UNIVERSITY OPEN ELECTIVE COURSES

AI & ML											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501AI02	Artificial Intelligence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI05	Machine Learning	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI27	AI & Data Science	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI28	AI in Healthcare	IC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI11	Deep Learning	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI10	Natural Language Processing	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI09	Reinforcement Learning	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	DAP
2501AI29	AI in Agriculture	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI30	Robotics & AI	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
2501AI31	AI in Finance & Economics	AC	2		1	3	50	50	100	CE,EEE,ME, ECE,CSE,IT, AIML,CSE(DS) PT,Min.E	DAP
Total			**19**		**13**	**32**					

Artificial Intelligence

	L	T	P	C
Course Code: 2501AI02	**2**	**0**	**1**	**3**

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

- **CO1:** Illustrate the historical development of AI, key milestones and contributors.
- **CO2:** Apply the basic principles of AI in problem solving
- **CO3:** Apply Local Search Algorithms and Optimization Techniques.
- **CO4:** Choose the appropriate representation of Knowledge.
- **CO5:** Summarize the expert systems and real time applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	1	-	-	-	1	1	-	1
CO2	3	2	-	2	-	-	-	1	1	-	1
CO3	3	2	1	2	1	-	-	1	1	-	1
CO4	2	-	1	-	-	-	-	1	1	-	-
CO5	2	2	1	1	1	-	-	1	1	-	1

UNIT-I

Introduction:
What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice:

1. Introduction to LISP:
   - To demonstrate simple recursive functions and list manipulation in LISP
2. Introduction to Prolog:
   - Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT-II

Problem formulation:
Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies

Practice :

1. Implementation of DFS for water jug problem using LISP/PROLOG
2. Implementation of BFS for tic-tac-toe problem using LISP/PROLOG

UNIT-III

Problem solving methods

Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice:

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hill climbing to solve 8 Puzzle Problem

UNIT-IV

Knowledge representation

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logicStructured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

Practice :

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
2. Create a frame based representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT – V

Expect Learning

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Practice:

1. Using PYTHON / LISP, develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.

2. Using PYTHON / LISP, create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

Text Books:

1 Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , Pearson, 3rd Edition, ISBN: 978-9332543515
2 Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George F. Luger, 2nd Edition, ISBN: 978-0805347807

Reference Books:

1 Artificial Intelligence, Saroj Kaushik, Cengage Learning India, ISBN: 978-8131510995
2 Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill, ISBN:978-0-07-052263-3
3 Artificial Intelligence: Foundations for Computational Agents, David Poole and Alan Mackworth, Cambridge University Press, ISBN: 978-1107195394

Web Links:

1 https://nptel.ac.in/courses/106105077
2 https://nptel.ac.in/courses/106106126
3 https://aima.cs.berkeley.edu

Machine Learning

	L	T	P	C
Course Code: 2501AI05	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1:** Outline the Concepts of Machine Learning and Statistical Learning
- **CO2:** Build Regression and Classification models for given data.
- **CO3:** Apply Instance based Learning techniques and SVM techniques linear and nonlinear data.
- **CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- **CO5:** Make use of ensemble learning techniques to improve the performance of a model.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	2	2	-	1	1	-	-
CO2	2	2	3	-	2	2	-	1	1	-	-
CO3	3	2	3	-	2	-	-	1	1	-	2
CO4	3	2	3	-	2	-	-	1	1	-	-
CO5	2	2	2	-	2	-	-	1	1	-	2

UNIT-I

INTRODUCTION

Machine Learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, The Learning Problem, Feasibility of Learning.

Practice :

1. Installation of Jupitar/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

UNIT-II

Supervised Learning(Regression/Classification):Basic Methods:

Concept Learning: General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

Bayesian Learning: Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

Instance-based Learning: k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

Practice :

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Exercises to solve the real-world problems using Binary Classifier
4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

UNIT-III

Linear Models and Regression: Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.
Support Vector Machines: Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.
Practice:

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique (SVM) to identify the rate of heart patients.

UNIT-IV

Classifier / Hypothesis Evaluation: Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.
Unsupervised Learning:
Clustering: Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.
Practice:

1. Develop a program for Bias, Variance, Remove duplicates, Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

UNIT – V

Ensemble Learning:
Bagging and Boosting, Adaboost and Random Forest ,

Computational Learning Theory: Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions, Overfitting, Regularization and Validation.

Practice:

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Capstone project:

Student Performance Prediction System

Objective: Predict a student's performance (pass/fail or score range) based on input features like study time, attendance, past grades, family background, etc.

Domain: Education

Techniques & Concepts Used:

- Supervised learning (Classification – Logistic Regression, SVM)
- Data preprocessing (handling nulls, encoding categorical variables)
- Evaluation metrics (accuracy, precision, recall)

Text Books:

1 Hands On Machine Learning with ScikitLearn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019, ISBN: 978-1492032649.

2 Data Science and Machine Learning Mathematical and Statistical Methods,Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 2019, ISBN: 978-1138492530.

Reference Books:

1 Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029.
2 Machine Learning Tools, Dr Muddafa Maruli Krishna, Dr A Vanathi, Final Thawaksr, Dr Lokesh P. Gangani, publisher: Book Rivers, ISBN: 978-93-5515-730-0.

Web Links:

1 https://www.deeplearning.ai/machinelearningyearning/
2 https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html
3 https://onlinecourses.nptel.ac.in/noc21_cs24/preview

	L	T	P	C
Course Code: 2501AI27	**2**	**0**	**1**	**3**

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

CO1: Explain the historical evolution, architecture, tools and applications of AI
CO2: Explain the fundamentals of Data Science, including its need, processes, and tools
CO3: Utilize pandas for effective data handling, including data structures, indexing, filtering, data summarization, and handling missing data.
CO4: Develop skills in data loading, storage, and file format management
CO5: Develop proficiency in data visualization techniques using Matplotlib

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	-	-	3
CO2	-	2	1	-	2	-	-	1	-	-	3
CO3	-	2	-	3	1	-	-	1	-	-	1
CO4	2	2	3	-	1	-	-	1	-	-	-
CO5	1	2	3	-	1	-	-	1	-	-	-

UNIT-I

Introduction to AI
Historical Evolution and AI today, Architecture of AI Systems, Theory (Knowledge, Logic, Search, Reasoning, Planning, Learning), Tools and Applications, Interface (Sensing, Actuation, Control), Domains and Scope of AI Applications, Inter-disciplinary Problem Solving, Intelligent/Expert Knowledge based Systems, Case-studies and Success Stories.
Practice:

1. Create a basic AI system architecture using a knowledge-based or expert system for a simple medical diagnosis system.

UNIT-II

Introduction To Data Science: Need for Data Science – What is Data Science Data Science
Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist – Tools
and Skills required.
NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, creating ndarrays, Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and

Slicing, Boolean Indexing, Fancy Indexing, Data Processing Using Arrays, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays, Sorting, Unique

Practice:

1. Perform various data manipulation tasks using NumPy, such as creating multidimensional arrays, conducting operations between arrays, indexing, slicing, and applying Boolean and fancy indexing

UNIT-III

Getting Started with pandas

Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, Data Frame, Index Objects, Essential Functionality Reindexing, dropping entries from an axis, Indexing, selection, and filtering, Sorting and ranking, Summarizing and Computing Descriptive Statistics, Unique Values, Value Counts, Handling Missing Data, filtering out missing data.

Practice:

1. Analyse the dataset to derive meaningful insights, such as summarizing data trends or finding unique values

UNIT-IV

Data Loading, Storage, and File Formats

Reading and Writing Data in Text Format, Reading TextFiles in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

Practice :

1. Load data from multiple formats, including text files, JSON, XML, and Excel, and store it in various formats such as HDF5 or MongoDB

UNIT – V

Plotting and Visualization

A Brief matplot lib A PIPrimer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, Plotting Functions in pandas, Line Plots, Bar Plots, Histograms and Density Plots, Scatter Plots.

Practice :

1. Create various plots (line, bar, histogram, scatter) using Matplotlib and pandas to visualize data from a dataset.

Text Books:

1. Python for Data Analysis, Wes McKinney, O'REILLY, 1st Edition, ISBN:978-1-449-31979-3
2. Doing Data Science, Rachel Schutt & O'neil, O'REILLY, 1st Edition, ISBN:978-1-449-35865-5

Reference Books:

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media,ISBN : 978-9352130962
2. Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , Matt Harrison, O'Reilly, ISBN : ISBN 153359824X.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_cs133/preview
2. https://onlinecourses.nptel.ac.in/noc24_cs68/preview
3. https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/

AI in Health Care

	L	T	P	C
Course Code: 2501AI28	**2**	**0**	**1**	**3**

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

- **CO1:** Explain fundamentals of Healthcare Data Analytics
- **CO2:** Demonstrate the technologies for analyzing Biomedical Image
- **CO3:** Apply predictive modeling techniques for Clinical Data
- **CO4:** Apply predictive analysis techniques for genomic data
- **CO5:** Illustrate NLP and Data mining for clinical text.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	-	-	3
CO2	-	2	1	-	2	-	-	1	-	-	3
CO3	-	2	-	3	1	-	-	1	-	-	1
CO4	2	2	3	-	1	-	-	1	-	-	-
CO5	1	2	3	-	1	-	-	1	-	-	-

UNIT-I

Fundamentals of Healthcare Data Analytics:
Healthcare Data Sources and Basic Analytics Advanced Data Analytics for Healthcare Applications and Practical Systems for Healthcare Resources for Healthcare Data Analytics Electronic Health RecordsComponents of EHR Coding Systems Benefits of EHR Barriers to Adopting EHR Challenges of Using EHR Data.

Practice:

1. Clean and explore a health care dataset to understand its structure and key attributes. Use the Diabetes dataset from the UCI Machine Learning Repository.

UNIT-II

Image Recognition and Analysis of Biomedical Images
Biomedical Imaging Modalities Object Detection Image Segmentation Image Registration Feature Extraction Mining of Sensor Data in Healthcare Mining Sensor Data in Medical Informatics Challenges in Healthcare Data Analysis Sensor Data Mining Applications.

Practice:

1. Build a model to predict if a patient will be readmitted to the hospital within 30 days.Use the Hospital Readmissions Reduction Program (HRRP) dataset.

UNIT-III

Predictive Modelling for Integrating Clinical and Genomic Data:
Introduction Issues and Challenges Different Types of Integration Different Goals of Integrative Studies Validation Information Retrieval for Healthcare KnowledgeBased Information in Healthcare and Biomedicine Content of KnowledgeBased Information Resources Indexing Retrieval Evaluation Research Directions.

Practice:

1. Perform survival analysis on a dataset of cancer patients to estimate survival rates. Use the SEER Cancer Incidence dataset

UNIT-IV

Basics of NLP in medical analysis
Processing Mining Information from Clinical Text Challenges of Processing Clinical Reports Clinical Applications Social Media Analytics for Healthcare Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks Social Media Analysis for Public Health Research Analysis of Social Media Use in Healthcare.

