality: Principles & Practice*, Pearson Education India; First edition, ISBN-10: 9332578494, 12 October 2016.
4. Steven M. LaValle, *Virtual Reality*, Cambridge University Press, 2016.
5. Sanni Siltanen, *Theory and Applications of Marker-based Augmented Reality*, Julkaisija – Utgivare Publisher, 2012, ISBN 978-951-38-7449-0.

Software Reliability Techniques

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce students to the fundamental concepts of **software reliability engineering**, including basic ideas of software and hardware reliability, metrics, and fault handling techniques. It aims to teach students how to apply different time-dependent and time-independent software reliability models. The course also covers reliability evaluation testing methods, operational profiles, and prediction techniques.

Course Outcomes:

CO1: Understand reliable software systems.
CO2: Apply fault handling and failure forecasting techniques in software systems.
CO3: Apply different time-dependent and time-independent software reliability models.
CO4: Examine reliability models for software systems.
CO5: Define software maintenance concepts and software quality based on international standards.

Course Contents:

Unit 1
Introduction to Software Reliability: The need for Software Reliability, Some Basic Concepts, Software Reliability and Hardware Reliability, Availability, Modelling and General Model Characteristics.

Unit 2
Software Reliability Modeling: Halstead's Software Metric, McCabe's Cyclomatic Complexity Metric, Error Seeding Models, Failure Rate Models, Curve Fitting Models, Reliability Growth Models, Markov Structure Models, Time Series Models, Non-homogeneous Poison Process Models.

Unit 3
Markovian Models: General Concepts, General Poison-Type Models, Binomial-Type Models, Poison-Type Models, Comparison of Binomial-Type and Poison-Type Models, Fault Reduction Factor for Poison-Type Models.

Unit 4
Descriptions of Specific Models: Finite Failure Category Models, Infinite Failure Category Models. Parameter Estimation: Maximum Likelihood Estimation, Least Squares Estimation, Bayesian Inference.

Unit 5
Comparison of Software Reliability Models: Comparison Criteria, Comparison of Predictive Validity of Model Groups, Evaluation of other Criteria. Software Reliability Prediction: Problems associated with different Software Reliability Models, Software Reliability prediction parameters, Intelligent Techniques for Software Reliability Prediction.

Learning Resources:

Text Books:

1. M. Xie, "Software Reliability Modelling", World Scientific; 1991.
2. John D. Musa, Anthony Iannino, Kazuhira Okumoto, "Software Reliability Measurement, Prediction, Application", McGraw-Hill Book Company; 1987.

Reference Books:

1. Hoang Pham, "System Software Reliability", Springer; 2005.
2. Hamdy A Taha, "Operations Research-An Introduction", 9th Edition, 2017 (Chs 1-8, 12, 14, 17).

Pattern Recognition

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques. It aims to help students apply performance evaluation methods for pattern recognition and critique comparisons of techniques in research literature. The course also enables students to apply pattern recognition techniques to real-world problems and implement simple pattern classifiers.

Course Outcomes:

CO1: Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
CO2: Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
CO3: Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques.
CO4: Apply pattern recognition techniques to real-world problems.
CO5: Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Course Contents:

Unit 1
Basic concepts of Pattern Recognition, Pattern Preprocessing and Feature Selection

Unit 2
Decision Functions
Bayesian decision theory

Unit 3
Parametric Estimation: Maximum likelihood estimation and Bayesian estimation
Non-parametric Estimation: Parzen windows, Nearest Neighbor estimation

Unit 4
Linear classifier: Perceptron, Support Vector Machines (SVM)
Non-linear classifiers: MLP, Non-linear SVM

Unit 5
Unsupervised learning and Clustering: Partitioning methods, Density-based methods, MST-based methods; Soft Computing based methods, Hierarchical Clustering, Cluster Validity
Syntactic Pattern Recognition: (Basic concepts)
Some real-life applications

Learning Resources:

Text Books:

1. Pattern Recognition Principles, Tou and Gonzalez, Addison-Wesley
2. Pattern Classification, Duda, Hart and Stork, Second Edition, Wiley

Reference Books:

1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer

2. Introduction to Statistical Pattern Recognition, Fukunaga, Second Edition, Academic Press

Soft Computing

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to understand basic knowledge representation, problem-solving, and learning methods of artificial intelligence. It aims to help students apply analytical concepts for solving logical problems using heuristic approaches and understand approaches to syntax and semantics in NLP. It also enables students to develop AI concepts using Python libraries.

Course Outcomes:

CO1: Understand the basic concept of artificial intelligence as a discipline and about intelligent agents.
CO2: Understand search techniques and gaming theory.
CO3: Apply knowledge representation techniques and problem-solving strategies to common AI applications.
CO4: Be aware of techniques used for classification and clustering.
CO5: Be aware of the basics of pattern recognition and the steps required for it.

Course Contents:

Unit 1
Introduction to Soft Computing, Components of Soft Computing and its Applications.

Unit 2
Fuzzy Set Theory - Definition, Fuzzy set theoretic operations, Properties of membership function, fuzzification and defuzzification, Development of fuzzy set membership functions, Fuzzy rules and fuzzy reasoning, Fuzzy inference systems.

Unit 3
Rough set theory - Definition, Object reduction in Rough set Theory, Recommendation method, Rough-Set-Based Interrelationship Mining for Incomplete Decision Tables.

Unit 4
Probabilistic Reasoning: Basic probability, Bayes rule and its application, knowledge representation in uncertain domain, Bayesian Networks.

Unit 5
Genetic Algorithms, Simulated Annealing, Use of GAs for single objective and multi objective problem solving.

Unit 6
Neural Networks - Artificial neural networks models, Supervised Learning, Unsupervised Learning, Applications.

Unit 7
Hybrid Systems and its applications.

Learning Resources:

Text Books:

1. Karry and Silva, "Soft Computing and Intelligent System Design", Pearson.

2. Timothy J. Ross, "Fuzzy Logic with Engineering Application", Wiley.
3. Jang, Sun, and Mizutani, "Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall.

Reference Books:

1. Akama, Kudo, and Murai, "Topics in Rough Set Theory: Current Applications to Granular Computing", Springer.
2. Tettamanzi, Andrea, Tomassini, and Marco, "Soft Computing: Integrating Evolutionary, Neural, and Fuzzy Systems", Springer, 2001.

Multimedia Technology

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to help students understand the concepts of **multimedia technologies** and the principles of designing effective media for communication, entertainment, training, and education. It also aims to familiarize students with the fundamentals of graphics, distributed systems, and virtual reality systems.

Course Outcomes:

CO1: Understand firm grounding in the fundamentals of the underpinning technologies in graphics, distributed systems, and multimedia.
CO2: Understand the principled design of effective media for entertainment, communication, training, and education.
CO3: Implement various graphics operations and algorithms using C language.
CO4: Analyze multimedia systems architecture and content-based information retrieval.
CO5: Become familiar with virtual reality systems.

Course Contents:

Unit 1
Introduction
Multimedia and its Application, Different Media, Hypertext and Hypermedia, Issues in Multimedia System, Component of a Multimedia System [2L]

Unit 2
Overview of Text and Graphics Types of Text Data (Plain/Formatted/Hypertext), Unicode Scheme, Concept of Font, File Formats (txt, doc, rtf, ps, pdf etc.), Vector and Raster Graphics

Unit 3
Image
Image Digitization, Digital Image, Binary/GrayScale/ Colour Image, Colour Models, File Formats, Overview of Contrast Intensification, noise removal, edge detection and segmentation Image Descriptors (Shape, Texture and Colour Features) Loss-less and Lossy Image Compression including JPEG An overview of Content Based Image Retrieval System

Unit 4
Audio
Audio Digitization (Sampling and Quantization, Representation based on PCM/DPCM/DM/ADM), File Formats Time Domain Descriptors (ZCR, STE etc.), Frequency Domain Descriptors (Spectral Centroid, Spectral Flux, Spectral Roll Off etc.), and Perception based Descriptors (Mel Scale, MFCC) Psycho Acoustics and Audio Compression An Overview of Audio Classification/Retrieval System

Unit 5
Video
Structure of Video Data, File FormatsVideo Compression Motion Estimation Structural Segmentation of Video Data Overview of Video Summarization, Browsing and Retrieval System

Unit 6
Animation
Keyframes &tweening, cel & path animation, principles and techniques of animation, Web

animation, 3D animation principles, camera, special effects, transformations and editing, rendering algorithms, features of animation software, file formats

Unit 7

Unsupervised Learning and Clustering Partitioning method, Density-based method, MST based method, Self organizing map, Hierarchical Clustering, Cluster validity

Unit 8

Syntactic Pattern Recognition Basic concepts Some real-life applications

Learning Resources:

Text Books:

1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods
2. Digital Image Processing and Analysis by B. Chanda and D. Dutta Majumder
3. Principles of Multimedia by Ranjan Parekh
4. Multimedia – A Practical Approach by Shanker, Jaico
5. Multimedia Systems by Buford J. K., Pearson Education

Reference Books:

1. Multimedia and Imaging Databases by S. Khoshafian, A. Brad Baker, Morgan Kaufmann
2. Multimedia Systems Design by Prabhat K. Andleigh& Kiran Thakkar, Prentice Hall PTR
3. Digital Multimedia by Nigel Chapman & Jenny Chapman, John-Wiley
4. Fundamentals of Computer Graphics and Multimedia by D.P. Mukherjee

Time Series Analysis and Forecasting (TSAF)

Course code: L:T:P-3:0:0

Rationale:

The course on *Time Series Analysis and Forecasting* provides students with a comprehensive understanding of methodologies used for analyzing and predicting sequential data, with a particular focus on business and economic applications. In an era where organizations generate massive amounts of temporal data, the ability to model, interpret, and forecast trends is critical for effective decision-making. This course introduces the theoretical foundations of time series models while emphasizing their practical application across diverse business domains such as marketing, retail, finance, operations, and human resource management. Students will develop an understanding of the principles, assumptions, strengths, and limitations of various forecasting techniques. Through hands-on examples and model-building exercises, learners will gain the skills to evaluate data, identify suitable models, apply estimation methods, and assess performance to ensure accurate forecasting. By integrating statistical principles with real-world applications, the course equips students with essential analytical tools to address contemporary business challenges and to contribute to data-driven strategic planning.

Course Outcomes& Learning levels

This course provides a comprehensive background in time series analysis and forecasting. At the end of this course, the students.

1. I Will have acquired the skills to use time-series models in business analytics in an informed, disciplined way.
2. Will learn how to avoid common mistakes in the use of forecasting techniques and thereby move toward more sound, correct practices in all phases of the analysis.
3. Will be able to use time-series methods intelligently and get as much out of its application as possible
4. Will have enough knowledge to effectively demonstrate the application of time-series models using R and Python.

Module 1: Introduction to utility of the R and Python (7.5 hours)

1. Introduction to the study & pedagogy.
2. Introduction to R and Python infrastructure for time series analysis.

Module 2: Essential characteristics of the time-series data (7.5 hours)

1. Time Series and Their Features; Basic Descriptive Techniques.
2. Trends and Time Series Decomposition.

Module 3: Forecasting Time Series and Smoothing (7.5 hours)

1. Smoothing Techniques
2. Introduction to Linear Time Series Models.
3. ARIMA Modeling.

Module 4: Models for Time series and forecasting (7.5 hours)

1. Volatility Models.
2. State – Space Representation of the time series.
3. Time-Series forecasting and performance Evaluation.

Recommended Texts & Reference Books

1. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994) Time Series Analysis, Forecasting and Control, Englewood Cliffs, NJ: Prentice-Hall.
2. Chris Chatfield, and Haipeng Xing (2019) The Analysis of Time Series: An Introduction with R. CRC Press, London.
3. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A hands-on Guide, Axelrod Schnall Publishers.