Practice:

1. Segment patients into different groups based on their health care utilization patterns. Use a dataset containing patient visit records, such as the National Hospital Ambulatory Medical Care Survey (NHAMCS).

UNIT – V

Advance topics in healthcare with AI
Automated Decision Systems The Artificial Intelligence field Basic concepts of Expert Systems Applications of Expert Systems Structure of Expert Systems Knowledge Engineering Development of Expert Systems – Locationbased Analytics Cloud Computing Business Intelligence.

Practice:

1. Analyze health care costs and identify factors driving high costs. Use the Medical Expenditure Panel Survey (MEPS) dataset.

Text Books:

1 Healthcare Data Analytics, Chandan K. Reddy, Charu C. Aggarwal, CRC Press, ISBN : 978-0367575687, 2020.

Reference Books:

1 Analytics in HealthcareA Practical Introduction, Christo El Morr, Hossam AliHassan, 2019, ISBN : 978-3030045050

Web Links:

1 https://onlinecourses.nptel.ac.in/noc22_hs40/preview
2 https://nptel.ac.in/courses/109107190

Deep Learning

	L	T	P	C
Course Code: 2501AI11	**2**	**0**	**2**	**4**

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

- **CO1:** Demonstrate the basic statistical concepts in deep learning.
- **CO2:** Explain architecture and mathematical foundation for various deep neural networks.
- **CO3:** Illustrate the challenges and optimization strategies in Deep Learning.
- **CO4:** Build a convolutional neural network using different activation functions.
- **CO5:** Build and train RNN and LSTMs using sequence modelling.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	1	-	3
CO2	-	2	1	-	2	-	-	1	1	-	3
CO3	-	2	-	3	1	-	-	1	1	-	1
CO4	2	2	3	-	1	-	-	1	1	-	-
CO5	1	2	3	-	1	-	-	1	1	-	-

UNIT-I

DEEP LEARNING CONCEPTS

Fundamentals about Deep Learning, Perception Learning Algorithms, Probabilistic modelling, Early Neural Networks, How Deep Learning different from Machine Learning, Scalars. Vectors, Matrixes, Higher Dimensional Tensors, Manipulating Tensors. Vector Data, Hyper parameters Vs Parameters - validation sets - Estimators, Bias, Variance, Overfitting and Underfitting, Introduction to Keras and TensorFlow and PyTorch.

Practice:

1. Installation and basic commands of scikit, TensorFlow and PyTorch
2. Implement Random Forest by using scikit, TensorFlow and PyTorch
3. Implement multilayer perceptron algorithm for MNIST Handwritten Digit Classification

UNIT-II

NEURAL NETWORKS

About Neural Network, Building Blocks of Neural Network, Introduction to Neural Networks, Feed-forward Networks, Deep Feed-forward Networks - Learning XOR, Gradient Based learning, Hidden Units, Back-propagation and other Differential Algorithms, Data Pre-processing for neural networks, Feature Engineering.

Practice:

1. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
2. a) Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset
   b) Design a neural network for predicting house prices using Boston Housing Price dataset.

UNIT-III

OPTIMIZATION TECHNIQUES

Optimizers – SGD (Stochastic Gradient Descent), Mini-batch Gradient Descent, MS prop (Root Mean Square Propagation),Adagrad (Adaptive Gradient Algorithm), Adadelta (Adaptive Delta), Adam (Adaptive Moment Estimation), Adamax (Adaptive Moment Estimation with Infinity Norm).

Activation Functions : sigmoid, tanh, ReLU, leaky ReLU, Soft Max, Linear Loss Functions - cross-entropy loss, the mean-squared error, the Huber loss, the hinge loss ,L2 loss , mean absolute loss Regularization – L1, L2 and drop out . Learning Rate, Normalization

Practice :

1. Implement word embeddings for IMDB dataset.
2. Implement one hot encoding of words or characters.
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients. Also apply the optimization techniques.
4. Write a Python program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set

UNIT-IV

CONVOLUTIONAL NEURAL NETWORK

About CNN, Building a convolutional neural network, Input Layers, Convolution Layers, Pooling Layers, Dense Layers, Backpropagation Through the Convolutional Layer, Filters and Feature Maps, Backpropagation Through the Pooling Layers, Dropout Layers and Regularization, Batch Normalization

Pre trained CNN: LeNet, Alex Net, VGG16, ResNet.

Practice :

1. Build a Convolution Neural Network for MNIST Handwritten Digit Classification.
2. a) Use a pre-trained convolution neural network (VGG16) for image classification
   b) Build a Convolution Neural Network for simple image (dogs and Cats) Classification
3. Student Portfolio Creation using GitHub, Hugging Face & Kaggl

UNIT – V

RNN

Recurrent Neural Networks, Sequence-to-Sequence Modelling – Embedding - Recurrent Neural Networks - Bidirectional RNNs, Analysing Variable Length Inputs – Tackling seq2seq Problem – Beam Search and Global Normalization – Recurrent Neural Networks (RNN)– Hidden States – Perplexity – Character-level Language Models –Modern RNNs: Gated Recurrent Units (GRU), Long Short-Term Memory (LSTM).

Practice:

1. Implement a Recurrent Neural Network for IMDB movie review classification problem.
2. Implement Boosting algorithms using scikit, Tensor flow and PyTorch

Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Capstone project:

Face Mask Detection Using Convolutional Neural Networks

Objective: Detect whether a person in an image is wearing a mask or not using real-time webcam input.
Domain: Healthcare / Public Safety
Techniques & Concepts Used:
* Image Classification (CNNs – using TensorFlow/Keras)
* Data Augmentation & Preprocessing
* Transfer Learning (e.g., MobileNetV2)
* Real-time camera integration using OpenCV

Text Books:

1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, ISBN: 9780262035613
2 Deep learning: A practitioner's approach, Josh Patterson and Adam Gibson, O'Reilly Media, First Edition, ISBN: 978-1491914250

Reference Books:

1 Fundamentals of Deep Learning, Designing next generation machine intelligence algorithms, Nikhil Buduma, O'Reilly, Shroff Publishers, ISBN: 978-9352135608

2 Deep learning Cookbook, Practical recipes to get started Quickly, DouweOsinga, O'Reilly, Shroff Publishers, ISBN: 978-9352137572

Web Links:

1 https://onlinecourses.nptel.ac.in/noc20_cs62/preview
2 https://keras.io/datasets/

Natural Language Processing

	L	T	P	C
Course Code: 2501AI10	**2**	**0**	**1**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain datasets for NLP tasks and context free grammar.
- **CO2:** Explain Text preprocessing and stemming algorithms.
- **CO3:** Explain feature engineering on text data
- **CO4:** Apply similarity measures and word embedding models
- **CO5:** Explain text summarization and semantic analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	-	1	-	-	1	1	-	2
CO2	2	2	2	-	2	-	-	1	1	-	2
CO3	2	2	3	-	1	-	-	1	1	-	2
CO4	2	2	3	-	1	-	-	1	1	-	1
CO5	2	2	3	-	1	-	-	1	1	-	1

UNIT – I

Overview of Natural Language Processing, Natural Language Processing and Python: Understanding Natural language Processing and applications, NLTK, Corpus and Dataset, understanding structure of sentence Defining Context free grammar, Morphological Analysis

Practice:

1. Word Analysis Learn about morphological features of a word by analysing it
2. Word Generation generate word forms from root and suffix information.

UNIT – II

Syntactic Analysis, Semantic analysis, Ambiguity resolution, Discourse integration, Preprocessing tokenization, stemming , lemmatization, Word tokenization and lemmatization

Practice:

1. Implement Porter Stemming Algorithm
2. NGrams learn to calculate bigrams from a given corpus and calculate probability of a sentence

UNIT – III

Feature engineering and NLP algorithms parsers, context free grammars, different types of parsers, POS tagging and different types of POS parsers.

Practice:

1. Morphology understanding the morphology of a word by the use of AddDelete table.
2. POS Tagging – calculate emission and transition matrix which will be helpful for tagging Parts of Speech

UNIT – IV

Basic statistical features of NLP: TFIDF, Vectorization Encoders and Decoders, Normalization, Advanced feature engineering and NLP algorithms Basics of Word2Vec

Practice:

1. Apply term frequency(TFIDF) to Measures the importance of a word to a specific document
2. Implement word embedding using word2vec

UNIT – V

Rule Based system for NLP, Machine Learning for NLP problems, Applications of NLP Text Summarization, Sentiment Analysis

Practice:

1. Chunking understand the concept of chunking and get familiar with the basic chunk tag set.
2. Building Chunker the importance of selecting proper features for training a model and size of training corpus in learning how to do cunking.

Text Books:

1 Python Natural Language Processing, Thanaki J, Packt Publishing Ltd, ISBN: 9781787121423

2 Springer Handbook of Speech Processing, Jacob Benesty, M. M. Sondhi, Yiteng Huang Springer, ISBN: 978-3-540-49127-9

Reference Books:

1 Speech & language processing, Jurafsky D, Pearson Education India, ISBN: 978-93325018414

2 Foundations of Statistical Natural Language Processing, Christopher, D. Manning and Hinrich Schütze, MIT Press, ISBN: 9780262133609

Web Links:

1 https://www.nltk.org/data.html

2 https://www.analyticsvidhya.com/blog/2017/01/ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython/

3 https://datahack.analyticsvidhya.com/contest/linguipediacodefestnaturallanguageprocessing1/?utm_source=ultimateguidetounderstandimplementnaturallanguageprocessingcodesinpython&utm_medium=blog

Reinforcement Learning

	L	T	P	C
Course Code:2501AI09	**1**	**0**	**2**	**3**

Course Outcomes:

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

CO1: Outline the basic concepts of Reinforcement learning.
CO2: Identify the appropriate learning tasks for Reinforcement learning techniques.
CO3: Implement adversarial training techniques to train GAN models.
CO4: Analyse the applications of VAEs in various domains.
CO5: Evaluate the ethical considerations and societal impact of reinforcement learning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	-	-	2	-	-	-	-	1	-	-
CO2	2	2	-	-	2	-	-	-	-	1	-	-
CO3	3	2	-	-	2	-	-	-	-	1	-	-
CO4	3	2	1	-	2	-	-	-	-	1	-	-
CO5	2	1	1	-	2	-	-	-	-	1	-	-

UNIT – I

Introduction to Reinforcement Learning
Basics of reinforcement learning (RL), RL components: agents, environments, rewardsbased Markov Decision Processes (MDPs), Exploration vs. Exploitation dilemma, Basic algorithms: Qlearning, SARSA, MonteCarlo (MC) Learning.
Practice:

1. Installation of TensorFlow and implement the basic programs.
2. Installation of PYTORCH and implement the basic programs.

UNIT – II

Advanced Reinforcement Learning Techniques
Deep QNetworks (DQN), Policy Gradient methods, ActorCritic architectures, Advantage ActorCritic (A2C) and Proximal Policy Optimization (PPO).
Practice:

1. Model an agent learning to drive a car up a steep mountain by applying the correct amount of throttle and braking. (Policy Gradient Methods)

2. Use deep reinforcement learning to train an agent to play various Atari games, such as Breakout, Space Invaders, or PacMan.