Image Processing

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to understand the different techniques employed for the enhancement of images. It aims to help students learn about the causes of image degradation and an overview of image restoration techniques. The course also covers the need for and techniques of image compression in both spatial and frequency domains, as well as different feature extraction methods for image analysis and recognition.

Course Outcomes:

CO1: Understand different techniques employed for the enhancement of images.
CO2: Learn different causes for image degradation and overview of image restoration techniques.
CO3: Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.
CO4: Learn different feature extraction techniques for image analysis and recognition.
CO5: Implement various graphics operations and algorithms using C language.

Course Contents:

Unit-1 - Fundamentals of Digital Image Processing (9 Hours)

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization. Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

Unit-2 - Image Enhancement (Spatial and Frequency Domain) (9 Hours)

Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Frequency Domain: Smoothing frequency domain filters- sharpening frequency domain filters Homomorphic filtering.

Unit-3 Image Restoration Techniques (9Hours)

Introduction to Image Restoration- degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.

Unit-4 - Concepts on Image Segmentation (9Hours)

Region of interest (ROI) selection - Feature extraction: Histogram based features - Intensity Features-Color, Shape Features-Local Binary Patterns (LBP), Texture descriptors- Grey Level Occurrence Matrix (GLCM). Fundamentals of Image Compression models – Error Free Compression – Variable Length Coding –Bit – Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding.

Unit-5 - Feature Extraction (9 Hours)

Extracting Interest Points and Their Descriptors (with Harris, SIFT and SURF) in Image Pairs, Principal Component Analysis (PCA) and Linear Discriminant Analysis for Image Recognition- Image Classification using SVM-ANN- Feedforward and Back propagation-Object Detection using CNN-RCNN

Learning Resources:

Textbooks

1. Rafael C. Gonzales, Richard E. Woods, *Digital Image Processing*, Third Edition, Pearson Education, 2010.
2. S. Sridhar, *Digital Image Processing*, Second Edition, Oxford University Press, 2016.
3. Anil K. Jain, *Fundamentals of Digital Image Processing*, PHI Learning Pvt. Ltd., 2011.
4. S. Jayaraman, S. Esaki Rajan, T. Veera Kumar, *Digital Image Processing*, Second Reprint, Tata McGraw Hill Pvt. Ltd., 2010.

References

1. Bhabatosh Chanda, Dwejesh Dutta Majumder, *Digital Image Processing and Analysis*, Second Edition, PHI Learning Pvt. Ltd., 2011.
2. Malay K. Pakhira, *Digital Image Processing and Pattern Recognition*, First Edition, PHI Learning Pvt. Ltd., 2011.

Digital Signal Processing

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to develop methods for processing discrete-time signals. It aims to help students acquire familiarity with digital filters in terms of design and implementation and to become familiar with how various types of filters affect signal characteristics. It also enables students to become familiar with some applications of digital processing.

Course Outcomes:

CO1: Develop methods for processing discrete-time signals.
CO2: Acquire familiarity with digital filters in terms of design and implementation and to become familiar with how various types of filters affect signal characteristics.
CO3: Become familiar with some applications of digital processing.
CO4: To understand the concept of digital signal processing and various operations on sequences.
CO5: To learn various methods for filter design and their realization.

Course Contents:

UNIT I DISCRETE FOURIER TRANSFORM (DFT)
The DFT & its properties; Inverse DFT, Linear filtering methods based on DFT - Use of DFT in linear filtering, filtering of long data sequences, Efficient computation of DFT algorithms-Radix2 (DIT & DIF), Radix4, Split radix algorithms. Linear filtering approach to computation of DFT-Goertzel algorithm, Chirp z transform, Fast Fourier Transform (FFT)

UNIT II DIGITAL FILTERS
Linear phase FIR filter, characteristic response, location of zeros, Design of FIR filter-Windowing, Frequency sampling, Design of IIR filters from Analog filters-Impulse invariance, Bilinear transformation, Matched z-transform.

UNIT III DIGITAL FILTER STRUCTURES
FIR filters - Direct form, Cascade form, Frequency sampling, Lattice IIR filter - Direct form I, Direct form II, Cascade form, Parallel form, Lattice & Lattice ladder. UNIT IV MULTIRATE DIGITAL SIGNAL PROCESSING Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D.

UNIT V DSP PROCESSORS
TMS C6xxx, Features, Architecture and Applications. Harvard Architecture, pipelining, Multiplier-Accumulator (MAC) Hardware. Architectures of Fixed- and Floating-point DSP processors. Addressing modes, functional modes. Memory architecture, on-chip peripherals of a DSP processor.

Learning Resources:

Text Books:

1. J. G. Proakis& D. G. Manolakis, Digital Signal Processing - Principles, Algorithms & Applications, PHI, 2000.
2. S. K. Mitra, Digital Signal Processing – A Computer Based Approach, MGH, 2010, 4th Edition.

Reference Books:

1. A. V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, PHI, 2000, 2nd Edition.

2. P. P. Vaidyanathan, Multi-Rate Systems and Filter Banks, Pearson Education, 1993.
3. Robert J. Schilling, Sandra L. Harris, Fundamentals of Digital Signal Processing using MATLAB, Thomson, 2010, 2nd Edition.

Other Suggested Readings:

1. Digital Signal Processing, IIT Delhi, Prof. S.C. Dutta Roy,
2. https://nptel.ac.in/courses/117102060

Video Analytics

COURSE CODE: **L:T:P-**

Rationale:

This course equips students with the theoretical knowledge and practical skills required for analyzing video data using computational and data mining techniques. It provides a foundation in understanding algorithms for object tracking, motion analysis, content-based video retrieval, and action recognition. By integrating statistical, machine learning, and pattern recognition approaches, students learn to address real-world challenges in video analytics. The course emphasizes analytical thinking, problem-solving, and the application of advanced algorithms to develop robust solutions in domains such as surveillance, multimedia content analysis, healthcare, and human-computer interaction.

Course Outcomes (COs)

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

CO 1: Understand the algorithms available for performing analysis on video data and address the challenges. *(Bloom's Level: L2 – Understand)*

CO 2: Understand the approaches for identifying and tracking objects and persons using motion-based algorithms. *(Bloom's Level: L2 – Understand)*

CO 3: Understand the algorithms available for searching and matching in video content. *(Bloom's Level: L2 – Understand)*

CO 4: Analyze approaches for action representation and recognition. *(Bloom's Level: L4 – Analyze)*

CO 5: Identify, analyze, and apply algorithms for developing solutions to real-world problems. *(Bloom's Level: L4 – Analyze/Apply)*

Content:

Module 1: Computational Statistics (– Hours)

Probability concepts, Sampling Concepts, Generating Random Variables, Exploratory Data Analysis, Monte Carlo Methods for Inferential Statistics, Data Partitioning, Probability Density Estimation, Statistical Pattern Recognition, Nonparametric Regression.

Module 2: Data Mining Fundamentals (– Hours)

Data mining algorithms, Instance and Features, Types of Features (data), Concept Learning and Concept Description, Output of data mining, Knowledge Representation, Classification and Regression Trees constructing.

Module 3: Decision Tree Algorithms (– Hours)

Classification trees, Algorithm for Normal Attributes, Information Theory and Information, Entropy, Building tree, Highly-Branching Attributes, ID3 to C4.5, CHAID, CART, Regression Trees, Model Trees, Pruning, Steps in Preprocessing, Discretization, Manual Approach, Binning, Entropy-based Discretization, Gaussian Approximation, K-tile method, Chi Merge, Feature extraction, selection and construction, Missing Data, Post processing.

Module 4: Regression and Association Rule Mining (– Hours)

Association Rule Mining: The Apriori Algorithm, Multiple Regression Analysis, Logistic Regression, k-Nearest Neighbor Classification, Constructing new attributes for algorithms of decision trees.

Module 5: Induction and Statistical Trees (– Hours)

Induction, Quick, Unbiased and Efficient Statistical Tree.

Text Books / References

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2011.
2. Yao Wang, JornOstermann and Ya-Qin Zhang, “Video Processing and Communications”, Prentice Hall, 2001.
3. A.MuratTekalp, “Digital Video Processing”, Pearson, 1995
4. Thierry Bouwmans, FatihPorikli, Benjamin Höferlin and Antoine Vacavant, “Background Modeling and Foreground Detection for Video Surveillance: Traditional and Recent Approaches, Implementations, Benchmarking and Evaluation”, CRC Press, Taylor and Francis Group, 2014.
5. Md. Atiqur Rahman Ahad, “Computer Vision and Action Recognition-A Guide for Image Processing and Computer Vision Community for Action Understanding”, Atlantis Press, 2011.

Social Network Analytics

Course code: L:T:P-

Rationale:

The course *Social Network Analytics* introduces students to the theory, methods, and practical applications of analyzing online social networks (OSNs) and social data. With the rapid growth of platforms like Facebook, Twitter, and Instagram, understanding the structure, dynamics, and influence patterns within social networks has become critical for both research and industry applications. The course equips students with foundational knowledge of social network modeling, data collection, and the measurement of social interactions. It emphasizes the use of social data analytics techniques, including topic modeling, sentiment analysis, information diffusion, and community detection, alongside practical case studies to demonstrate real-world applications. By integrating data mining concepts with social network analysis, students gain the ability to identify patterns, predict trends, and derive insights from complex social datasets. This course prepares learners to apply computational, analytical, and modeling techniques to explore behavior, influence, and decision-making within online communities, contributing to informed decision-making in areas such as marketing, urban planning, public policy, and digital media.

Course Outcomes:

CO1: To understand the basics of social networks and its modelling.
CO2: To understand the fundamental of social data analytics.
CO3: Understand and apply the data mining concepts in social networks.
CO4: Carry out some case studies in social network analysis.

CONTENT:

Unit 1
Online Social Networks (OSNs)
Introduction – Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data. Techniques to study different aspects of OSNs — Follower-followee dynamics, link farming, spam detection, hashtag popularity and prediction, linguistic styles of tweets. Case Study: An Analysis of Demographic and Behaviour Trends using Social Media: Facebook, Twitter and Instagram

Unit 2
Fundamentals of Social Data Analytics
Introduction – Working with Social Media Data, Topic Models, Modelling social interactions on the Web – Agent Based Simulations, Random Walks and variants, Case Study: Social Network Influence on Mode Choice and Carpooling during Special Events: The Case of Purdue Game Day

Unit 3
Applied Social Data Analytics
Application of Topic models, Information Diffusion, Opinions and Sentiments – Mining, Analysis and Summarization, Case Study: Sentiment Analysis on a set of Movie Reviews using Deep Learning techniques, Recommendation Systems, Language dynamics and influence in online communities, Community identification, link prediction and topical search in social networks, Case Study: The Interplay of Identity and Social Network: A Methodological and Empirical Study

Text and Reference Literature

1. Cioffi-Revilla, Claudio. Introduction to Computational Social Science, Springer, 2014.
2. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+,

Github, and More, 2nd Edition, O’Reilly Media, 2013.
3. Robert Hanneman and Mark Riddle. Introduction to social network methods. Online Text Book, 2005.
4. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013.
5. Claudio Castellano, Santo Fortunato, and Vittorio Loreto, Statistical physics of social dynamics, Rev. Mod. Phys. 81, 591, 11 May 2009.
6. S. Fortunato and C. Castellano, Word of mouth and universal voting behaviour in proportional elections, Phys. Rev. Lett. 99, (2007).
7. Douglas D. Heckathorn, The Dynamics and Dilemmas of Collective Action, American Sociological Review (1996).
8. Michael W. Macy and Robert Willer, From factors to actors: Computational Sociology and Agent-Based Modeling, Annual Review of Sociology Vol. 28: 143-166 (2002).
9. Nilanjan Dey Samarjeet Borah Rosalina Babo Amira Ashour, Social Network Analytics – Computational Research Methods and Techniques, First Edition, eBook ISBN: 9780128156414, Paperback ISBN: 9780128154588, Imprint: Academic Press, Published Date: 23rd November 2018

Data Mining

Course code: **L:T:P:3:0:0**

Rationale:

The objective of this course is to introduce students to the fundamental concepts of data warehousing and data mining. It aims to teach them how to design a data warehouse, apply data pre-processing techniques, and develop data mining models and algorithms for various business applications.

Course Outcomes:

CO1: To understand data mining principles and techniques as a basis for business decisions.
CO2: To apply pre-processing, data quality, and data cleaning techniques for better data.
CO3: To implement and analyze data mining algorithms for association rule mining.
CO4: To evaluate and apply classification, clustering, and prediction techniques.
CO5: To design and implement a data warehouse and perform data analysis using OLAP tools.

Course Contents:

Unit 1 – Introduction to Data Mining and Preprocessing
Introduction to Data Mining: Process of Knowledge Discovery; Database to Data Warehouses; Data Mining Functionalities
Data Preprocessing: Data Summarization; Data Cleaning; Data Integration; Data Transformation; Data Reduction; Data Discretization & Concept Hierarchy Generation

Unit 2 – Data Warehousing and OLAP
Data Warehousing Techniques: OLAP vs. OLTP; Data cubes; Multidimensional Data Models and Schemas with their definitions; OLAP operations; Data Warehouse Architectures and Design Strategies

Unit 3 – Frequent Pattern Mining and Association
Frequent Pattern Mining, Association Rule Generation, Correlation Analysis: Concepts; Frequent Itemset Mining Algorithms - Apriori, FP-Tree Growth; Association Rules & their types; Association to Correlation Data visualization

Unit 4 – Classification and Clustering
Classification Algorithms: Eager Learning Techniques – Decision trees, Naïve Bayesian Methods, Lazy Learning Techniques - K Nearest Neighbours, Case Based Reasoning
Cluster Analysis- Various Data types involved and Data Structures; Categories of Clustering Methods: Partitioning, Hierarchical, Density-based, Model-based; Industry Standard Techniques

Unit 5 – Advanced Mining and Applications
Mining Specific Data: Stream, Time-Series and Sequence Data Mining; Graph Mining; Text Mining; Web Data Mining Applications and Trends in Data Mining: Outlier Analysis and Fraud Detection; Social Impacts of Data Mining

Learning Resources:

Textbooks

1. J. Han, M. Kamber, and J. Pei, *Data Mining: Concepts and Techniques*, 3rd Edition, ELSEVIER.
2. P.-N. Tan, M. Steinbach, V. Kumar, *Introduction to Data Mining*, Pearson Education.

Reference Books

1. Margaret H. Dunham & S. Sridhar, *Data Mining: Introductory and Advanced Topics*, Pearson Education.

2. A. Berson, S. J. Smith, *Data Warehousing, Data Mining, & OLAP*, Tata McGraw-Hill Edition.

PE-VII (Any One FromThe Given of PE-VII)

Big Data Analytics

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to understand the challenges of conventional systems and the fundamentals of Big Data. It helps students comprehend the internal workings of different modules of Apache Hadoop and evaluate the performance of Big Data problems using the MapReduce model. It also aims to infer results from real-time applications using Apache Flume.

Course Outcomes:

CO1: To analyze the need and importance of fundamental concepts of Big Data.
CO2: To understand the internal functioning of different modules of Apache Hadoop.
CO3: To evaluate the performance of Big Data problems using the MapReduce model.
CO4: To infer results of real-time applications using Apache Flume.
CO5: To gain knowledge on Hive, its architecture, and its various components.
Course Contents:

Unit 1 – Introduction to Big Data

Analytics – Nuances of big data – Value – Issues – Case for Big data – Big data options Team challenge – Big data sources – Acquisition – Features of Big Data - Security, Compliance, auditing and protection - Evolution of Big data – Best Practices for Big data Analytics - Big data characteristics - Volume, Veracity, Velocity, Variety – Big Data Architecture – Big Data and Cloud.

Unit 2 – Data Analysis

Evolution of analytic scalability – Convergence – parallel processing systems – Cloud computing – grid computing – Map reduce Basics – Map Reduce Algorithm Design - enterprise analytic sand box – analytic data sets – Analytic methods – analytic tools – Cognos – Microstrategy – Pentaho - Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods.

Unit 3 – Stream Computing

Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window - Realtime Analytics Platform(RTAP) applications IBM Infosphere – Big data at rest – Infosphere streams – Data stage – Statistical analysis – Intelligent scheduler – Infosphere Streams.

Unit 4 – Predictive Analytics and Visualization

Predictive Analytics – Supervised – Unsupervised learning – Neural networks – Kohonen models – Normal – Deviations from normal patterns – Normal behaviours – Expert options – Variable entry - Mining Frequent itemsets - Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications.

Unit 5 – Frameworks and Applications

IBM for Big Data – Map Reduce Framework - Hadoop – Hive – Sharding - MongoDB – NoSQL Databases - S3 - Hadoop Distributed file systems – Hbase – Impala – Analyzing big data with Twitter and Facebook – Big data for E-commerce – Big data for blogs.

Learning Resources:

Text Books

1. Frank J Ohlhorst, "Big Data Analytics: Turning Big Data into Big Money", Wiley and SAS Business Series, 2012.
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.

Reference Books

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley and SAS Business Series, 2012.
2. Paul Zikopoulos, Chris Eaton, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill, 2011.
3. Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, "Harness the Power of Big Data – The Big Data Platform", McGraw Hill, 2012.

Information Storage and Retrieval

Course code: **L:T:P:3:0:0**

Rationale:

The course is designed to cover the basic concepts of information retrieval, such as data structures, indexing, and relevance feedback. It helps students understand text and multimedia data retrieval. It also aims to introduce advanced topics like web search, social networking analysis, and retrieval efficiency.

Course Outcomes:

CO1: To understand the fundamental principles and models of information storage and retrieval.
CO2: To design and implement indexing techniques for efficient retrieval.
CO3: To evaluate the performance of an information retrieval system using standard metrics.
CO4: To apply clustering and classification algorithms for information retrieval.
CO5: To analyze the challenges and modern trends in web search and multimedia retrieval.

Course Contents:

Unit 1 – Introduction to Information Retrieval
Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses, Information Retrieval System Capabilities.

Unit 2 – Information Storage
Storage of structured, semi-structured and unstructured data, introduction to VLDB (Very large databases), Resource Description Framework (RDF) for Storing semi-structured data.

Unit 3 – Natural Language Interface to Databases
Natural language query processing, intermediate representation, SQL command generation.

Unit 4 – Cataloging and Indexing
Indexing Processes, Information Extraction. Data Structures: Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure Automatic Indexing: Classes of automatic indexing, Statistical indexing, Concept indexing.

Unit 5 – Information Retrieval Models
Boolean model, Vector Space Model, Probabilistic information retrieval models.

Unit 6 – User Search Techniques
Similarity measures and ranking, Query expansion, Relevance feedback, Pseudo relevance feedback.

Unit 7 – Text Search Algorithms
Pattern matching Algorithms: Rabin-Karp, Knuth-Morris-Pratt, Boyer-Moore. Searching the web: PageRank algorithm, HITS algorithm.

Unit 8 – Multimedia Information Retrieval
Attribute-based image retrieval, Text-based image retrieval, Query by Image Content (Using content descriptors; color and texture, Identifying shapes - image objects) Streamed Image Retrieval - basic concepts, Improving Result Quality.

Unit 9 – Information Retrieval from Digital Libraries

Digital Libraries: history, definition, characteristics, architectures, collection management, Metadata. Representation of different media, Interoperability between different information resources, collections, and systems.

Unit 10 – Evaluation of Information Retrieval Systems

Measures used in system evaluation, Measurement example – TREC results.

Learning Resources:

Textbooks

1. Modern Information Retrieval, Ricardo Baeza-Yates, Pearson Education, 2007
2. Introduction to Information Retrieval, Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press, 2008

References

1. Mark T. Maybury, Kluwer Academic Press, 2000
2. Information Retrieval: Algorithms and Heuristics, David A. Grossman and Ophir Frieder, 2nd Edition, Springer International Edition, 2004
3. Information Retrieval Data Structures and Algorithms, William B. Frakes, Ricardo Baeza-Yates, Pearson Education, 1992
4. Information Storage & Retrieval, Robert Korfhage, John Wiley & Sons

Programming Environment and User Interface Design

Course code: **L:T:P:3:0:0**

Rationale:

This course aims to provide a clear understanding of graphical user interface (GUI) design principles and methodologies. It helps students learn to apply user-centered design approaches and develop interfaces for various platforms. It also focuses on the evaluation of user interfaces for usability and accessibility.

Course Outcomes:

CO1: To understand the human-computer interaction (HCI) fundamentals and design processes.
CO2: To analyze user requirements and design task flows for user interfaces.
CO3: To apply various GUI design principles and guidelines for effective interface design.
CO4: To develop user interfaces using modern programming languages and toolkits.
CO5: To evaluate the usability of a user interface using different evaluation methods.

Course Contents:

Unit I
Introduction :Importance of User Interfaces (UI) in Computer Applications. UI Design as an Engineering problem. Ergonomic aspects of UI, Cognitive and Cultural aspects of UI, Principles of UID Ease of Learning. Ease of Use – Consistency - Terseness. Design of Programming Environment Human Computer Interaction: Hick-Hyman Law Fitt's Law

Unit II
Formal methods for specification of UIs: Grammar, PetriNets, Menu Trees etc. UI Development Case study

Unit III
Interaction Elements Methodology for Design of Command Names Error Messages and Exception Handling Direct Manipulation - Graphic Design

Unit IV
Multilingual UI: Internationalization, Handling locale-sensitive UI components like screen, layouts, colors, date, time etc Web Design: Designing navigation, Increasing accessibility- interface for differently-abled users

Unit V
Advanced UIs :Groupware, 3D UIs, Virtual reality, Augmented reality, Multimedia UIs Evaluation of UIs

Learning Resources:

Textbooks

1. Norman, D. A. (1990). *The Design of Everyday Things*. New York, NY: Doubleday.
2. Schneiderman, B. (5th Ed.). *Designing the User Interface*. Addison Wesley.

References

1. Cooper, A. (3rd Ed.). *About Face: The Essentials of Interaction Design*. Wiley.

Advanced Numerical Computation

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce students to advanced numerical techniques for solving complex mathematical problems that are not solvable by analytical methods. It emphasizes the development of algorithms and the implementation of these techniques to solve real-world engineering problems.

Course Outcomes:

CO1: To apply numerical methods for solving linear and non-linear systems of equations.
CO2: To use interpolation and approximation techniques for data analysis.
CO3: To perform numerical differentiation and integration with a high degree of accuracy.
CO4: To solve ordinary and partial differential equations using finite difference and other methods.
CO5: To implement advanced numerical algorithms and analyze their convergence and stability.

Course Contents:

Unit I
Linear system of Equations: Solution using Over-relaxation Method, Solution of sparse linear system of equations, Eigenvalue and Eigenvectors, Singular Value Decomposition. [12L]

Unit I
Non-linear system of Equations: Newton's Method, Broyden's method. [2L]

Unit III
Ordinary Differential Equations: Initial Value problem: Solution using Runge-Kutta Method, Predictor-Corrector Method. [6L]

Unit IV
Boundary Value Problem: Solution using Shooting Method, Finite Difference Method, Finite Element Method. [8L]

Unit V
Partial Differential Equations: Modeling of practical applications using different types of Partial Differential Equations, Solution using Successive Over-Relaxation Method, Fourier Transform Method, Finite Element Methods.

Learning Resources:

Text Books

1. Numerical Methods for Scientists and Engineers by H.M. Antia, Third Edition, Hindustan Book Agency (India), 2012.
2. An Algorithmic Approach to Nonlinear Analysis and Optimization by Edward J. Beltrani, Academic Press, New York and London, 1970.