UNIT – III

Generative Adversarial Networks (GANs)

Introduction to generative models, Basics of GANs: generator, discriminator, Training GANs: adversarial training, Variants of GANs: Conditional GANs, Wasserstein GANs, etc., data augmentation.

Practice:

1. Train an agent to play Flappy Bird, a sidescrolling game where the agent controls the flight of a bird through a series of pipes.
2. Simulate a colony of ants foraging for food in a dynamic environment, where the agent learns to find and retrieve food while avoiding obstacles and predators.

UNIT – IV

Variational Autoencoders (VAEs)

Introduction to autoencoders, Variational inference and latent variable models, Encoder and decoder architectures in VAEs, Training VAEsMaximizing Evidence Lower Bound(ELBO).

Practice:

1. Track Detection for Autonomous vehicles using VAE
2. Train a robotic arm to perform various tasks, such as reaching a target location or manipulating objects, using reinforcement learning.

UNIT – V

Advanced Topics in Reinforcement Learning

Modelbased RL and world models, multiagent reinforcement learning, Transfer learning and metalearning in RL

Practice:

1. Develop a trading agent that learns to make profitable trades in financial markets by analyzing historical data and adapting its trading strategy over time
2. Experiment with different strategies for solving the multiarmed bandit problem, where an agent must decide which arm of a slot machine to pull to maximize cumulative reward.

Text Books:

1 Reinforcement Learning An Introduction, R. S. Sutton and A. G. Bart,. MIT Press, 2018, ISBN: 9780262039246

Reference Books:

1 Algorithms for Reinforcement Learning, Szepesvári, Csaba, United States: Morgan & Claypool, ISBN: 978-1608454921

2 Markov Decision Processes: Discrete Stochastic Dynamic Programming, Arman, Martin L., Germany, Wiley, ISBN: 978-0471727828

Web Links:

1 https://onlinecourses.nptel.ac.in/noc20_cs74/preview

2 https://www.coursera.org/learn/fundamentalsofreinforcementlearning

AI in Agriculture

	L	T	P	C
Course Code: 2501AI29	**2**	**0**	**1**	**3**

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

- **CO1:** Demonstrate the basic statistical concepts in Artificial Intelligence.
- **CO2:** Apply AI techniques like machine learning, image processing, and IoT for efficient soil management
- **CO3:** Develop AI-based decision support systems for water management
- **CO4:** Utilize AI for farm mechanization, focusing on the navigation of farm machinery
- **CO5:** Implement AI and ML methods in food processing, packaging, and market analysis

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	-	-	3
CO2	-	2	1	-	2	-	-	1	-	-	3
CO3	-	2	-	3	1	-	-	1	-	-	1
CO4	2	2	3	-	1	-	-	1	-	-	-
CO5	1	2	3	-	1	-	-	1	-	-	-

UNIT-I

AI fundamentals
Basic concepts of Artificial Intelligence (AI), Artificial Neural Networks (ANNs), Machine Learning (ML), Machine Vision, Internet of Things (IoT), Cloud Computing, Statistical Computing, Deep Learning, Expert Systems, Automated Data Analytics.
Practice:

1. Implement a simple Artificial Neural Network (ANN) to classify a dataset for predicting crop type based on soil features.

UNIT-II

AI for Agricultural Systems
Application of AI-ML for digital soil mapping, augmented reality for precise soil sampling, image processing for rapid soil property prediction via smartphone, soil spectroscopy-exploring the high dimensional soil spectral data, spectral preprocessing methods, modelling soil properties via ML algorithms, IoT in soil management.

Practice:

1. Use AI and ML techniques to create a digital soil map by processing soil data, utilizing spectral preprocessing methods, and building models to predict soil properties.

UNIT-III

AI for Water Management:

On-farm water, nutrient and pest management, crop damage assessment, decision support systems, crop modelling, smart irrigation, yield prediction, rainfall-runoff, streamflow, sediment and water quality.

Practice:

1. Implement an AI model for predicting rainfall-runoff, streamflow, and water quality, and validate it against historical data to optimize water use in agriculture.

UNIT-IV

AI for Farm Mechanization

Application of AI for navigation of farm machinery, energy demand prediction for farm mechanization, and quality of tilth; Uniformity prediction for sowing, planting and transplanting; Crop disease detection, quantification of severity and mitigation; crop yield monitoring, and prediction of harvesting and threshing quality; AI for farm machinery management and custom hiring.

Practice:

1. Create a model using AI to navigate farm machinery and predict energy demand for various farm tasks.

UNIT – V

AI for Food Processing

Application of AI and ML in food processing and packaging. Non-destructive quality evaluation of food based on spectral data, Image based quality detection, varietal identification of fruits and vegetables, sorting of products and packages, decision making for the consumers and profit enhancement by the industry people by proper market survey using AI, new product formulation.

Practice:

1. Implement an AI solution for non-destructive quality evaluation of food products based on spectral data.

Text Books:

1 Artificial Intelligence in Agriculture: A Comprehensive Guide, Rajesh Singh, Anita Gehlot, and Lakhveer Kaur, 2021, ISBN: 978-1119714743.

2 Artificial Intelligence in Agriculture: A Systems Approach, Mohammad Naushad Emmambux, 2023 ISBN: 978-9819925243.

Reference Books:

1 Data Science and Artificial Intelligence for Agricultural Applications S. Raja, P. Vignesh, and R. Bhuvaneswari, 2021, ISBN: 978-3030852129.

Web Links:

1 https://keras.io/datasets/
2 http://deeplearning.net/tutorial/deeplearning.pdf

Robotics & AI

	L	T	P	C
Course Code: 2501AI30	**2**	**0**	**1**	**3**

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

- **CO1:** Explain the fundamental concepts of robotics and AI, including key components and types of robots.
- **CO2:** Analyse and apply kinematics and dynamics for robotic motion and trajectory planning.
- **CO3:** Develop and implement perception and sensing techniques for robotic applications.
- **CO4:** Design control systems and apply AI techniques for autonomous robot operation and navigation.
- **CO5:** evaluate current applications and future trends in robotics and AI, considering ethical implications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	-	-	3
CO2	-	2	1	-	2	-	-	1	-	-	3
CO3	-	2	-	3	1	-	-	1	-	-	1
CO4	2	2	3	-	1	-	-	1	-	-	-
CO5	1	2	3	-	1	-	-	1	-	-	-

UNIT-I

Introduction to Robotics and AI
Definition and History of Robotics and AI, Fundamental Concepts: Autonomous Systems, Artificial Intelligence, Machine Learning, Types of Robots: Industrial, Service, Humanoids, Autonomous Vehicles, Key Components of a Robot: Sensors, Actuators, Control Systems, Power Supply, Overview of Robotics Software: ROS (Robot Operating System),Ethical Considerations and Challenges in Robotics and AI

Practice:

1. Implement forward and inverse kinematics for a 2-DOF or 3-DOF robotic arm and plan a path for the end effector to reach a target position.

UNIT-II

Kinematics and Dynamics of Robots
Basics of Kinematics: Forward and Inverse Kinematics, Types of Robotic Manipulators: Articulated, SCARA, Cartesian, Delta Denavit- Hartenberg (D-H) Parameters and

Transformation Matrices, Robot Dynamics: Newton-Euler and Lagran gian Methods, Trajectory Planning and Control, Practical Examples and Case Studies in Robotic Motion

Practice:

1. Develop a computer vision-based system for detecting and tracking objects in real-time.

UNIT-III

Robot Perception and Sensing

Introduction to Sensors in Robotics: Proximity, Vision, LIDAR, IMU, GPS, Computer Vision and Image Processing for Robotics, Object Detection, Recognition, and Tracking Depth Sensing and 3D Perception, Sensor Fusion Techniques, Introduction to SLAM (Simultaneous Localization and Mapping), Machine Learning in Perception: Neural Networks and Deep Learning for Robotics

Practice:

1. Implement a basic SLAM algorithm to enable a mobile robot to navigate an unknown environment.

UNIT-IV

Robot Control Systems and AI Techniques

Basics of Control Theory: PID Controllers, State-Space Representation, Advanced Control Techniques: Adaptive and Robust Control, Fuzzy Logic, and Neural Network-Based Control, Reinforcement Learning for Robotics: Basics and Applications, Motion Planning Algorithms: A*, Dijkstra, RRT (Rapidly exploring Random Trees)

Practice:

1. Train a robot to navigate through an environment using reinforcement learning techniques

UNIT – V

AI in Robotics

Autonomous Navigation, Decision Making, and Task Planning, Swarm Robotics: Principles and Coordination Algorithms

Practice:

1. Develop a simple HRI interface that allows a robot to understand and respond to basic voice commands

Text Books:

1 Deep Learning, Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT Press, ISBN : 978-0262035613, 2016.

2 Deep learning: A practitioner's approach, Josh Patterson and Adam Gibson, O'Reilly Media, First Edition , ISBN : 978-1491914250, 2017.

Reference Books:

1 Fundamentals of Deep Learning, Designing next-generation machine intelligence algorithms, Nikhil Buduma, O'Reilly, Shroff Publishers, ISBN: 978-1492082187, 2022.
2 Deep learning Cookbook, Practical recipes to get started Quickly, DouweOsinga, O'Reilly, Shroff Publishers, ISBN : 978-9352137572, 2018.

Web Links:

1 https://keras.io/datasets/
2 http://deeplearning.net/tutorial/deeplearning.pdf
3 https://arxiv.org/pdf/1404.7828v4.pdf

AI in finance & Economics

	L	T	P	C
Course Code: 2501AI31	**2**	**0**	**1**	**3**

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

- **CO1:** Illustrate financial market fundamentals, risk-return analysis, and statistical methods.
- **CO2:** Apply R programming to economic theories, portfolio construction, asset pricing models.
- **CO3:** Analyse algorithmic trading strategies, including trend determination, risk measures
- **CO4:** Formulate economic problems using AI/ML techniques, optimization and search methods
- **CO5:** Evaluate causal relationships and decision-making in economics through techniques like Granger causality, Shapley value analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	2	1	-	2	-	-	1	-	-	3
CO2	-	2	1	-	2	-	-	1	-	-	3
CO3	-	2	-	3	1	-	-	1	-	-	1
CO4	2	2	3	-	1	-	-	1	-	-	-
CO5	1	2	3	-	1	-	-	1	-	-	-

UNIT-I

Introduction
financial markets, Risk-Return Analysis in Investment Decisions – Measures of Risk and Return, Introduction to probability and statistics ,Statistical Inference: Hypothesis Testing and Confidence Intervals

UNIT-II

Introduction to R programming
Programming with R, Economic Theory of Choice, Market Microstructure and Liquidity (Order-drive vs. Quote-driven markets) Introduction to portfolio construction and optimization, Introduction to Asset pricing models, CAPM, Single and Multi-index models, Portfolio management and performance evaluation
Practice:

1. AI and Machine Learning in Trading execution and portfolio management: Regression Algorithm and Case Study

UNIT-III

Algorithmic Trading

Optimizers – Introduction to tail risk measures-VaR and CVaR ,Algorithmic trading, trend determination, moving average indicators, momentum indicators

Practice:

1. AI and Machine Learning in Banking and Financial Services: Classification Algorithm and Case Study

UNIT-IV

Basic ideas of AI/ML in Economics

Motivating Applications of AI/ML in Economics & Politics. formulating / deciphering real life problems using these techniques, Optimization and Search techniques, Basic Predictive Algorithms, Time Series Prediction

Practice:

1. Learning Theory for Economics
2. Customer Behavior Analysis for Recommender Systems

UNIT – V

Causality and Attribution & Auction Theory

Shapley value analysis of predictive models, Granger Causality, Causal Graphical Models and do-Calculus, Randomized Control Trials **,** Mechanism Design with Economics applications, Vickrey, Myerson Auctions, Case studies of auctions, advertising strategies on the internet

Practice:

1. Reinforcement Learning in Finance
2. Multi-agent simulation of economic systems, Econo-physics

Text Books:

1 Sohnke M. Bartram, Mark M. Carhart, and John M. Griffin, “Artificial Intelligence in Asset Management", ISBN: 978-1108497261, 2021.