Reference Books

1. Numerical Mathematical Analysis by J. B. Scarborough and H. Milford, Oxford University Press, 1930.
2. Optimization and Non-smooth Analysis by F. H. Clarke, John Wiley and Sons, Inc., New York, 1983.

Distributed Computing

Course code: **L:T:P:3:0:0**

Rationale:

The course is designed to provide a comprehensive understanding of the principles, architectures, and applications of distributed computing. It aims to familiarize students with distributed systems models, communication protocols, and middleware technologies. It also covers concepts related to distributed file systems, consistency, and fault tolerance.

Course Outcomes:

CO1: To understand the fundamentals and challenges of distributed computing.
CO2: To analyze different models of distributed systems and their communication protocols.
CO3: To design and implement distributed applications using RPC, RMI, and other technologies.
CO4: To evaluate the performance and consistency of distributed file systems and shared memory.
CO5: To address issues of fault tolerance, security, and synchronization in a distributed environment.

Course Contents:

Unit-1 - Introduction to Distributed Computing **(9 Hours)**
Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges, A model of distributed executions, Global state of a distributed system, Cuts of a distributed computation, A framework for a system of logical clocks, Jard–Jourdan's adaptive technique, Physical clock synchronization: NTP, Classifications and basic concepts, Complexity measures and metrics

Unit-2 - Snapshot Recording and Graph Algorithms **(9 Hours)**
Snapshot algorithms for FIFO channels, Variations of the Chandy–Lamport algorithm, Snapshot algorithms for non-FIFO channels, Snapshots in a causal delivery system, Monitoring global state, Necessary and sufficient conditions for consistent global snapshots, Finding consistent global snapshots in a distributed computation, Elementary graph algorithms, A spanning-tree-based termination detection algorithm

Unit-3 - Distributed Mutual Exclusion Algorithms **(9 Hours)**
Lamport's algorithm, Ricart–Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm, Agarwal–El Abbadi quorum-based algorithm, Token-based algorithms, Suzuki–Kasami's broadcast algorithm, Raymond's tree-based algorithm

Unit-4 - Deadlock Detection **(9 Hours)**
Models of deadlocks, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single-resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy–Misra–Haas algorithm for the OR model, Kshemkalyani–Singhal algorithm for the P-out-of-Q model

Unit-5 - Checkpointing and Rollback Recovery **(9 Hours)**
Background and definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based rollback recovery, Koo–Toueg coordinated checkpointing algorithm, Juang–Venkatesan algorithm for asynchronous checkpointing and recovery, Manivannan–Singhal quasi-synchronous checkpointing algorithm, Peterson–Kearns algorithm based on vector time, Helary–Mostefaoui–Netzer–Raynal communication-induced protocol

Learning Resources:

Text Books

1. Ajay D. Kshemkalyani, Mukesh Singhal, *Distributed Computing: Principles, Algorithms, and Systems*, Cambridge University Press.
2. Tanenbaum S., *Distributed Operating Systems*, Pearson Education.

Reference Books

1. Tanenbaum S., Maarten V. Steen, *Distributed Systems: Principles and Paradigms*, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, *Distributed Systems: Concepts and Design*, Pearson Education.

Optimization Techniques

Course code: **L:T:P:3:0:0**

Rationale:

This course aims to equip students with the knowledge of various optimization methods, their applications, and their role in solving complex engineering and business problems. It covers both linear and non-linear programming, as well as heuristic and meta-heuristic approaches.

Course Outcomes:

CO1: To formulate and solve linear programming problems using graphical and simplex methods.
CO2: To apply non-linear programming techniques to solve unconstrained and constrained optimization problems.
CO3: To understand the principles of dynamic programming and its applications in optimization.
CO4: To implement heuristic algorithms for solving complex optimization problems.
CO5: To analyze and interpret the results of optimization models for decision-making.

Course Contents:

Unit 1
Modelling with linear programming – The Simplex method, Sensitivity Analysis, Integer linear programming: Branch and Bound technique – Transportation Model and its variants, Network Model: CPM and PERT - Deterministic and non-deterministic inventory models.

Unit 2
Heuristic and Meta Heuristic Programming: Simulated Annealing, Genetic Algorithm, Particle warm Optimization algorithm and Teaching learning-based optimization algorithm - Non-Linear Programming algorithms.

Unit 3
Introduction to Quadratic Programming: Constrained Optimization Problem Solving, Convex Optimization Methods.

Unit 4
Simulation Modelling: Random number generation, Random variate generation – Verification and Validation of simulation models.

Unit 5
Simulation of Computer Systems and Computer Networks.

Learning Resources:

Text Books

1. Hamdy A. Taha, *Operations Research: An Introduction*, 9th Edition, Pearson, 2017 (Chapters 1–8, 12, 14, 17)
2. Jerry Banks, Hon S. Carson, Barry L. Nelson, David M. Nicol, *Discrete Event Simulation*, 5th Edition, Pearson, 2010 (Chapters 8–12, 14, 15)

Information and Coding Theory

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce the fundamental concepts of information theory and coding theory. It aims to teach students how to measure information, understand channel capacity, and apply various error detection and correction codes to ensure reliable data communication.

Course Outcomes:

CO1: To understand the concepts of information, entropy, and mutual information.
CO2: To apply source coding techniques like Huffman and Shannon-Fano for data compression.
CO3: To analyze discrete and continuous communication channels and calculate their capacity.
CO4: To implement linear block codes and cyclic codes for error detection and correction.
CO5: To apply convolutional codes and Viterbi algorithm for reliable communication.

Course Contents:

Unit – I: Information Theory
Introduction to Information Theory, Information and Entropy ,Joint Entropy, Mutual Information, Extension of a zero Memory Source, Source Encoding, Kraft's Inequality, Huffman Coding ,Shannon's 1st Fundamental Theorem ,Idea of Markov Source BSC, BEC and Channel Capacity

Unit – II: Coding Theory (Basics)
Introduction to Coding Theory ,Block Codes: Introduction ,Parity Check Code, Product Code, Repetition Code ,Hamming Code, Minimum Distance of Block Codes

Unit – III: Review of Linear Algebra and Galois Field
Finite Field, Vector Spaces, Matrices, Roots of Equation, GF(2p), Primitive Field Element,Irreducible and Primitive Polynomial, Minimal Polynomial

Unit – IV: Linear Codes
Definition, Systematic Format, Generator and Parity Check Matrices, Syndrome and Error Detection, Standard Array and Syndrome Decoding, Hamming Code

Unit – V: Cyclic and Advanced Codes
Cyclic Codes: Definition, Generator Polynomial and Its Properties, Parity Check Polynomial, Encoding and Decoding ,Cyclic Hamming Code ,Introduction to BCH Codes and Advanced topics

Learning Resources:

Text Books

1. Principles of Digital Communication – Das, Mukherjee, Chatterjee
2. Introduction to Error Control Codes – S. Gravano
3. Error Control Coding: Fundamentals and Applications – Shu Lin, Daniel J. Costello, Jr.

Reference Books

1. The Theory of Error-Correcting Codes, Vol 1 & 2 – F. J. MacWilliams and N. J. A. Sloane
2. Coding and Information Theory – Richard W. Hamming
3. Handbook of Coding Theory, Vol 1 & 2 – V. S. Pless and W. C. Huffman
4. Algebraic Codes for Data Transmission – Richard E. Blahut
5. Introduction to Coding Theory – Jacobus Hendricus van Lint
6. Coding and Information Theory – Steven Roman
7. Error Control Coding – Shu Lin and Daniel J. Costello

<u>**Cryptography**</u>

Course code: **L:T:P:3:0:0**

Rationale:

This course provides a comprehensive overview of cryptographic techniques and their application in network and data security. It aims to help students understand the mathematical foundations of cryptography, including number theory and finite fields, and to apply both symmetric and asymmetric encryption algorithms.

Course Outcomes:

CO1: To understand the fundamental concepts of cryptography, including security attacks and services.
CO2: To analyze and implement symmetric encryption algorithms like DES and AES.
CO3: To apply public-key cryptography and digital signatures for secure communication.
CO4: To understand message authentication, hash functions, and key management.
CO5: To evaluate the security of cryptographic protocols and their application in real-world scenarios

Course Contents:

Unit 1 – Introduction to Cryptography
Cryptosystem. Encryption and Decryption. Cryptographic Attacks. Notions of Security. Perfect Secrecy. Symmetric and Asymmetric Key Cryptosystems. Block and Stream Ciphers.

Unit 2 – DES and AES
Data Encryption Standard. Advanced Encryption Standard. Variants of DES and AES.

Unit 3 – Stream Ciphers
LFSR based stream ciphers, software stream ciphers.

Unit 4 – Cryptanalysis
Differential Cryptanalysis. Linear Cryptanalysis. Correlation. Algebraic and other attacks.

Unit 5 – Public Key and Related Concepts
RSA and other public key systems. Elliptic Curve Cryptosystems. Hash Functions. Identification and Authentication. Digital Signatures.

Unit 6 – Key Management
Key Distribution. Key Agreement. Key Exchange protocols. Public key infrastructure.

Unit 7 – Protocols and Techniques
Secret Sharing. Multiparty Computation. Zero-knowledge Protocols.

Learning Resources:

Text Books

1. Fundamentals of Computer Security by Josef Pieprzyk, Thomas Hardjono and Jennifer Seberry, Springer, 2008.
2. Cryptography: Theory and Practice by Douglas Stinson, CRC Press, 2006.

Reference Books

1. Applied Cryptography: Protocols, Algorithms, and Source Code in C by Bruce Schneier, Wiley, 1996.
2. Handbook of Applied Cryptography by Alfred Menezes, Paul van Oorschot and Scott Vanstone, CRC Press, 1996.

<u>Information Security</u>

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to introduce students to the core concepts of information security and its various domains. It helps them understand the security risks and vulnerabilities in modern information systems and apply appropriate countermeasures to protect data and assets.

Course Outcomes:

CO1: To understand the principles and concepts of information security.
CO2: To identify security threats, vulnerabilities, and risks in various systems.
CO3: To apply access control and authentication mechanisms for securing information.
CO4: To implement security policies and procedures for a secure environment.
CO5: To analyze and evaluate the security of databases, operating systems, and networks.

Course Contents:

Unit I – Introduction
History, What is Information Security?, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC.

Unit II – Security Investigation
Need for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues, An Overview of Computer Security, Access Control Matrix, Policy, Security policies, Confidentiality policies, Integrity policies and Hybrid policies.

Unit III – Security Analysis
Risk Management, Identifying and Assessing Risk, Assessing and Controlling Risk, Systems: Access Control Mechanisms, Information Flow and Confinement Problem.

Unit IV – Logical Design
Blueprint for Security, Information Security Policy, Standards and Practices, ISO 17799/BS 7799, NIST Models, VISA, International Security Model, Design of Security Architecture, Planning for Continuity.

Unit V – Physical Design
Security Technology, IDS, Scanning and Analysis Tools, Cryptography, Access Control Devices, Physical Security, Security and Personnel.

Learning Resources:

Text Book
1. Michael E. Whitman, Herbert J. Mattord, *Principles of Information Security*, Vikas Publishing House, New Delhi, 2003.

Reference Books
1. Micki Krause, Harold F. Tipton, *Handbook of Information Security Management*, Vol. 1-3, CRC Press LLC, 2004.
2. Stuart McClure, Joel Scrambray, George Kurtz, *Hacking Exposed*, Tata McGraw Hill, 2003.
3. Matt Bishop, *Computer Security Art and Science*, Pearson/PHI, 2002.

Approximation Algorithms

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to provide an understanding of approximation algorithms for NP-hard problems. It aims to introduce techniques for designing approximation algorithms, such as greedy algorithms, local search, and dynamic programming. It also helps students analyze the performance of these algorithms and their approximation ratios.

Course Outcomes:

CO1: To understand the concepts of NP-hard problems and the need for approximation algorithms.
CO2: To apply greedy and local search heuristics for designing approximation algorithms.
CO3: To analyze the approximation ratio and complexity of a given algorithm.
CO4: To design approximation algorithms for classical problems like Vertex Cover, Knapsack, and Traveling Salesperson.
CO5: To understand the limitations of approximation algorithms and the concept of inapproximability.

Course Contents:

Unit I
Review of Complexity Classes, NP and NP Completeness, Space Complexity, Hierarchies, Circuit satisfiability, Savitch and Immerman-Szelepcsényi Theorems, Karp Lipton Theorem.

Unit II
Randomized Complexity classes, Randomized Polynomial Time (RP), Bounded Probabilistic Polynomial Time (BPP), Zero-error Probabilistic Polynomial (ZPP), Adleman's theorem, Sipser Gacs theorem, Randomized Reductions, Counting Complexity, Permanent’s and Valiant’s Theorem.

Unit III
Parallel complexity, P-completeness, Sup-liner space classes, Renegold's theorem.

Unit IV
Polynomial hierarchy, Toda's theorem, Arthur Merlin games.

Unit V
Graph Isomorphism problem, Goldwasser-Sipser theorem, Interactive Proofs, Shamir's theorem

Learning Resources:

Text Book

1. *Computational Complexity: A Modern Approach* by Sanjeev Arora and Boaz Barak, Cambridge University Press, 2009.

Reference Books

1. *Computational Complexity* by C. H. Papadimitriou, Addison Wesley, First Edition, 1993.
2. *Randomized Algorithms* by R. Motwani, Cambridge University Press, 1995.
3. *Approximation Algorithms* by V. Vazirani, Springer, First Edition, 2004.

OPEN ELECTIVE-II & III

OE-II (Any one FromThe Given of OE-II)

Advanced Numerical Methods

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to provide students with a deeper understanding of numerical methods for solving complex engineering and scientific problems. It covers advanced topics beyond basic numerical techniques, including finite element methods, computational fluid dynamics, and solutions to large systems of equations.

Course Outcomes:

CO1: To apply advanced numerical methods for solving linear and non-linear systems of equations efficiently.
CO2: To use numerical techniques for solving boundary value problems in ordinary and partial differential equations.
CO3: To perform numerical optimization and root-finding for complex functions.
CO4: To analyze the stability and error characteristics of various numerical algorithms.
CO5: To implement and apply advanced numerical methods for real-world simulation and modeling.

Course Contents:

UNIT I

Error Analysis: Exact and approximate numbers, Rounding of numbers, Significant digits, Correct digits, various types of errors encountered in computations, Propagation of errors.

UNIT II

Solutions of system of linear equations: (i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU decomposition method. (ii) Iterative methods: Jacobi and Gauss-Seidel methods.

UNIT III

Roots of non-linear equations: Bisection method, Regula-Falsi method, Newton-Raphson method, direct iterative method with convergence criteria, Newton-Raphson method for solution of a pair of non-linear equations.

UNIT IV

Eigenvalues and eigenvectors: Dominant and smallest eigenvalues/eigenvectors by power method.

UNIT V

Interpolation: Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation. 6

UNIT VI

Numerical differentiation: First and second order derivatives by various interpolation formulae.

UNIT VII

Numerical integration: Trapezoidal, Simpsons 1/3rd and 3/8th rules with errors and their combinations, Gauss Legendre 2-points and 3-points formulae.

UNIT VIII

Numerical Solutions of first and second order ordinary differential equations: Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.

Learning Resources:

TextBooks:

1. Gerald, C. F. and Wheatly, P. O., "Applied Numerical Analysis", 7th Ed., Pearson Education India, 2007.
2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", 8th Ed., New Age International Pvt. Ltd., New Delhi, 2022.

References:

1. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw-Hill Publisher, 1982.
2. Krishnamurthy, E. V. and Sen, S. K., "Applied Numerical Analysis", East-West Publication, 1998.

Random Processes

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce the concepts of random variables and stochastic processes. It aims to provide students with the necessary mathematical tools to model and analyze random phenomena in various engineering domains, such as signal processing, communication systems, and control systems.

Course Outcomes:

CO1: To understand the fundamental concepts of probability and random variables.
CO2: To analyze the statistical properties of random processes, including stationarity and ergodicity.
CO3: To apply correlation functions and power spectral density to characterize random signals.
CO4: To model and analyze the response of linear systems to random inputs.
CO5: To solve problems involving random processes in communication and signal processing applications.

Course Contents:

UNIT I RANDOM VARIABLES 9
Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

UNIT II RANDOM PROCESSES 9
Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

UNIT III SPECIAL RANDOM PROCESSES 9
Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 9
Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9
Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

Learning Resources:

Text Books:

1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th Edition, New Delhi, 2002.

References:

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., “Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.

4. Stark. H. and Woods. J.W., “Probability and Random Processes with Applications to Signal Processing", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., “Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

Queuing and Reliability Modelling

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to provide an in-depth understanding of queuing theory and reliability modeling, which are essential for analyzing the performance of computer systems and communication networks. It helps students apply queuing models to solve resource allocation problems and use reliability theory to assess the dependability of software and hardware.

Course Outcomes:

CO1: To apply queuing models to analyze system performance, including waiting times and server utilization.
CO2: To understand the concepts of Markov chains and their application in queuing theory.
CO3: To use reliability models to estimate the probability of system success or failure.
CO4: To perform reliability analysis for complex systems using fault trees and reliability block diagrams.
CO5: To model and solve problems related to reliability, availability, and maintainability (RAM) in engineering systems.

Course Contents:

UNIT I RANDOM PROCESSES 9

Classification – Stationary process – Markov process – Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

UNIT II MARKOVIAN QUEUEING MODELS 9

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula – Queues with finite waiting rooms.

UNIT III ADVANCED QUEUEING MODELS 9

M/G/1 queue – PollaczekKhinchin formula – M/D/1 and M/EK/1 as special cases – Series queues – Open Jackson networks.

UNIT IV SYSTEM RELIABILITY 9

Reliability and hazard functions – Exponential, Normal, Weibull and Gamma failure distribution – Time-dependent hazard models – Reliability of Series and Parallel Systems.

UNIT V MAINTAINABILITY AND AVAILABILITY 9

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems

Learning Resources:

Text Books:

1. Shortle J.F., Gross D., Thompson J.M., Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York, 2018.
2. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.

References:

1. Medhi J., "Stochastic Models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.

2. Taha H.A., “Operations Research”, 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi K.S., “Probability and Statistics with Reliability, Queueing and Computer Science Applications”, 2nd Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1983.

Production and Operations Management for Entrepreneurs

Course code: **L:T:P:3:0:0**

Rationale:

The course objective is to provide a solid understanding of the principles of production and operations management for entrepreneurial ventures. It aims to equip students with the skills to design, plan, and control operational systems to optimize efficiency, quality, and cost-effectiveness.

Course Outcomes:

CO1: To understand the strategic role of operations management in a business.
CO2: To apply forecasting, capacity planning, and inventory management techniques.
CO3: To design and analyze production and service delivery systems.
CO4: To implement quality management and lean manufacturing principles.
CO5: To develop an operations plan for a new product or service.

Course Contents:

UNIT I INTROUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research 308

UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters – Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing – Plant design optimisation -Forecasting methods.

UNIT V CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

Learning Resources:

References:

1. Mikell P. Groover, *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson, 2007.
2. Amitabh Raturi, *Production and Inventory Management*, 2008.
3. Adam Jr. Ebert, *Production and Operations Management*, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, *Production and Operation Management*, Macmillan India, 1992.
5. Chary S.N., *Production and Operations Management*, TMH Publications, 2010.
6. Terry Hill, *Operation Management*, Palgrave McMillan (Case Study), 2005.

Multivariate Data Analysis

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to introduce students to the theory and application of multivariate statistical methods. It helps them analyze datasets with multiple variables simultaneously and uncover underlying structures and relationships. It is an essential course for students specializing in data science, machine learning, and quantitative research.

Course Outcomes:

CO1: To understand the concepts and assumptions of multivariate statistical analysis.
CO2: To apply dimensionality reduction techniques like Principal Component Analysis (PCA) and Factor Analysis.
CO3: To perform multivariate regression and correlation analysis.
CO4: To use classification techniques such as Discriminant Analysis and clustering methods.
CO5: To interpret and visualize the results of multivariate data analysis.

Course Contents:

UNIT I INTRODUCTION 9
Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

UNIT II PREPARING FOR MULTIVARIATE ANALYSIS 9
Conceptualization of research model with variables, collection of data –-Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS9
Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

UNIT IV LATENT VARIABLE TECHNIQUES 9
Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

UNIT V ADVANCED MULTIVARIATE TECHNIQUES 9
Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

Learning Resources:

References:

1. Joseph F. Hair, Rolph E. Anderson, Ronald L. Tatham & William C. Black, *Multivariate Data Analysis*, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S. Fidell, *Using Multivariate Statistics*, 6th Edition, Pearson, 2012.
3. Richard A. Johnson and Dean W. Wichern, *Applied Multivariate Statistical Analysis*, Prentice Hall, New Delhi, 2005.
4. David R. Anderson, Dennis J. Seveency, and Thomas A. Williams, *Statistics for Business and Economics*, Thompson, Singapore, 2002.

Additive Manufacturing

Course code: **L:T:P:3:0:0**

Rationale:

The course is designed to introduce students to the principles and applications of additive manufacturing (AM), also known as 3D printing. It covers the fundamental technologies, materials, and design considerations for AM. The course aims to prepare students for the rapidly evolving field of digital fabrication and rapid prototyping.

Course Outcomes:

CO1: To understand the basic principles, classifications, and applications of additive manufacturing technologies.
CO2: To identify and select appropriate materials and processes for specific AM applications.
CO3: To apply design for additive manufacturing (DFAM) principles for creating functional parts.
CO4: To operate and troubleshoot a 3D printer for producing parts.
CO5: To analyze the advantages and disadvantages of AM compared to traditional manufacturing processes.

Course Contents:

UNIT I INTRODUCTION 9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION 9

Photo polymerization: Stereolithography Apparatus (SLA) - Materials - Process - Top down and Bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Material Extrusion: Fused Deposition Modeling (FDM) - Process - Materials - Applications and Limitations.

UNIT III POWDER BED FUSION AND BINDER JETTING 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION 9

Material Jetting: Multijet Modeling - Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials - Benefits - Applications.

UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY 9

Sheet Lamination: Laminated Object Manufacturing (LOM) - Basic Principle - Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

Learning Resources:

Text Books:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani, *Additive Manufacturing Technologies*, 3rd Edition, Springer, Cham, Switzerland, 2021. ISBN: 978-3-030-56126-0.
2. Andreas Gebhardt and Jan-Steffen Hötter, *Additive Manufacturing: 3D Printing for Prototyping and Manufacturing*, Hanser Publications, United States, 2015. ISBN: 978-1-56990-582-CME343.

References:

1. Andreas Gebhardt, *Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing*, Hanser Gardner Publication, Cincinnati, Ohio, 2011. ISBN: 9783446425521.
2. Milan Brandt, *Laser Additive Manufacturing: Materials, Design, Technologies, and Applications*, Woodhead Publishing, United Kingdom, 2016. ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, *Additive Manufacturing*, 1st Edition, CRC Press, United States, 2015. ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., *Rapid Prototyping: Theory and Practice*, Springer, United States, 2006. ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., *Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development*, CRC Press, United States, 2011. ISBN: 9780849334092.

New Product Development

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to provide a holistic understanding of the new product development (NPD) process from a business and engineering perspective. It aims to equip students with the tools and techniques for identifying customer needs, generating innovative ideas, and managing the entire product lifecycle from concept to commercialization.

Course Outcomes:

CO1: To understand the stages and key activities in the new product development process.
CO2: To apply market research and customer needs analysis techniques.
CO3: To generate and evaluate new product ideas using brainstorming and other creative methods.
CO4: To develop a business plan and marketing strategy for a new product.
CO5: To understand the role of intellectual property and legal aspects in product development.