Reference Books:

1 Christian L. Dunis, Peter W. Middleton, Andreas Karathanasopolous, and Konstantinos Theofilatos, "Artificial Intelligence for Financial Markets: Cutting Edge Applications for Risk Management, Portfolio Optimization, and Economics", ISBN: 978-3030307152, 2020.

Web Links:

1 https://keras.io/datasets/

2 http://machinelearning.net/tutorial/machinelearning.pdf

Production Excellence											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501ME81	Fundamentals of Production Excellence	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME82	Six Sigma for Production Excellence	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME83	Quality Excellence in Production	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME84	Digital Transformation for Production Excellence	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME85	Agile Production Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME86	Process Excellence & Optimization	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME87	Risk Management in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
2501ME88	Ethical & Social Responsibility in Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,	FPE

										CSE(DS) PT,Min.E	
2501ME89	Data-Driven Decision Making for Production Excellence	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
2501ME58	Industry 5.0 for Engineers	AC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,MinE	FPE
2501ME90	Cost Excellence in Production	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	FPE
Total			**23**		**9**	**32**					

Fundamentals of Production Excellence

	L	T	P	C
Course Code: 2501ME81	**2**	**0**	**0**	**2**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain the key principles, evolution, and organizational relevance of production excellence
- **CO2:** Apply lean manufacturing tools and waste reduction techniques to improve production systems.
- **CO3:** Evaluate quality management strategies such as TQM and Six Sigma for continuous improvement.
- **CO4:** Analyze methods for resource efficiency and sustainability in production environments
- **CO5:** Assess the role of advanced manufacturing technologies, including Industry 4.0 and 3D printing, in achieving production excellence.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	1	-	-	-	-	1
CO2	3	3	3	2	2	1	-	2	2	1	2
CO3	2	3	3	3	2	2	2	2	2	1	2
CO4	2	2	2	-	2	2	2	1	1	1	2
CO5	3	2	3	2	2	2	-	2	2	2	3

UNIT-I

Introduction to Production Excellence

Definition and Importance of Production Excellence: Overview of production systems and their evolution, Key principles of production excellence, Relationship between production excellence and organizational success

Elements of Production Excellence: Lean manufacturing principles, Continuous improvement (Kaizen) and problem-solving techniques, Process optimization and operational efficiency

Productivity and Competitiveness: How production excellence contributes to competitiveness, Benchmarking against industry best practices, Role of leadership and culture in driving excellence

Assignments:

- Case Study: Analysis of a company that has successfully implemented production excellence
- Research Project: Benchmarking production processes in a selected industry

UNIT-II

Lean Manufacturing and Waste Reduction

Overview of Lean Manufacturing: History and philosophy of lean production, Key concepts: value, waste, flow, pull, and perfection, Lean tools: 5S, Just-In-Time (JIT), Kanban, and value stream mapping

Types of Waste (Muda): Identifying the 7 types of waste (overproduction, waiting, transportation, etc.), Techniques for waste reduction and elimination, Case studies of waste reduction in manufacturing

Lean Implementation Strategies: Steps for implementing lean manufacturing, Challenges in lean transformation and how to overcome them, The role of technology in lean manufacturing (automation, AI, IoT)

Assignments:

- Group Project: Develop a waste reduction plan for a manufacturing process
- Value Stream Mapping Exercise: Apply lean tools to optimize a production flow

UNIT-III

Quality Management and Continuous Improvement

Total Quality Management (TQM): Principles of TQM and its impact on production , excellence, Key quality management tools (Pareto charts, cause-and-effect diagrams, etc.), The role of customer focus in quality management

Six Sigma and Process Improvement: Introduction to Six Sigma methodologies (DMAIC, DMADV), Tools for process improvement (control charts, process mapping, FMEA), Case studies of Six Sigma projects in production environments.

Continuous Improvement (Kaizen): Philosophy and techniques of Kaizen, Engaging employees in continuous improvement initiatives, Measuring and sustaining improvement over time

Assignments:

- Case Study: Application of TQM in a real-world production setting
- Six Sigma Project: Analyze a production problem using Six Sigma tools

UNIT-IV

Resource Efficiency and Sustainability in Production

Resource Optimization: Efficient use of materials, energy, and water in production processes, Lean manufacturing's role in resource efficiency, Techniques for reducing resource waste and improving operational efficiency

Sustainable Manufacturing Practices: Principles of sustainable production, Environmental impact of production processes and how to mitigate them, Circular economy principles and waste minimization

Energy Management in Production: Energy-efficient technologies for production systems, Renewable energy integration in manufacturing, Case studies of sustainable production practices in different industries

Assignments:

- Research Paper: Sustainable manufacturing practices in a specific industry
- Group Project: Develop a resource efficiency improvement plan for a manufacturing unit

UNIT-V

Advanced Technologies in Production Excellence

Industry 4.0 and Smart Manufacturing: Role of AI, IoT, and big data in modern production systems, Automation, robotics, and advanced manufacturing technologies, Benefits of digital transformation in achieving production excellence

Additive Manufacturing (3D Printing): Introduction to additive manufacturing technologies, Benefits and challenges of 3D printing in production, Case studies of companies using 3D printing for production optimization

Supply Chain and Logistics Integration: Role of supply chain management in production excellence, Integrating lean and agile supply chain practices with production, Use of AI and machine learning for optimizing logistics and production flows

Assignments:

- Research Project: Analyze the impact of Industry 4.0 technologies on production excellence
- Case Study: Application of 3D printing in production optimization

Textbooks

1. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones, Free Press, ISBN: 978-0743249270

2. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, Jeffrey Liker, McGraw-Hill, ISBN: 978-0071392310

Reference Books:

1. Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Mikel Harry and Richard Schroeder, Crown Business, ISBN: 978-0385494380
2. 4. Production and Operations Analysis Steven Nahmias, Waveland Press, Inc., (7th Edition ,ISBN: 978-1478623069
3. 5. Smart Manufacturing: Industry 4.0 and the Industrial Internet of Things, John Soldatos, Oliver Niggemann, and Thorsten Lehmhus, CRC Press,ISBN: 978-0367332336

Six Sigma for Production Excellence

Course Code: 2501ME82	L	T	P	C
	2	0	1	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Understand the Six Sigma fundamental principles, Frameworks, and Roles and Certifications and its importances.
CO2: Apply the Define and Measure phases by formulating problem statements, collecting data, and identifying by using various measurement tools.
CO3: Analyse production data to identify root causes of defects using tools and implement improvement strategies.
CO4: Develop and implement control plans using appropriate control charts, SOPs, and continuous improvement strategies.
CO5: Utilize advanced statistical tools, & software and understand future trends including Industry 4.0, AI, and sustainable manufacturing.

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	2	-	1	1	-	-	-	1	-
CO2	2	-	2	-	1	1	-	-	-	2	-
CO3	2	-	3	-	1	2	-	-	-	2	-
CO4	2	-	3	-	1	2	-	-	-	2	-
CO5	2	-	3	-	1	2	-	-	-	2	-

UNIT-I

Introduction to Six Sigma and Production Excellence

Introduction to Six Sigma: Definition and history of Six Sigma, Six Sigma methodology and philosophy, Importance of Six Sigma in achieving production excellence, Key concepts: Defects, variability, process capability, and continuous improvement

Six Sigma Frameworks: DMAIC (Define, Measure, Analyze, Improve, Control), DMADV (Define, Measure, Analyze, Design, Verify)

Six Sigma Roles and Certifications: Green Belt, Black Belt, and Master Black Belt roles, Importance of leadership and teams in Six Sigma projects

Assignments:

- Case Study: Successful implementation of Six Sigma in a manufacturing company

- Group Project: Define a production problem and design a Six Sigma project outline

UNIT-II

Define and Measure Phases of Six Sigma

Define, Phase: Identifying production issues and project selection, Defining project scope and objectives, Developing a project charter and SIPOC diagram (Suppliers, Inputs, Process, Outputs, Customers), Understanding customer requirements (Voice of Customer)

Measure Phase: Identifying critical-to-quality (CTQ) characteristics, Data collection methods for measuring production performance, Key performance metrics: Yield, DPMO (Defects Per Million Opportunities), and process sigma level, Measurement tools: Pareto charts, histograms, control charts

Assignments:

- Data Collection Project: Collect production data and define CTQ metrics
- SIPOC Diagram: Develop a SIPOC diagram for a chosen production process

UNIT-III

Analyze and Improve Phases of Six Sigma

Analyze Phase: Root cause analysis: Fishbone diagrams, 5 Whys, Statistical analysis tools: Regression analysis, hypothesis testing, ANOVA, Identifying and verifying root causes of production defects, Process capability analysis (Cp, Cpk) and its significance in production excellence.

Improve Phase: Generating solutions to address root causes of defects, Brainstorming, FMEA (Failure Mode and Effects Analysis), and solution prioritization, Piloting and testing solutions for process improvement, Lean Six Sigma tools for improvement: Kaizen, 5S, Poka-Yoke (error-proofing)

Assignments:

- Root Cause Analysis: Identify root causes of a production issue using 5 Whys or fishbone diagram
- Improvement Project: Propose a solution to a production problem using Lean Six Sigma tools

UNIT-IV

Control Phase and Sustaining Improvements

Control Phase: Developing control plans and monitoring processes, Control charts: Types and applications (X-bar, R-chart, P-chart, etc.), Ensuring process stability and maintaining

improvements over time, Documenting changes and implementing standard operating procedures (SOPs)

Sustaining Production Excellence: Continuous monitoring and feedback loops, Role of leadership in sustaining Six Sigma improvements, Building a culture of continuous improvement in production environments, Tools for long-term sustainability: PDCA cycle, statistical process control (SPC)

Assignments:

- Control Chart Exercise: Develop and analyze control charts for a production process
- Final Project: Implement a Six Sigma project for process improvement and control

UNIT-V

Advanced Six Sigma Concepts and Applications in Production

Advanced Statistical Tools in Six Sigma: Design of Experiments (DO) for optimizing production processes, Advanced regression analysis and multivariate analysis, Process simulation and modeling for production optimization, Use of software tools for Six Sigma (Minitab, JMP, etc.)

Lean Six Sigma Integration: Combining Lean and Six Sigma for enhanced production excellence, Lean tools: Kanban, JIT (Just-in-Time), SMED (Single-Minute Exchange of Die)

Case studies of Lean Six Sigma in manufacturing industries

Future Trends in Six Sigma for Production Excellence: In ry 4.0 and the role of AI and automation in Six Sigma, Applications of Six Sigma in sustainable production and green manufacturing, Emerging trends: Predictive analytics and real-time data for Six Sigma

Assignments:

- Research Project: Application of advanced Six Sigma tools in a real-world production setting
- Group Presentation: Emerging trends and the future of Six Sigma in production excellence.

Text Books:

1. The Six Sigma Handbook, Thomas Pyzdek and Paul Keller, McGraw-Hill Education, 5th Edition,ISBN: 978-1260121827

2. Lean Six Sigma and Minitab: The Complete Toolbox Guide for Business Improvement,

Quentin Brook, OPEX Resources, ISBN: 978-0954681388

Reference Books:

1. Six Sigma for Managers, Greg Brue, McGraw-Hill, ISBN: 978-0071455480

2. Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions, Michael George, McGraw-Hill, ISBN: 978-0071418218

3. Design for Six Sigma: A Roadmap for Product Development, Kai Yang and Basem El-Haik, McGraw-Hill, ISBN: 978-0071547673

Quality Excellence in Production

Course Code: 2501ME83	L	T	P	C
	2	0	1	3

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain key quality concepts, dimensions, and the importance of quality management in production systems.
- **CO2:** Apply quality control tools to analyze and solve real-life production problems.
- **CO3:** Explain the process of ISO certification and discuss its impact on production efficiency and organizational competitive.
- **CO4:** Explain the Six Sigma methodology and its significance in systematic quality improvement.
- **CO5:** Analyze case studies to identify the benefits and challenges of implementing QbD across different industries.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	1	-	1	1	-	-	1		-
CO2	2	-	-	-	1	1	1	1	-	1	-
CO3	2	1	-	-	1	1	1	-	-	-	-
CO4	2	1	-	-	2	1	-	1	-	-	-
CO5	2	1	-	1	-	1	-	-	1	-	-

UNIT-I

Introduction to Quality Management in Production

Definition and Importance of Quality: Overview of quality concepts and dimensions in production, The role of quality management in achieving production excellence, Key quality pioneers and philosophies (Deming, Juran, Crosby), Principles of Quality Management:, Total Quality Management (TQM), The concept of continuous improvement (Kaizen), Quality culture and leadership in production

Cost of Quality (COQ): Understanding the four categories of quality costs: prevention, appraisal, internal failure, external failure, How to measure and manage quality-related costs

Assignments:

- Research Paper: Impact of TQM on production efficiency
- Case Study: Analysis of quality management in a manufacturing company.

UNIT-II

Quality Control Tools and Techniques

Introduction to Quality Tools: Seven basic quality control tools: Cause-and-effect diagrams, control charts, flowcharts, check sheets, histograms, Pareto charts, scatter diagrams, Application of quality tools in real-life production environments. Statistical Process Control (SPC): Understanding variability in production processes, Control charts and process capability analysis (Cp, Cpk), Case studies on the use of SPC for process improvement

Sampling and Inspection: Types of sampling methods (random, systematic, stratified), Acceptance sampling plans (AQL, LTPD), Role of inspection in quality management

Assignments:

- Project: Develop control charts for a chosen production process
- Application: Implement one of the seven quality tools in a production environment

UNIT-III

Quality Standards and Certifications

Introduction to Quality Standards: Overview of ISO 9000 series standards, Importance of international standards in quality management, The process of ISO certification and its impact on production excellence

Industry-Specific Quality Certifications: AS9100 (Aerospace), ISO/TS 16949 (Automotive), ISO 13485 (Medical Devices), Understanding the relevance of different certifications to various industries, Auditing for Quality Assurance: Types of audits (internal, external, supplier), Role of audits in maintaining and improving quality standards, Continuous improvement through auditing and feedback

Assignments:

- Research Paper: How ISO 9001 improves production processes
- Group Project: Develop a quality audit plan for a manufacturing company

UNIT-IV

Six Sigma and Lean for Quality Excellence

Introduction to Six Sigma: Six Sigma methodology and its relevance in quality improvement, DMAIC (Define, Measure, Analyze, Improve, Control) process in Six Sigma, Tools and techniques used in Six Sigma (e.g., process mapping, FMEA), Lean Manufacturing and Waste Reduction: Lean principles and the concept of waste elimination (Muda), Tools for Lean implementation (5S, JIT, Kanban, value stream mapping), Integrating Lean and Six Sigma for operational excellence, Case Studies: Successful Lean Six Sigma projects in production environments, Benefits of applying Lean Six Sigma in improving quality

Assignments:

- Group Project: Identify and reduce waste in a production process using Lean tools
- Case Study: Application of Six Sigma for quality improvement in a manufacturing setting

UNIT-V

Advanced Quality Management Practices

Quality by Design (QbD): Importance of designing quality into products and processes, Principles of QbD and its role in achieving production excellence, Case studies on the implementation of QbD in various industries, Supplier Quality Management: Ensuring supplier quality in production, Developing supplier relationships and performance monitoring, Tools for managing supplier quality (supplier scorecards, audits), Technology and Innovation in Quality Management: Role of Industry 4.0 and smart manufacturing in quality excellence, Use of data analytics and AI for predictive quality control, Future trends in quality management

Assignments:

- Research Project: Quality by Design in modern manufacturing
- Presentation: The impact of Industry 4.0 on quality management in production

Textbooks:

1. Juran's Quality Handbook: The Complete Guide to Performance Excellence, Joseph A. De Feo and J.M. Juran, McGraw-Hill Education, 7th Edition, ISBN: 978-1259643613

2. Quality Control and Management, James R. Evans and William M. Lindsay, Cengage Learning, ISBN: 978-1305662544

Reference Books:

1. The Certified Six Sigma Green Belt Handbook, Roderick A. Munro, Govindarajan Ramu, Daniel J. Zrymiak, ASQ Quality Press, ISBN: 978-0873898911

2. The Lean Six Sigma Pocket A Quick Reference Guide to Nearly 100 Tools for Improving Quality and Speed, Michael L. George, John Maxey, David Rowlands, McGraw-Hill, ISBN: 978-0071441193

3. Total Quality Management and Operational Excellence: Text with Cases, John S. Oakland, Routledge, ISBN: 978-1138198006.

Digital Transformation for Production Excellence

	L	T	P	C
Course Code: 2501ME84	**2**	**0**	**1**	**3**

Course Outcomes

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

- **CO1:** Understand and explain the key drivers, technologies, and implications of digital transformation in production systems.
- **CO2:** Analyze and apply data analytics, AI, and machine learning techniques for improving production processes and decision-making.
- **CO3:** Evaluate and design automation strategies, including robotics and collaborative technologies, to enhance production excellence.
- **CO4:** Develop digital solutions incorporating smart factory and digital supply chain concepts with cybersecurity considerations.
- **CO5:** Formulate strategies for successful digital transformation including change management and future-readiness in manufacturing environments.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	1	-	-	-	2	-	1
CO2	3	-	2	-	1	-	-	-	1	-	2
CO3	3	-	1	2	1	-	-	2	2	-	1
CO4	3	-	-	2	1	-	1	-	2	2	1
CO5	3	1	-	-	1	-	1	-	1	1	1

UNIT-I

Introduction to Digital Transformation in Production

Understanding Digital Transformation: Definition and significance of digital transformation in modern manufacturing, Key drivers of digital transformation (customer expectations, technological advancements, competitive pressure), Impact of digital transformation on production processes and operations, Digital Technologies in Production: Overview of key digital technologies: Internet of Things (IoT), artificial intelligence (AI), robotics, cloud computing, and big data analytics, The role of these technologies in enhancing productivity, quality, and operational efficiency, Industry 4.0 and Smart Manufacturing: Introduction to Industry 4.0 and its components (cyber-physical systems, IoT, and smart factories) ,Case studies of Industry 4.0 implementations in various industries

Assignments:

- Case Study: Impact of Industry 4.0 on production excellence

- Group Project: Research and present a real-life example of digital transformation in production

UNIT-II

Data-Driven Production and Analytics

The Role of Data in Production Excellence: Understanding the importance of data collection, analysis, and utilization in production, Data sources in production systems: sensors, machines, ERP systems, Introduction to big data and data analytics for production decision-making, Predictive and Prescriptive Analytics: Predictive analytics for forecasting machine failures, maintenance schedules, and demand planning, Prescriptive analytics for optimizing production processes and improving decision-making, Case studies on the use of predictive analytics in production systems, AI and Machine Learning in Production: Introduction to machine learning algorithms and their application in manufacturing, Role of AI in process optimization, defect detection, and quality control,

Assignments:

- Data Analytics Project: Use production data to identify potential improvements
- Research Paper: Applications of AI and machine learning in predictive maintenance.

UNIT-III

Automation and Robotics for Production Excellence

Automation in Manufacturing: Introduction to automation technologies (robotics, automated guided vehicles, CNC machines), Benefits of automation: increased efficiency, reduced human error, improved quality, Levels of automation: from simple robotic arms to fully autonomous systems, Collaborative Robots (Cobots): Role of collaborative robots in augmenting human workers in production environments, Safety and productivity considerations in implementing cobots, Advanced Robotics and AI Integration: Case studies of fully automated and AI-integrated production lines, Benefits of robotic process automation (RPA) for repetitive tasks in production

Assignments:

- Case Study: Successful implementation of robotics in a production line
- Group Project: Propose an automation plan for a selected manufacturing process

UNIT-IV

Smart Factories and Digital Supply Chains

Smart Factory Concepts:, Definition and components of a smart factory (interconnected systems, autonomous processes, real-time data), Role of IoT in enabling smart factories (sensor networks, real-time monitoring), Benefits of smart factories in achieving production

excellence (cost savings, agility, transparency), Digital Supply Chain Transformation: How digital technologies optimize supply chain operations (demand forecasting, inventory management, logistics), Integration of digital twins, blockchain, and AI in the supply chain

Case studies on digital supply chain transformation, Cybersecurity in Digital Production: Importance of cybersecurity in Industry 4.0 environments, Common cybersecurity challenges in smart factories and digital supply chains, Best practices for securing digital production systems

Assignments:

- Smart Factory Project: Design a smart factory model using IoT and automation technologies
- Research Paper: Digital supply chain innovations and their impact on production efficiency

UNIT -V

Change Management and Digital Transformation Strategies

Challenges in Digital Transformation: Common barriers to digital transformation in production environments (legacy systems, resistance to change, lack of skills), Strategies for overcoming challenges and driving successful transformation, Role of leadership in fostering a culture of innovation and digital adoption, Change Management for Digital Transformation: Understanding the importance of change management in implementing new technologies, Tools and frameworks for managing organizational change (ADKAR model, Kotter's 8-Step Process), Engaging employees and managing transitions to digital workflows, Future Trends in Digital Transformation for Production Excellence: Emerging technologies and trends: edge computing, 5G networks, augmented reality (AR) in production, Case studies on future trends and their potential impact on the manufacturing sector.