Course Contents:

UNIT I FUNDAMENTALS OF NPD 9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT III ESSENTIALS OF NPD 9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT IV CRITERIONS OF NPD 9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT V REPORTING & FORWARD-THINKING OF NPD 9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost).

Learning Resources:

Text Books:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

References:

1. Revolutionizing Product Development – Steven C. Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands, 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr

Industrial Design & Rapid Prototyping Techniques

Course code: **L:T:P:3:0:0**

Rationale:

This course aims to introduce students to the fundamentals of industrial design and rapid prototyping. It helps them understand the principles of form, function, and aesthetics in product design and apply modern rapid prototyping techniques to quickly create physical models.

Course Outcomes:

CO1: To understand the principles and history of industrial design.
CO2: To apply sketching, rendering, and computer-aided design (CAD) tools for product visualization.
CO3: To use rapid prototyping techniques like FDM, SLA, and SLS for creating physical prototypes.
CO4: To evaluate the form, fit, and function of a prototype.
CO5: To manage a design project from concept to a tangible prototype.

Course Contents:

UNIT I – UI/UX 9

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry - User engagement ethics - Design alternatives

UNIT II – APP DEVELOPMENT 9

SDLC - Introduction to App Development - Types of Apps - Web Development - Understanding Stack - Frontend - Backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup - Reading and writing data to cloud - Embedding ML models to Apps - Deploying application

UNIT III – INDUSTRIAL DESIGN 9

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

UNIT IV – MECHANICAL RAPID PROTOTYPING 9

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT V – ELECTRONIC RAPID PROTOTYPING 9

Basics of electronic circuit design - Lumped circuits - Electronic Prototyping - Working with simulation tool - Simple PCB design with EDA

Learning Resources:

Text Books:

1. Basics of electronic circuit design - Lumped circuits - Electronic Prototyping - Working with simulation tool - Simple PCB design with EDA

2. Peter Fiell, Charlotte Fiell, *Industrial Design A-Z*, TASCHEN America LLC, 2003
3. Samar Malik, *Autodesk Fusion 360 - The Master Guide*
4. Steve Krug, *Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability*, Pearson, 3rd edition, 2014

References:

1. Adobe XD Learning Resources
2. Android Developer Guide
3. Autodesk Fusion 360 Learning Courses
4. PrusaSlicer Help and Tutorials

Micro and Precision Engineering

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to introduce students to the specialized field of micro and precision engineering. It aims to provide knowledge of microfabrication techniques, precision measurement tools, and the design of miniaturized systems. It is a fundamental course for students interested in MEMS, nanotechnology, and micro-robotics.

Course Outcomes:

CO1: To understand the principles and challenges of micro and precision engineering.
CO2: To apply microfabrication techniques, such as photolithography and thin-film deposition.
CO3: To use precision metrology tools for measuring micro-scale features.
CO4: To design and analyze microelectromechanical systems (MEMS).
CO5: To understand the applications of micro and precision engineering in various industries.

Course Contents:

UNIT I

Learn about the precision machine tools. Learn about the macro and micro components. Understand handling and operating of the precision machine tools. Learn to work with miniature models of existing machine tools/robots and other instruments. Learn metrology for micro system. INTRODUCTION TO MICROSYSTEMS: Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II

FABRICATION PROCESSES FOR MICRO-SYSTEMS: Additive, subtractive, forming process, microsystems-Micro-pumps, micro-turbines, micro engines, micro-robot, and miniature biomedical devices.

UNIT III

INTRODUCTION TO PRECISION ENGINEERING: Machine tools, holding and handling devices, positioning fixtures for fabrication/assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick-slip mechanism and other piezo-based devices.

UNIT IV

PRECISION MACHINING PROCESSES: Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V

METROLOGY FOR MICRO SYSTEMS: Metrology for micro systems - Surface integrity and its characterization.

Learning Resources:

Text Books:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

References:

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994
4. Murthy, R. L., Precision Engineering in Manufacturing, New Age International, New Delhi, 2005

Cost Management of Engineering Projects

Course code: **L:T:P:3:0:0**

Rationale:

This course aims to equip students with the skills to effectively manage the financial aspects of engineering projects. It covers fundamental concepts of project cost estimation, budgeting, and control, as well as an understanding of the economic factors influencing project success.

Course Outcomes:

CO1: To apply cost estimation techniques for engineering projects.
CO2: To develop project budgets and manage financial resources effectively.
CO3: To use cost control and earned value management for tracking project performance.
CO4: To understand the financial and economic evaluation of engineering projects.
CO5: To manage project risks related to cost and schedule.

Course Contents:

UNIT I INTRODUCTION TO COSTING CONCEPTS
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory

Learning Resources:

Text Books:

1. John M. Nicholas, Herman Steyn, Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561
2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X

References:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, A. H. Wheeler Publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al., Cost Accounting: A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S. Kaplan, Anthony A. Atkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE-III (Any one FromThe Given of OE-III)

Reverse Engineering

Course code: **L:T:P:3:0:0**

Rationale:

The course is designed to introduce students to the principles and applications of reverse engineering. It aims to provide the skills to analyze and deconstruct a product or a system to understand its design, functionality, and components. The course also covers the ethical and legal aspects of reverse engineering.

Course Outcomes:

CO1: To understand the principles, phases, and applications of reverse engineering.
CO2: To analyze software and hardware systems to understand their internal workings.
CO3: To use reverse engineering tools for software disassembly and code analysis.
CO4: To apply reverse engineering techniques for security analysis and vulnerability assessment.
CO5: To understand the legal and ethical considerations of reverse engineering.

Course Contents:

Unit-I Introduction & geometric form **9 hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

Unit-II Material characteristics and process identification **9 hours**

Alloy structure equivalency – phase formation and identification – mechanical strength – hardness – part failure analysis – fatigue – creep and stress rupture – environmentally induced failure material specification - composition determination - microstructure analysis - manufacturing process verification.

Unit-III Data processing **9 hours**

Statistical analysis – data analysis – reliability and the theory of interference – weibull analysis – data conformity and acceptance – data report – performance criteria – methodology of performance evaluation – system compatibility.

Unit-IV 3d scanning and modelling **9 hours**

Introduction, working principle and operations of 3d scanners: laser, white light, blue light - applications - software for scanning and modelling: types - applications - preparation techniques for scanning objects - scanning and measuring strategies - calibration of 3d scanner - step by step procedure: 3d scanning - geometric modelling – 3d inspection - case studies.

Unit-V Industrial applications **9 hours**

Reverse engineering in the automotive industry; aerospace industry; medical device industry. Case studies and solving industrial projects in reverse engineering. Legality: patent – copyrights – trade secret – third-party materials.

Learning Resources:

Text books

1. Robert W. Messler, Reverse engineering: mechanisms, structures, systems & materials, 1st edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse engineering technology of reinvention, CRC Press, 2011

References

1. Scott J. Lawrence, Principles of reverse engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product design: techniques in reverse engineering and new product development, Prentice Hall, 2001
3. Kathryn A. Ingle, Reverse engineering, McGraw-Hill, 1994
4. Linda Wills, Reverse engineering, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, Reverse engineering: an industrial perspective, Springer-Verlag London Limited, 2008

<u>Sustainable Manufacturing</u>

Course code: **L:T:P:3:0:0**

Rationale:

This course aims to introduce the concepts and principles of sustainable manufacturing. It helps students understand the environmental, social, and economic impacts of manufacturing processes and to design and implement strategies for reducing waste, conserving energy, and minimizing pollution.

Course Outcomes:

CO1: To understand the principles and concepts of sustainable manufacturing.
CO2: To analyze the environmental impact of manufacturing processes using life cycle assessment.
CO3: To apply green design and manufacturing principles for product development.
CO4: To implement waste reduction, energy efficiency, and pollution prevention strategies.
CO5: To understand the role of renewable energy and resource management in sustainable manufacturing.

Course Contents:

Unit-I Economic sustainability **9**

Industrial revolution - economic sustainability: globalization and international issues sustainability status - emerging issues - innovative products - reconfiguration manufacturing enterprises - competitive manufacturing strategies - performance evaluation - management for sustainability - assessments of economic sustainability

Unit-II Social and environmental sustainability **9**

Social sustainability – introduction - work management - human rights - societal commitment - customers - business practices - modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: pollution - use of resources - pressure to reduce costs - environmental management: processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing operations - modelling and assessing environmental sustainability

Unit-III Sustainability practices **9**

Sustainability awareness - measuring industry awareness - drivers and barriers - availability of sustainability indicators - analysis of sustainability practicing - modeling and assessment of sustainable practicing - sustainability awareness - sustainability drivers and barriers - availability of sustainability indicators - designing questionnaires - optimizing sustainability indexes - elements – cost and time model

Unit-IV Manufacturing strategy for sustainability **9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - manufacturing strategy in business success strategy formation and formulation - structured strategy formulation - sustainable manufacturing system design options - approaches to strategy formulation - realization of new strategies/system designs

Unit-V Trends in sustainable operations **9**

Principles of sustainable operations - life cycle assessment manufacturing and service activities - influence of product design on operations - process analysis – capacity management - quality management - inventory management - just-in-time systems - resource efficient design - consumerism and sustainable well-being

Learning Resources:

Text Books:

1. Ibrahim Garbie, "Sustainability in manufacturing enterprises concepts, analyses and assessments for industry 4.0", Springer International Publishing, United States, 2016, ISBN-13: 978-3319293042
2. Davim J.P., "Sustainable manufacturing", John Wiley & Sons, United States, 2010, ISBN: 978-1-848-21212-1

References:

1. Jovane F, Ęmper, W.E. and Williams, D.J., "The manufuture road: towards competitive and sustainable high-adding-value manufacturing", Springer, 2009, United States, ISBN 978-3-540-77011-4
2. Kutz M., "Environmentally conscious mechanical design", John Wiley & Sons, United States, 2007, ISBN: 978-0-471-72636-4
3. Seliger G., "Sustainable manufacturing: shaping global value creation", Springer, United States, 2012, ISBN 978-3-642-27289-9

Electric and Hybrid Vehicles

Course code: **L:T:P:3:0:0**

Rationale:

The course is designed to introduce students to the principles and technologies of electric and hybrid vehicles (EHVs). It aims to provide knowledge of the components, architectures, and control systems of EHVs. The course also covers the challenges and future trends in this rapidly growing industry.

Course Outcomes:

CO1: To understand the components and working principles of electric and hybrid vehicles.
CO2: To analyze the performance of different EHV architectures, including series, parallel, and series-parallel hybrids.
CO3: To apply battery management systems and charging technologies for EHVs.
CO4: To model and simulate the energy consumption and performance of EHVs.
CO5: To understand the challenges and future trends in EHV technology

Course Contents:

Unit-I Design considerations for electric vehicles **9**

Need for electric vehicle - comparative study of diesel, petrol, hybrid and electric vehicles. Advantages and limitations of hybrid and electric vehicles - design requirement for electric vehicles - range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various resistance - transmission efficiency - electric vehicle chassis and body design, electric vehicle recharging and refuelling systems

Unit-II Energy sources **9**

Battery parameters - different types of batteries – lead acid - nickel metal hydride - lithium ion - sodium based - metal air. Battery modelling - equivalent circuits, battery charging - quick charging devices. Fuel cell - fuel cell characteristics - fuel cell types - half reactions of fuel cell. Ultra capacitors. Battery management system

Unit-III Motors and drives **9**

Types of motors - dc motors - ac motors, pmsm motors, bldc motors, switched reluctance motors working principle, construction and characteristics

Unit-IV Power converters and controllers **9**

Solid state switching elements and characteristics – bjt, mosfet, igbt, scr and triac - power converters – rectifiers, inverters and converters - motor drives - dc, ac motor, pmsm motors, bldc motors, switched reluctance motors – four quadrant operations – operating modes

Unit-V Hybrid and electric vehicles **9**

Main components and working principles of a hybrid and electric vehicles, different configurations of hybrid and electric vehicles. Power split devices for hybrid vehicles - operation modes - control strategies for hybrid vehicle - economy of hybrid vehicles - case study on specification of electric and hybrid vehicles

Learning Resources:

Text Books

1. Iqbal Husain, “Electric and hybrid vehicles - design fundamentals”, CRC Press, 2003
2. Mehrdad Ehsani, “Modern electric, hybrid electric and fuel cell vehicles”, CRC Press, 2005

References

1. James Larminie and John Lowry, “Electric vehicle technology explained”, John Wiley & Sons, 2003
2. Lino Guzzella, “Vehicle propulsion system”, Springer Publications, 2005
3. Ron Hodkinson, “Light weight electric/ hybrid vehicle design”, Butterworth Heinemann Publication, 2005

Space Engineering

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to introduce students to the fundamentals of space engineering, including orbital mechanics, spacecraft design, and space mission operations. It provides a multi-disciplinary approach covering topics from aerospace engineering, electronics, and computer science as applied to space missions.