Assignments:

- Group Presentation: Change management strategies for digital transformation in a real-world production setting
- Final Project: Develop a digital transformation roadmap for a manufacturing organization.

Text Books:

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, ISBN: 978-1484220467

2. Smart Manufacturing: Industry 4.0 and the Industrial Internet of Things, John Soldatos, Oliver Niggemann, Thorsten Lehmhus, CRC Press, ISBN: 978-0367332336

Reference Books:

1. Digital Transformation: Survive and Thrive in an Era of Mass Extinction, Thomas M. Siebel, Rosetta Books, ISBN: 978-1948122481

2. The Fourth Industrial Revolution, Author: Klaus Schwab, Crown Business, ISBN: 978-1524758868

3. Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results, Bernard Marr, Wiley, ISBN: 978-1119231387

Agile Production Systems

	L	T	P	C
Course Code: 2501ME85	**2**	**0**	**1**	**3**

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

- **CO1:** Identify key differences between traditional, lean, and agile production systems.
- **CO2:** Describe core strategies and technologies used in agile manufacturing.
- **CO3:** List characteristics and components of an agile supply chain.
- **CO4:** Demonstrate the use of Scrum or Kanban in managing a production task.
- **CO5:** Explain how emerging technologies support agile and sustainable production.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	-	3	-	2	-	-	-	-	-	-
CO3	-	2	-	-	1	1	-	-	-	-	-
CO4	-	-	1	2	2	-	-	2	2	2	
CO5	2	-	-	-	v	3	-	-	-	-	2

UNIT-I

Introduction to Agile Production Systems

Overview of Agile Production: Definition and importance of agility in production systems, Evolution of production systems: From traditional, lean, to agile, Key characteristics of agile production: flexibility, responsiveness, and customer focus, Differences between lean and agile production systems, Drivers of Agility in Production: Market demands and the need for customized products, Shorter product life cycles and rapid technological advancements, The role of globalization and competition in driving agility, Agile vs. Traditional Manufacturing: Comparison of mass production, lean, and agile approaches, Benefits and challenges of adopting agile production systems

Assignments:

- Case Study: A comparison between lean and agile production systems in a manufacturing company.
- Group Project: Identify the drivers for adopting agile production in a real-world company.

UNIT-II

Agile Manufacturing Frameworks and Strategies

Core Concepts of Agile Manufacturing: Understanding agility and flexibility in manufacturing, Importance of modularity and reconfigurable manufacturing systems, Agile supply chain integration and collaboration with partners, Mass customization and agile , product design strategies, Agile Manufacturing Strategies: Quick response manufacturing (QRM), Postponement strategy and its role in agile production, Hybrid manufacturing systems: Combining lean and agile principles, Tools and Technologies Enabling Agile Production: Automation, robotics, and AI in achieving agility, Advanced manufacturing technologies (3D printing, CNC machining)

Assignments:

- Research Paper: Impact of advanced technologies on agility in production systems
- Case Study: Implementation of mass customization in a manufacturing firm

UNIT-III

Agile Supply Chain and Logistics

Agile Supply Chain Concepts: Agile supply chain characteristics: flexibility, responsiveness, and customer-centricity, Differences between lean and agile supply chains, The role of collaboration and information sharing in agile supply chains, Strategies for Agile Supply Chains:, Supply chain segmentation based on product demand variability, Supplier management and the role of strategic partnerships, Role of logistics in enabling agile production systems, Supply Chain Flexibility and Adaptability: Real-time data and decision-making in supply chain management, Risk management and handling disruptions in agile supply chains, Case studies of agile supply chain implementation in various industries

Assignments:

- Group Project: Design an agile supply chain for a manufacturing company
- Research Paper: The role of real-time data in improving supply chain agility

UNIT-IV

Agile Project Management for Production Systems

Introduction to Agile Project Management: Principles and benefits of agile project management in production, Differences between traditional and agile project management, Agile methodologies: Scrum, Kanban, and their application in production, Agile Practices in Manufacturing Projects: Iterative development and continuous improvement in production systems, Customer feedback and its integration into product development, Agile team structures and roles (Scrum Master, Product Owner, Development Team), Agile Frameworks for Production Optimization: Using Scrum and Kanban to manage production workflows,

Real-world examples of agile project management in manufacturing environments, Role of leadership in fostering an agile culture

Assignments:

- Agile Project: Implement a Scrum or Kanban framework in a simulated production environment
- Research Paper: The role of agile project management in improving production efficiency

UNIT-V

Future Trends and Sustainability in Agile Production Systems

Emerging Trends in Agile Production: Digital transformation and its impact on agile manufacturing, Industry 4.0 and smart factories as enablers of agility, Use of AI, IoT, and big data analytics for real-time decision-making in agile production systems, Sustainability and Agile Production: The role of agile systems in sustainable manufacturing, Green manufacturing practices and agile production, Reducing waste and improving resource efficiency through agility, Future of Agile Production: Evolving customer expectations and the need for hyper-customization, Integration of new technologies such as augmented reality and virtual reality in agile production, Predictive analytics and automation as future enablers of agile production

Assignments:

- Group Presentation: The impact of Industry 4.0 technologies on agile production
- Final Project: Develop a sustainable agile production system for a manufacturing company

Textbooks

1. Agile Manufacturing: Forging New Frontiers, Paul T. Kidd, Addison-Wesley Professional, ISBN: 978-0201631634.

2. Agile Manufacturing: The 21st Century Competitive Strategy, A. Gunasekaran, Elsevier, ISBN: 978-0080435671

Reference Books:

1. Manufacturing Systems and Technologies for the New Frontier: The 41st CIRP Conference on Manufacturing Systems, Mamoru Mitsuishi, Kanji Ueda, Fumihiko Kimura, Springer, ISBN: 978-1848002661

2. Agile Supply Chain: Integrating Suppliers and Customers into the Network, Pamela Danese, Pietro Romano, Springer, ISBN: 978-1849960809

3. The Lean Mindset: Ask the Right Questions, Mary Poppendieck, Tom Poppendieck, blisher: Addison-Wesley, ISBN: 978-032189690.

Process Excellence & Optimization

	L	T	P	C
Course Code: 2501ME86	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Apply core concepts of TQM, Six Sigma, and Lean to map processes and evaluate performance using KPIs.
- **CO2:** Implement Lean tools such as 5S, Kaizen, and Value Stream Mapping (VSM) to identify non-value-adding activities and enhance process efficiency.
- **CO3:** Utilize Six Sigma methodologies and statistical techniques to minimize process variation and improve overall quality.
- **CO4:** Apply optimization strategies using simulation models, data analytics, and benchmarking to enhance process performance.
- **CO5:** Integrate sustainability into process improvements and assess the impact of Industry 4.0 and IoT on process excellence.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-	-	-	-	-	-	-
CO2	2	2	2	-	-	-	-	-	-	-	-
CO3	2	2	3	-	-	-	-	-	-	-	-
CO4	2	2	3	-	-	-	-	-	-	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-

UNIT-I: Introduction to Process Excellence

Fundamentals of Process Excellence:, Definition and importance of process excellence in organizations, Key principles and methodologies: Total Quality Management (TQM), Six Sigma, Lean ,The role of process excellence in achieving competitive advantage, Process Mapping and Analysis: Techniques for mapping processes (flowcharts, SIPOC diagrams), Identifying process inputs, outputs, and key performance indicators (KPIs), Analyzing process performance using metrics and benchmarks, Process Improvement Frameworks: Overview of popular frameworks: DMAIC (Define, Measure, Analyze, Improve, Control), PDCA (Plan-Do-Check-Act), Case studies on successful process improvement initiatives

Assignments:

- Case Study: Analyzing a process improvement case in a real-world organization
- Project: Create a process map and identify key areas for improvement

UNIT-II: Lean Principles and Tools

Introduction to Lean Manufacturing: History and principles of Lean manufacturing, Key Lean concepts: Value stream mapping, waste reduction, continuous improvement, Lean vs. traditional manufacturing, Lean Tools and Techniques: 5S (Sort, Set in order, Shine, Standardize, Sustain), Kaizen (Continuous Improvement), Value Stream Mapping and its application in identifying and eliminating waste, Implementing Lean in Organizations: Strategies for successful Lean implementation, Overcoming challenges and resistance to change, Measuring the impact of Lean initiatives

Assignments:

- Group Project: Develop a Lean implementation plan for a chosen process
- Research Paper: The impact of Lean principles on process optimization

UNIT-III: Six Sigma for Process Optimization

Introduction to Six Sigma: History and principles of Six Sigma, Understanding the Six Sigma methodology: DMAIC and DMADV (Define, Measure, Analyze, Design, Verify), The role of Six Sigma in reducing process variation and improving quality, Six Sigma Tools and Techniques: Statistical tools: Control charts, process capability analysis, hypothesis testing, Design of Experiments (DOE) and Failure Modes and Effects Analysis (FMEA), The concept of Sigma levels and their impact on process performance, Implementing Six Sigma: Steps for successful Six Sigma deployment, The role of Green Belts, Black Belts, and Master Black Belts, Case studies of Six Sigma applications in various industries,

Assignments:

- Six Sigma Project: Use Six Sigma tools to analyze and improve a process
- Research Paper: Benefits and challenges of implementing Six Sigma in organizations

UNIT-IV: Advanced Process Optimization Techniques

Process Simulation and Modeling: Introduction to process simulation and its importance in optimization, Tools and software for process modeling (e.g., MATLAB, Simulink), Case studies on the use of simulation for process improvement, Advanced Analytics and Optimization: Use of data analytics and machine learning in process optimization, Predictive modeling and real-time analytics for process improvement, The role of optimization algorithms in improving process performance, Benchmarking and Best Practices: Benchmarking techniques for comparing process performance, Identifying and implementing best practices from industry leaders, Case studies on successful benchmarking initiatives

Assignments:

- Project: Develop a process simulation model for a chosen process
- Research Paper: The role of advanced analytics in process optimization

UNIT-V: Sustainability and Process Excellence

Sustainable Process Improvement: Principles of sustainability and their integration into process excellence, Environmental impact assessment and reduction strategies, The role of green manufacturing practices in process optimization, Integrating Sustainability with Process Optimization: Techniques for balancing process efficiency with environmental and social responsibilities, Case studies of organizations implementing sustainable process improvements, Future Trends in Process Excellence: Emerging trends and technologies impacting process excellence (e.g., Industry 4.0, IoT), The future of process optimization in a sustainable world.

Assignments:

- Group Project: Design a sustainable process improvement plan for a manufacturing or service organization
- Final Project: Analyze future trends in process excellence and their potential impact

Textbook

1. Process Optimization: A Statistical Approach by Ignacio Castillo, Michael A. O'Neill , Springer, ISBN: 978-144715292.

Risk Management in Production Excellence

	L	T	P	C
Course Code: 2501ME87	**2**	**0**	**1**	**3**

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

CO1: Explain Fundamentals of Risk Management
CO2: Apply risk identification tools like FMEA and HAZOP, and assess risks using Risk Matrix, FTA, and ETA methods.
CO3: Evaluate the effectiveness of risk controls through monitoring and real-world case studies.
CO4: Identify and assess risks in supply chain and operations using structured frameworks and tools.
CO5: Discuss the Future Trends and Challenges in Risk Management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	2	1	-	-	1	-
CO2	2	-	-	-	-	2	1	-	-	1	-
CO3	2	-	-	-	-	2	1	-	-	1	-
CO4	2	-	-	-	-	2	1	-	-	1	-
CO5	2	-	-	-	-	2	1	-	-	1	-

UNIT-I

Introduction to Risk Management in Production

Fundamentals of Risk Management: Definition and importance of risk management in production environments, Key concepts: risk, risk management, risk assessment, risk mitigation, The role of risk management in achieving production excellence, Types of Risks in Production: Operational risks (equipment failure, process disruptions), Strategic risks (market fluctuations, supply chain disruptions), Compliance and safety risks (regulatory non-compliance, workplace accidents), Risk Management Frameworks and Standards: Overview of risk management frameworks (ISO 31000, COSO), The risk management process: identification, assessment, response, and monitoring, Case studies on effective risk management in production

Assignments:

- Research Paper: The role of risk management in achieving production excellence
- Group Project: Identify and assess key risks in a production process

UNIT-II

Risk Identification and Assessment

Risk Identification Techniques: Methods for identifying risks: brainstorming, checklists, SWOT analysis, Tools for risk identification: Failure Modes and Effects Analysis (FMEA), Hazard and Operability Study (HAZOP), The role of historical data and trend analysis in risk identification, Risk Assessment Methods: Qualitative vs. quantitative risk assessment, Risk assessment techniques: Risk Matrix, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Prioritizing risks based on impact and likelihood, Case Studies: Examples of risk identification and assessment in different industries, Assignments:

- Risk Assessment Project: Conduct a risk assessment for a selected production process
- Case Study: Analyze a real-world example of risk identification and assessment

UNIT-III

Risk Mitigation and Control Strategies

Risk Mitigation Strategies: Developing risk mitigation plans and strategies, Risk avoidance, risk reduction, risk transfer, and risk acceptance, The role of contingency planning and emergency response plans, Control Measures and Best Practices: Implementing control measures: engineering controls, administrative controls, personal protective equipment (PPE), Best practices for risk management in production settings , Monitoring and reviewing the effectiveness of control measures , Case Studies: Successful examples of risk mitigation and control in production environments

Assignments:

- Project: Develop a risk mitigation plan for a chosen production scenario
- Research Paper: Best practices for risk control and mitigation in production

UNIT-IV

Risk Management in Supply Chain and Operations

Supply Chain Risk Management: Identifying and managing risks in the supply chain, Strategies for improving supply chain resilience and flexibility, The role of suppliers and partners in risk management, Operational Risk Management: Managing risks associated with production processes and operations, Implementing operational controls and process improvements, The impact of technology and automation on operational risk management, Case Studies: Examples of effective risk management in supply chain and operations

Assignments:

- Group Project: Develop a risk management plan for a supply chain scenario

- Case Study: Analyze the impact of operational risk management on production performance

UNIT-V

Future Trends and Challenges in Risk Management

Emerging Trends in Risk Management:, The role of digital technologies (IoT, big data, AI) in risk management , Future challenges and opportunities in managing production risks, The impact of Industry 4.0 on risk management practices, Integrating Risk Management with Production Excellence: Aligning risk management strategies with production goals and objectives, The role of leadership and culture in effective risk management, Developing a risk-aware culture in production environments, Case Studies and Future Directions: Analysis of future trends and their impact on risk management in production, Assignments:

- Research Project: The impact of emerging technologies on risk management in production
- Final Project: Develop a comprehensive risk management strategy for a production organization

Text Book:

1. Risk Management in Production: A Comprehensive Guide by Chris M. Hertig, Wiley, ISBN: 978-11194775

Ethical & Social Responsibility in Production Excellence

	L	T	P	C
Course Code: 2501ME88	**2**	**0**	**1**	**3**

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

- **CO1:** Define basic ethical principles and explain the role of social responsibility in production activities.
- **CO2:** Identify ethical issues in labour, environment, and supply chain operations.
- **CO3:** Discuss the importance of CSR in improving production and company reputation
- **CO4:** Apply legal and ethical standards to ensure compliance in production systems
- **CO5:** Analyze future challenges for ethical and responsible production.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1						2	2		2		1
CO2		2				2	2				
CO3						2	2	2	2		
CO4		2		2		2	2		2		
CO5			2			2	2	2	2	2	1

UNIT-I

Introduction to Ethics and Social Responsibility in Production

Fundamentals of Ethics in Production: Definition and importance of ethics in production environments, Key ethical principles: integrity, fairness, transparency, and accountability, Ethical decision-making models and frameworks, Social Responsibility in Production: Definition and scope of social responsibility, The role of corporate social responsibility (CSR) in production excellence, Balancing profitability with ethical and social considerations, Case Studies: Examples of ethical dilemmas and social responsibility issues in production settings, Assignments:

- Research Paper: The role of ethics and social responsibility in achieving production excellence
- Group Project: Analyze an ethical case study related to production practices

UNIT-II

Ethical Practices in Production Operations

Ethical Labor Practices: Ensuring fair labor practices: wages, working conditions, and worker rights, Addressing issues of child labor, forced labor, and discrimination, The role of

international standards and certifications (e.g., Fair Trade, SA8000), Environmental Responsibility: Ethical considerations in environmental management and sustainability, Implementing green manufacturing practices: waste reduction, resource conservation, and pollution control, Compliance with environmental regulations and standards, Ethical Supply Chain Management: Ensuring ethical practices throughout the supply chain, Supplier audits and ethical sourcing, Addressing issues of transparency and traceability,

Assignments:

- Project: Develop an ethical labor and environmental practices plan for a production organization
- Case Study: Analyze the impact of ethical practices on production operations

UNIT-III

Corporate Social Responsibility (CSR) and Production Excellence

Introduction to CSR: The concept and importance of CSR in production, CSR strategies and initiatives related to production excellence, Measuring the impact of CSR activities on business performance, Implementing CSR Programs: Designing and implementing CSR programs in production environments, Engaging stakeholders: employees, customers, and communities, Reporting and communicating CSR efforts and outcomes, Case Studies: Successful CSR initiatives in the production sector, Analysis of CSR impacts on company reputation and performance

Assignments:

- Group Project: Design a CSR program for a production company
- Research Paper: The impact of CSR on production excellence and organizational success

UNIT-IV

Legal and Ethical Compliance in Production

Regulatory Compliance: Overview of key regulations and standards affecting production (e.g., OSHA, EPA, ISO), Ensuring compliance with local, national, and international laws, The role of compliance programs and audits in maintaining ethical standards, Ethical Compliance Programs: Developing and implementing ethical compliance programs, Training and educating employees on ethical practices and legal requirements, Handling ethical violations and whistleblowing mechanisms, Case Studies: Examples of legal and ethical compliance issues in production, Analysis of successful compliance and ethics programs

Assignments:

- Project: Develop an ethical compliance program for a production organization
- Case Study: Analyze a real-world example of compliance and ethical challenges in production

UNIT-V

Future Trends and Challenges in Ethical and Social Responsibility

Emerging Trends in Ethics and Social Responsibility: The impact of technological advancements on ethical and social responsibility (e.g., AI, automation), The growing importance of sustainability and social justice issues, The role of innovation in addressing ethical and social responsibility challenges, Strategic Approaches to Ethical and Social Responsibility: Integrating ethical and social responsibility into business strategy, Building a culture of ethics and responsibility in production organizations, Future challenges and opportunities in maintaining ethical and social standards, Case Studies and Future Directions: Analysis of future trends and their impact on ethical practices in production

Assignments:

- Research Project: Future trends in ethical and social responsibility in production
- Final Project: Develop a strategic plan for addressing emerging ethical and social responsibility challenges

Textbook:

1. Business and Society: Stakeholders, Ethics, Public Policy by Anne Lawrence, James Weber, McGraw-Hill Education, ISBN: 978-1260565584.

Data-Driven Decision Making for Production Excellence

	L	T	P	C
Course Code: 2501ME89	**2**	**0**	**1**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain the importance of data-driven decision making and identify key data sources in production.
- **CO2:** Apply basic techniques to collect and manage production data using suitable tools.
- **CO3:** Use simple statistical tools and visualizations to interpret production data.
- **CO4:** Identify how data can support production decisions like quality control and scheduling.
- **CO5:** Describe emerging technologies like IoT and AI in improving production decisions.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			2	1				2	
CO2	2	2		1	3					1	
CO3	2	2		2	3					2	1
CO4	2	2	2	1	2				1	2	1
CO5	2	1	2		2	2				1	2

UNIT-I

Introduction to Data-Driven Decision Making

Fundamentals of Data-Driven Decision Making: Definition and importance of data-driven decision making in production, Key concepts: data collection, analysis, interpretation, and application, The role of data in achieving production excellence and operational efficiency, Data Sources and Types: Types of data: structured vs. unstructured data, Sources of production data: sensors, ERP systems, production logs, and external sources, Data quality and reliability: ensuring accuracy and consistency, Introduction to Data Analytics: Overview of data analytics methods: descriptive, diagnostic, predictive, and prescriptive analytics, Tools and technologies for data analysis (e.g., Excel, R, Python, BI tools)

Assignments:

- Research Paper: The role of data-driven decision making in improving production processes
- Group Project: Identify and categorize data sources for a production system

UNIT-II

Data Collection and Management

Data Collection Techniques: Methods for collecting production data: manual vs. automated, Tools and technologies for data collection: sensors, IoT devices, and software, Ensuring data integrity and accuracy in the collection process, Data Management Practices: Data storage solutions: databases, data warehouses, and cloud storage, Data management practices: data cleaning, data normalization, and data integration, Ensuring data security and privacy: compliance with regulations and best practices, Case Studies: Examples of successful data collection and management practices in production environments

Assignments:

- Project: Develop a data collection plan for a production process
- Case Study: Analyze data management practices in a real-world production organization