Course Outcomes:

CO1: To understand the principles of orbital mechanics and spacecraft dynamics.
CO2: To analyze and design spacecraft subsystems, including propulsion, attitude control, and power.
CO3: To apply communication protocols and data handling techniques for space missions.
CO4: To understand the various phases of a space mission, from launch to operation.
CO5: To model and simulate simple space missions.

Course Contents:

Unit-I Standard atmosphere **6**

History of aviation – standard atmosphere - pressure, temperature and density altitude

Unit-II Aerodynamics **10**

Aerodynamic forces – lift generation viscosity and its implications - shear stress in a velocity profile - lagrangian and eulerian flow field - concept of a streamline – aircraft terminology and geometry - aircraft types - lift and drag coefficients using naca data

Unit-III Performance and propulsion **9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations - thrust/power available and thrust/power required

Unit-IV Aircraft stability and structural theory **10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - hooke's law - brittle and ductile materials - moment of inertia - section modulus

Unit-V Space applications **10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - kepler's laws of orbits - newtons law of gravitation

Learning Resources:

Text Books

1. John D. Anderson, Introduction to flight, 8th ed., McGraw-Hill Education, New York, 2015
2. E Rathakrishnan, "Introduction to aerospace engineering: basic principles of flight", John Wiley, NJ, 2021

3. Stephen A. Brandt, "Introduction to aeronautics: a design perspective", American Institute of Aeronautics & Astronautics, 1997

Reference

1. Kermode, A.C., "Mechanics of flight", Himalayan Book, 1997

Industrial Management

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to provide students with the foundational knowledge of industrial management principles and practices. It aims to equip them with the skills to effectively manage human resources, production, and operations in an industrial setting.

Course Outcomes:

CO1: To understand the functions of management, including planning, organizing, staffing, and controlling.
CO2: To apply principles of human resource management, motivation, and leadership.
CO3: To use production management techniques for inventory control and quality management.
CO4: To analyze business environments and apply strategic management concepts.
CO5: To understand the legal and ethical responsibilities of an industrial manager.

Course Contents:

Unit-I Introduction **9**

Technology management - definition - functions - evolution of modern management - scientific management development of management thought. approaches to the study of management, forms of organization - individual ownership - partnership - joint stock companies - co-operative enterprises - public sector undertakings, corporate frame work - share holders - board of directors - committees - chief executive line and functional managers, - financial - legal - trade union

Unit-II Functions of management **9**

Planning - nature and purpose - objectives - strategies – policies and planning premises - decision making - organizing - nature and process - premises - departmentalization - line and staff - decentralization - organizational culture, staffing - selection and training - placement - performance appraisal - career strategy – organizational development. leading - managing human factor - leadership - communication, controlling - process of controlling - controlling techniques, productivity and operations management - preventive control, industrial safety

Unit-III Organizational behavior **9**

Definition - organization - managerial role and functions - organizational approaches, individual behaviour - causes - environmental effect - behaviour and performance, perception - organizational implications. personality - contributing factors - dimension – need theories - process theories - job satisfaction, learning and behaviour - learning curves, work design and approaches

Unit-IV Group dynamics **9**

Group behaviour - groups - contributing factors - group norms, communication - process - barriers to communication - effective communication, leadership - formal and informal characteristics – managerial grid - leadership styles - group decision making - leadership role in group decision, group conflicts - types - causes - conflict resolution - inter group relations and conflict, organization centralization and decentralization - formal and informal - organizational structures organizational change and development - change process – resistance to change - culture and ethics

Unit-V Modern concepts **9**

Management by objectives (mbo) - management by exception (mbe), strategic management - planning for future direction - swot analysis - evolving development strategies, information technology in management decisions support system - management games business process re-engineering (bpr) – enterprises resource planning (erp) - supply chain management (scm) - activity based management (am) - global perspective - principles and steps advantages and disadvantage

Text Books

2. Koontz H &Weihrich H, "Essentials of management", McGraw-Hill, 2010
3. Stephen P. Robbins & Mary Coulter, "Management", Pearson Education, 2017

References

1. Maynard H.B, "Industrial engineering handbook", McGraw-Hill, sixth 2008

Quality Engineering

Course code: **L:T:P:3:0:0**

Rationale:

This course is designed to introduce students to the principles and tools of quality engineering. It aims to provide a systematic approach to quality management, including statistical process control, quality function deployment, and design of experiments.

Course Outcomes:

CO1: To understand the fundamental concepts and philosophies of quality management.
CO2: To apply statistical process control techniques to monitor and improve process quality.
CO3: To use quality function deployment (QFD) for translating customer needs into product specifications.
CO4: To implement design of experiments (DOE) for optimizing product and process parameters.
CO5: To evaluate and implement quality management systems like ISO 9000.

Course Contents:

UNIT I – INTRODUCTION TO QUALITY ENGINEERING

Definition of Quality – Quality Management Systems – Historical Evolution: Deming, Juran, Crosby – Total Quality Management (TQM) Principles – Quality Costs and Metrics – Customer Focus – Quality Planning.

UNIT II – STATISTICAL QUALITY CONTROL

Process Variation – Control Charts: X-bar, R, P, NP, C Charts – Acceptance Sampling – Process Capability Analysis – Six Sigma Concepts and Methodologies – Design of Experiments (DOE).

UNIT III – QUALITY TOOLS AND TECHNIQUES

Pareto Analysis – Cause-and-Effect Diagram – Failure Mode and Effects Analysis (FMEA) – Histogram, Scatter Plot, Check Sheet – Benchmarking and Continuous Improvement Techniques – ISO 9001:2015 Overview.

UNIT IV – PROCESS IMPROVEMENT

Process Standardization – Lean Manufacturing – Kaizen – Value Stream Mapping – Process Audits and Corrective Action – Statistical Process Control in Manufacturing and Services.

UNIT V – APPLICATIONS AND ADVANCED TOPICS

Reliability Engineering – Six Sigma Projects – Quality in Supply Chain Management – Software Quality Assurance – Case Studies in Automotive, Electronics, and Pharmaceutical Industries – Emerging Trends: AI in Quality Monitoring, Predictive Maintenance.

Learning Resources:

Textbooks:

1. Dale H. Besterfield, *Quality Control*, 8th Edition, Pearson, 2013.
2. Douglas C. Montgomery, *Introduction to Statistical Quality Control*, 7th Edition, Wiley, 2012.
3. James R. Evans, *Total Quality Management*, 3rd Edition, Cengage, 2013.
4. Subir Chowdhury, *The Power of Six Sigma*, 2nd Edition, Dearborn Trade, 2001.
5. K.C. Arora, *Quality Management*, Tata McGraw-Hill, 2010.

References:

1. Juran, J.M., *Juran's Quality Handbook*, 6th Edition, McGraw-Hill, 2010.

2. Pyzdek, T., *The Six Sigma Handbook*, 3rd Edition, McGraw-Hill, 2003.
3. Oakland, J.S., *Total Quality Management*, 4th Edition, Routledge, 2014.
4. Antony, J., *Design for Six Sigma*, Pearson, 2006.
5. Grant, E.L., *Statistical Quality Control*, McGraw-Hill, 2012.

Fire Safety Engineering

Course code: **L:T:P:3:0:0**

Rationale:

The course objectives are to provide an understanding of fire science, fire dynamics, and fire safety engineering principles. It aims to equip students with the knowledge to design fire prevention and protection systems, as well as to conduct fire risk assessments in various building and industrial settings.

Course Outcomes:

CO1: To understand the fundamental principles of combustion and fire dynamics.
CO2: To apply heat transfer principles to model fire growth and spread.
CO3: To design and evaluate fire detection and alarm systems.
CO4: To select and design fire suppression and extinguishing systems.
CO5: To conduct a fire risk assessment and develop a fire safety plan for a building.

Course Contents:

UNIT I – INTRODUCTION TO FIRE SCIENCE
Fire Triangle and Combustion Process – Types of Fires and Fuels – Fire Properties: Flame Spread, Heat Release, Smoke Generation – Fire Behavior and Fire Growth Models – Fire Dynamics in Buildings.

UNIT II – FIRE DETECTION AND ALARM SYSTEMS
Smoke Detectors – Heat Detectors – Flame Detectors – Fire Alarm Systems Design – Fire Notification Protocols – Maintenance and Testing of Detection Systems.

UNIT III – FIRE PROTECTION SYSTEMS
Active Fire Protection: Sprinklers, Standpipes, Fire Extinguishers – Passive Fire Protection: Fire-Resistant Materials, Compartmentation – HVAC Considerations – Smoke Control Systems – Fire Safety Codes and Standards (NFPA, IS).

UNIT IV – FIRE RISK ASSESSMENT AND EMERGENCY PLANNING
Hazard Identification – Fire Risk Analysis Techniques – Fire Safety Audit – Evacuation Planning and Simulation – Emergency Response Planning – Fire Safety Management Systems.

UNIT V – ADVANCED TOPICS AND APPLICATIONS
Industrial Fire Protection – High-Rise Building Fire Safety – Wildfire and Forest Fire Management – Fire Safety in Chemical and Petrochemical Industries – Emerging Technologies: Smart Fire Sensors, IoT in Fire Monitoring.

Learning Resources:

Text Books:

1. National Fire Protection Association (NFPA), *Fire Protection Handbook*, 20th Edition, NFPA, 2015.
2. Gupta, P.K., *Industrial Safety and Fire Engineering*, Khanna Publishers, 2010.
3. Hurley, M.J., *Fire Safety Engineering*, 2nd Edition, CRC Press, 2011.
4. Purser, D., *Introduction to Fire Safety Management*, Butterworth-Heinemann, 2010.
5. Beyler, C.L., *Fire Dynamics*, CRC Press, 2009.

References:

1. IS 1640 – Fire Safety Code, Bureau of Indian Standards, 2012.

2. DiNenno, P.J., *SFPE Handbook of Fire Protection Engineering*, 5th Edition, Springer, 2016.
3. Buchan, W., *Principles of Fire Protection*, 2nd Edition, Butterworth-Heinemann, 2007.
4. Drysdale, D., *An Introduction to Fire Dynamics*, 3rd Edition, Wiley, 2011.
5. Chitty, A., *Fire Safety Engineering Design of Structures*, CRC Press, 2012.

Introduction to Non-destructive Testing

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to introduce students to the principles and applications of non-destructive testing (NDT). It provides knowledge of various NDT methods for evaluating the properties and integrity of materials and components without causing damage.

Course Outcomes:

CO1: To understand the principles and applications of various non-destructive testing methods.
CO2: To apply visual inspection, liquid penetrant, and magnetic particle testing techniques.
CO3: To use ultrasonic and eddy current testing for detecting surface and sub-surface defects.
CO4: To analyze radiographic images for identifying internal flaws in materials.
CO5: To select appropriate NDT methods for specific applications and interpret the test results.

Course Contents:

UNIT I – INTRODUCTION TO NDT
Concept of NDT – Advantages and Limitations – Applications in Manufacturing, Construction, Aerospace – Material Properties Relevant to NDT – Safety Precautions – Codes and Standards (ASNT, ASTM).

UNIT II – VISUAL AND SURFACE INSPECTION TECHNIQUES
Visual Inspection – Magnification Tools – Dye Penetrant Testing – Magnetic Particle Testing – Surface Preparation – Applications and Limitations.

UNIT III – RADIOGRAPHIC AND ULTRASONIC TESTING
X-ray and Gamma Ray Radiography – Principles, Equipment, and Image Interpretation – Ultrasonic Testing: Pulse-Echo and Through-Transmission Methods – Immersion Techniques – Defect Detection and Sizing.

UNIT IV – ELECTROMAGNETIC AND OTHER NDT METHODS
Eddy Current Testing – Magnetic Flux Leakage – Thermography – Acoustic Emission Testing – Leak Detection Methods – Application in Pipelines, Pressure Vessels, and Aircraft.

UNIT V – ADVANCED TOPICS AND INDUSTRIAL APPLICATIONS
Automated NDT Systems – Digital Radiography and Computed Tomography – Structural Health Monitoring – Data Analysis and Interpretation – Case Studies in Aerospace, Civil, and Nuclear Industries – Emerging Trends: AI-Assisted NDT, Drones for Inspection.

Learning Resources:

Text Books:

1. Baldev Raj et al., *Practical Non-Destructive Testing*, Alpha Science, 2010.
2. Paul E. Mix, *Introduction to Non-Destructive Testing*, 2nd Edition, Wiley, 2005.
3. ASNT, *Non-Destructive Testing Handbook*, 3rd Edition, American Society for NDT, 2011.
4. Halmshaw, R., *Non-Destructive Testing*, 2nd Edition, Edward Arnold, 1991.
5. J Prasad, *Non-Destructive Testing Techniques*, Narosa Publishing, 2010.

References:

1. Hellier, C., *Handbook of Nondestructive Evaluation*, 2nd Edition, McGraw-Hill, 2012.
2. Raj, B., *Non-Destructive Testing Methods*, Alpha Science, 2011.
3. ASTM Standards on NDT, ASTM International, 2015.

4. S. Krishnaswamy, *NDT in Materials Evaluation*, New Age International, 2008.
5. Madhu, V., *Modern NDT Techniques*, Springer, 2014.

Mechatronics

Course code: **L:T:P:3:0:0**

Rationale:

The course objective is to provide a multidisciplinary approach that combines mechanical engineering, electronics, and computer science. It aims to help students understand the integration of these disciplines for the design and development of intelligent systems and products.

Course Outcomes:

CO1: To understand the principles of mechatronics and the synergy of its components.
CO2: To analyze and model mechanical systems using sensors, actuators, and control systems.
CO3: To apply microcontroller and programming techniques for system control.
CO4: To design and implement simple mechatronic systems.
CO5: To understand the applications of mechatronics in robotics, automation, and smart products.

Course Contents:

UNIT I – INTRODUCTION TO MECHATRONICS
Definition and Scope – Mechatronics Systems Design – Integration of Mechanical, Electrical, and Control Systems – Sensors and Transducers: Position, Velocity, Temperature, Pressure – Signal Conditioning – System Architecture and Examples.

UNIT II – ACTUATORS AND MECHANICAL COMPONENTS
DC Motors, Stepper Motors, Servo Motors – Pneumatic and Hydraulic Actuators – Mechanical Transmission Elements: Gears, Belts, Couplings – Actuator Selection and Application – Drive Systems and Feedback Devices.

UNIT III – MICROCONTROLLERS AND EMBEDDED SYSTEMS
Microcontroller Architecture – Programming and Interfacing – ADC/DAC – PWM Control – Embedded System Design – Communication Protocols (I2C, SPI, UART) – Case Study: Motor Control System.

UNIT IV – CONTROL SYSTEMS IN MECHATRONICS
Open Loop and Closed Loop Control – PID Controllers – Sensors Feedback Loop – System Modeling and Simulation – MATLAB/Simulink for Mechatronics – Real-Time Control Systems.

UNIT V – APPLICATIONS AND ADVANCED TOPICS
Robotics: Industrial and Mobile Robots – Automated Manufacturing Systems – Intelligent Systems – Home Automation – Mechatronics in Automotive Applications – Emerging Trends: IoT-enabled Mechatronics, Smart Sensors, AI in Mechatronics.

Learning Resources:

Text Books:

1. W. Bolton, *Mechatronics: Principles and Applications*, 5th Edition, Pearson, 2015.
2. D. Alfred, *Introduction to Mechatronics and Measurement Systems*, McGraw-Hill, 2010.
3. Musa Jouaneh, *Introduction to Mechatronics and Robotics*, CRC Press, 2012.
4. R.K. Jain, *Mechatronics: Principles, Concepts, and Applications*, Tata McGraw-Hill, 2010.
5. Deb, S.K., *Mechatronics: Concepts, Design and Applications*, Oxford University Press, 2014.

References:

1. Bradley, D., *Mechatronics: Electronics in Products and Processes*, Elsevier, 2008.
2. Madou, M., *Fundamentals of Microfabrication*, CRC Press, 2011.

3. Alciatore, D.G., *Introduction to Mechatronics and Measurement Systems*, McGraw-Hill, 2010.
4. Shetty, D., *Mechatronics System Design*, Cengage, 2011.
5. Uicker, J., *Theory of Machines and Mechanisms*, Oxford University Press, 2012.

Foundation of Robotics

Course code: **L:T:P:3:0:0**

Rationale:

The course aims to introduce the fundamental concepts of robotics, including the history, components, and kinematics of robot manipulators. It provides a foundation for students to understand the mathematical representation of robots, motion control, and programming.

Course Outcomes:

CO1: To understand the history, classification, and applications of robotics.
CO2: To apply homogeneous transformation matrices for representing robot position and orientation.
CO3: To solve direct and inverse kinematics problems for robot manipulators.
CO4: To analyze the differential motion of robot manipulators and understand the concept of a Jacobian.
CO5: To understand the basics of robot programming and control.

Course Contents:

UNIT I – INTRODUCTION TO ROBOTICS
History and Classification of Robots – Robot Components: Manipulators, End Effectors, Actuators, Sensors – Degrees of Freedom, Workspace, and Robot Geometry – Applications of Robots in Industry and Research.

UNIT II – ROBOT KINEMATICS AND DYNAMICS
Forward and Inverse Kinematics – Homogeneous Transformation Matrices – Differential Motion and Velocity – Jacobian and Workspace Analysis – Robot Dynamics: Euler-Lagrange Formulation – Trajectory Planning.

UNIT III – ROBOT ACTUATION AND SENSORS
Actuators: DC Motors, Stepper Motors, Servo Motors, Pneumatic and Hydraulic Systems – Sensor Types: Position, Force, Vision, Proximity – Sensor Integration and Feedback – Signal Conditioning and Data Acquisition.

UNIT IV – ROBOT CONTROL AND PROGRAMMING
Control Systems: Open Loop, Closed Loop, PID – Adaptive and Intelligent Control – Robot Programming Languages (RAPID, VAL, Python Robotics Libraries) – Path Planning Algorithms – Simulation Tools (MATLAB, ROS, Gazebo).

UNIT V – ROBOT APPLICATIONS AND EMERGING TECHNOLOGIES
Industrial Robots: Welding, Assembly, Material Handling – Medical and Rehabilitation Robotics – Autonomous Mobile Robots – Humanoid and Service Robots – AI in Robotics – Trends in Swarm Robotics, Collaborative Robots, and Smart Manufacturing.
Learning Resources:

Text Books:

1. Saeed B. Niku, *Introduction to Robotics: Analysis, Systems, Applications*, 2nd Edition, Wiley, 2010.
2. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson, 2014.
3. Richard D. Klafter, *Robotics Engineering: An Integrated Approach*, Prentice Hall, 2013.
4. Groover, *Industrial Robotics: Technology, Programming and Applications*, McGraw-Hill, 2015.
5. M.P. Groover, *Fundamentals of Robotics*, Wiley, 2012.

References:

1. Siciliano, B., *Robotics: Modelling, Planning, and Control*, Springer, 2010.
2. Craig, J., *Introduction to Robotics: Mechanics and Control*, 3rd Edition, Pearson, 2005.
3. Fu, K.S., *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw-Hill, 1987.
4. Spong, M.W., *Robot Modeling and Control*, Wiley, 2006.
5. Bekey, G.A., *Autonomous Robots: From Biological Inspiration to Implementation and Control*, MIT Press, 2005.

(Data Science LAB)

Course code: **L:T:P:0:0:2**

Rationale:

The course aims to provide practical, hands-on experience in applying fundamental data science concepts and tools. Students will learn to use essential libraries like NumPy, Pandas, and Matplotlib to perform data analysis and visualization tasks. The lab is designed to bridge the gap between theoretical knowledge and practical application by enabling students to load, clean, analyze, and visualize data from various sources. Through this, students will develop a strong foundation in exploratory data analysis and statistical modeling, which are crucial for data-driven decision-making.

Course Outcomes:

CO1: To configure and utilize the Python programming environment for data science, including the installation of essential libraries like NumPy and Pandas.
CO2: To perform fundamental data manipulation and preparation using data frames for exploratory data analysis.
CO3: To apply descriptive and inferential statistical techniques to real-world datasets for generating meaningful insights.
CO4: To effectively visualize data using various plotting functions to identify patterns and trends.
CO5: To conduct end-to-end data analysis and compare results across different datasets to draw valid conclusions.

List of experiments:

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
   a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
   b. Bivariate analysis: Linear and logistic regression modeling
   c. Multiple Regression analysis
   d. Also compare the results of the above analysis for the two data sets.
6. Apply and explore various plotting functions on UCI data sets.
   a. Normal curves
   b. Density and contour plots
   c. Correlation and scatter plots
   d. Histograms
   e. Three dimensional plotting
7. Visualizing Geographic Data with Basemap

List of Equipments (30 Students per Batch)
Tools: Python, Numpy, Scipy, Matplotlib, Pandas, Statsmodels, Seaborn, Plotly, Bokeh
Note: Example data sets like UCI, Iris, Pima Indians Diabetes, etc.

Lab-II
(Digital Project Management LAB)

Course code: **L:T:P:0:0:2**

Rationale:

This lab provides practical experience in using digital tools for effective project management. The course aims to equip students with the skills to plan, schedule, and monitor projects using industry-standard software. It focuses on hands-on application of concepts like task definition, resource allocation, and progress tracking to ensure projects are completed on time and within budget. Through these exercises, students will learn to manage project lifecycles, identify and resolve conflicts, and communicate project status through dashboards and reports.

Course Outcomes:

CO1: To use project management software to create and structure a new project plan, including tasks, milestones, and durations.
CO2: To define and manage project resources, assign them to tasks, and resolve potential conflicts.
CO3: To create and update a project baseline to monitor and compare actual progress against the planned schedule.
CO4: To monitor the critical path and generate dashboards and reports for effective project tracking and communication.

List of experiments:

2. Introduction to Microsoft Project and familiarization with the interface.
3. Creating a new project by specifying project name, start date, and finish date.
4. Defining project tasks and setting their durations.
5. Creating and managing project milestones.
6. Establishing dependencies among tasks.
7. Defining and managing project calendar.
8. Specifying project resources, resource types, and resource rates.
9. Assigning resources to project tasks.
10. Creating and saving a baseline project plan.
11. Updating the project plan with percentage completion of tasks.
12. Reviewing task status and comparing planned progress with actual progress.
13. Monitoring the critical path of the project.
14. Evaluating resource assignments and resolving resource conflicts.
15. Generating dashboards for project monitoring.
16. Preparing reports on resources, costs, and overall project progress.

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