UNIT-III

Data Analysis and Visualization

Data Analysis Techniques: Statistical analysis: mean, median, variance, and correlation, Advanced analytics: regression analysis, clustering, and time series analysis, Machine learning algorithms for predictive analytics: classification, regression, and clustering, Data Visualization: Importance of data visualization in decision making, Tools and techniques for data visualization: charts, graphs, dashboards, Best practices for creating effective visualizations and communicating insights, Case Studies: Examples of data analysis and visualization used to solve production problems

Assignments:

- Data Analysis Project: Analyze a dataset from a production process and draw insights
- Visualization Project: Create a dashboard to visualize key production metrics

UNIT-IV

Data-Driven Decision Making in Production Processes

Applying Data Insights to Production: Using data to optimize production processes: scheduling, quality control, and resource allocation, Decision-making frameworks: using data to support decision making and problem solving, Real-time decision making and its impact on production efficiency, Case Studies in Data-Driven Decision Making: Examples of organizations that have successfully implemented data-driven decision making, Analysis of the impact of data-driven decisions on production performance and outcomes, Challenges and Solutions: Common challenges in implementing data-driven decision making, Strategies for overcoming barriers and integrating data-driven approaches into production

Assignments:

- Group Project: Develop a data-driven decision-making strategy for a production scenario
- Research Paper: Challenges and solutions in implementing data-driven decision making in production

UNIT -V

Future Trends and Innovations in Data-Driven Production

Emerging Technologies: The impact of Industry 4.0 and smart manufacturing on data-driven decision making ,Advances in data analytics technologies: artificial intelligence, machine learning, and big data, The role of IoT and real-time data in enhancing production excellence, Future Directions: Trends in data-driven decision making: automation, predictive maintenance, and adaptive systems, The future of data analytics in production: new tools, techniques, and best practices, Case Studies and Innovations: Analysis of cutting-edge innovations and their impact on production decision making, Future scenarios and their implications for production excellence

Assignments:

- Research Project: Explore future trends and innovations in data-driven decision making for production
- Final Project: Develop a forward-looking data strategy for a production organization considering emerging technologies

Textbook:

1. Data-Driven Production: How to Use Data Analytics for Production Excellence by John F. McDonald, Emily A. Voss, Wiley, ISBN: 978-1119632348

Industry 5.0 for Engineers

Course Code: 2501ME58	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Explain the basic concept of Industry 5.0.
- **CO2:** Explain the concepts of Industrial IOT, IOS and Predictive Analytics
- **CO3:** Explain the cyber physical systems and AI technologies
- **CO4:** Analyse the applications of Industry 5.0 in various sectors
- **CO5:** Analyse case studies on automation and healthcare services

Mapping of Course Outcomes with Program Outcomes: :

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	1	1	-	2	-	-	-	-	-	-
CO3	1	1	1	-	2	-	-	-	-	-	-
CO4	1	3	1	-	2	-	-	-	-	-	-
CO5	1	3	1	-	2	-	-	-	-	-	-

UNIT – I

Introduction to Industry 5.0

Introduction of Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 5.0, Comparison of Industry 5.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Automation and Transformation Processes.

UNIT – II

Importance of Internet of Things (IOTs)

Introduction to Internet of Things (IoT), Industrial Internet of Things (IIoT), Internet of Services, Fundamental of Predictive Analytics, Smart Logistics, Smart Devices and Products.

UNIT – III

Technology Evolution

Basics of cyber Physical Systems, Process Automations and Collaborative robots, Fundamental to artificial Intelligence, Mobile Computing, Cyber Security, Ethical technology, Responsive and distributed supply chain system, Human-centric and Value-oriented approaches.

UNIT – IV

Technology Implementation and Case Studies

3D printing, Solar energy sector, Healthcare sector, Maintain records related to education, finance, clean bioenergy generation and Intelligent NextG Wireless Networks.

UNIT – V

Case studies on CNC/NC automation - Benefits, challenges, and industry applications., In-house, Healthcare services-Examples of innovations improving patient care and operational efficiency.

Text Books:

1. The Future of the Industrial Economy by Uthayan Elangovan, Industry 5.0, , First Edition, Taylor & Francis, ISBN: 978-1-032-04127-8, 2022.
2. Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances by Alessandro Massaro, Wiley-IEEE Press, 2021, ISBN: 2021028944.

Reference Books:

1. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, A press, 2016.
2. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing by Lan Gibson, David W. Rosen and Brent Stucker, Springer.
3. The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0by Hans Bernhard Kief, Helmut Roschiwal, Karsten Schwarz, Industrial Press Inc., U.S. ISBN 0831136367, Nov 2021.
4. Healthcare 4.0 Next Generation Processes with the Latest Technologies by Chanchaichujit, Albert Tan, Fanwen Meng, Sarayoot Eaimkhong, Palgrave Pivot, 2019,ISBN978-981-13-8113-3.

Web Links:

1. http://www.mqtt.org/
2. https://opcfoundation.org/about/opc-technologies/opc-ua/
3. https://www.ethercat.org/default.htm

Cost Excellence in Production

Course Code: 2501ME90	L	T	P	C
	2	0	1	3

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

- **CO1:** Explain cost types and apply basic cost analysis tools in production.
- **CO2:** Apply cost control and reduction techniques to improve production efficiency.
- **CO3:** Use ABC and TCO methods to analyze and manage production costs.
- **CO4:** Interpret financial metrics and perform cost-benefit analysis in production.
- **CO5:** Assess emerging trends and develop strategies for cost excellence.

Mapping of Course Outcomes with Program Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	-	1	-	-	-	-	-	-
CO2	2	2	3	-	2	1	-	-	-	-	-
CO3	2	2	2	-	3	-	-	-	-	1	-
CO4	2	-	1	-	1	-	-	-	-	2	-
CO5	-	-	-	-	-	2	-	-	-	1	2

UNIT -I

Introduction to Cost Management in Production

Fundamentals of Cost Management: Definition and importance of cost management in production, Key concepts: cost types (fixed, variable, direct, indirect), cost behavior, and cost allocation, The role of cost management in achieving production excellence ,Cost Analysis Techniques: Methods for cost analysis: cost-volume-profit analysis, break-even analysis, Tools for cost estimation: cost forecasting, budgeting, and variance analysis, Case Studies: Examples of cost management practices in different production environments

Assignments:

- Research Paper: The importance of cost management in achieving production excellence
- Group Project: Perform a cost analysis for a production process and identify cost-saving opportunities

UNIT -II

Cost Control and Reduction Strategies

Cost Control Techniques: Techniques for controlling production costs: standard costing, budgetary control, and cost monitoring, Implementing cost control measures: process improvements, lean manufacturing, Identifying and managing cost variances ,Cost Reduction

Strategies: Strategies for reducing production costs: waste reduction, process optimization, and supplier management, Tools for cost reduction: value analysis, activity-based costing (ABC), Measuring the impact of cost reduction initiatives, Case Studies: Successful examples of cost control and reduction in production settings

Assignments:

- Project: Develop a cost control plan for a production process
- Case Study: Analyze a real-world example of successful cost reduction in production

UNIT -III

Advanced Cost Management Techniques

Activity-Based Costing (ABC): Principles and implementation of ABC, Analyzing and allocating overhead costs using ABC, Comparing ABC with traditional costing methods, Total Cost of Ownership (TCO): Understanding TCO and its components, Applying TCO in supplier selection and procurement decisions, Case studies on the application of TCO in production environments, Cost Benchmarking: Techniques for cost benchmarking and performance measurement, Identifying cost benchmarks and best practices, Using benchmarking data to drive cost improvement

Assignments:

- Group Project: Implement ABC in a production scenario and compare results with traditional costing
- Research Paper: The role of TCO and benchmarking in cost excellence

UNIT -IV

Financial Analysis and Decision-Making

Financial Metrics and Analysis: Key financial metrics: return on investment (ROI), return on assets (ROA), and profit margins Analyzing financial statements and performance reports , Using financial data to make informed production decisions , Cost-Benefit Analysis: Conducting cost-benefit analysis for production projects and investments, Evaluating the financial viability of cost-saving initiatives, Tools and techniques for effective cost-benefit analysis, Case Studies: Examples of financial analysis and decision-making in production settings

Assignments:

- Project: Conduct a cost-benefit analysis for a proposed production investment
- Case Study: Analyze financial metrics and their impact on production decisions

UNIT -V

Future Trends and Challenges in Cost Management

Emerging Trends in Cost Management: Impact of Industry 4.0 and digital transformation on cost management, Advances in cost management technologies: big data analytics, AI, and automation, Challenges and Opportunities: Common challenges in cost management: global competition, supply chain disruptions ,Opportunities for innovation and improvement in cost management practices ,Strategic Planning for Cost Excellence: Developing a strategic plan for cost excellence in a dynamic production environment, Measuring and evaluating the impact of cost management strategies

Assignments:

- Research Project: Future trends and challenges in cost management for production
- Final Project: Develop a comprehensive cost management strategy for a production organization

Text Books:

1. Cost Management: A Strategic Emphasis, Edward J. Blocher, David E. Stout, J. Fred Weston, McGraw-Hill Education, ISBN: 978-1260247737

Supply Chain Management											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501MB17	Introduction to Supply Chain Management	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB18	Logistics & Distribution Management	FC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB19	Supply Chain Project Management	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB20	Supply Chain Innovation &Trends	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB21	Supply Chain Analytics	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB22	Demand Planning & Forecasting	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB23	Supply Chain Risk Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML,	ISCM

										CSE(DS) PT,Min.E	
2501MB24	Inventory Management & Control	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB25	E-Commerce &Supply Chain Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB26	Operations Management	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
2501MB27	Supply Chain Ethics &Corporate Social Responsibility (CSR)	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	ISCM
Total			**22**		**10**	**32**					

Introduction to Supply Chain Management

Course Code: 2501MB17	L	T	P	C
	2	0	0	2

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Analyze the interdependencies between logistics and other business functions (e.g., marketing, production, finance).
- **CO2:** Explore the different logistical activities.
- **CO3:** Identify the development of supply chain strategy.
- **CO4:** Examine the logistical operational integration and supply chain relationships.
- **CO5:** Assess the role of Supply Chain in e-business and b2b practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	-	-	1		-	-	-	-
CO2	-	-	-	-	-	1		-	-	-	-
CO3	-	-	-	-	-	1	1	-	-	-	-
CO4	1	-	-	-	-	1	1	-	-	-	-
CO5	1	1	-	-	1	1	1	-	-	-	-

UNIT-I

Logistics management and Supply Chain management - Definition, Evolution, Importance. The concepts of logistics. Logistics relationships. Functional applications – HR, Marketing, Operations, Finance, IT. Logistics Organization - Logistics in different industries

UNIT-II

Logistics Activities: – functions, objectives, solution. Customer Service, Warehousing and Material Storage, Material Handling, order processing, information handling and procurement Transportation and Packaging. Third party and fourth party logistics - Reverse Logistics - Global Logistics

UNIT – III

Fundamentals of Supply Chain and Importance: Development of SCM concepts and Definitions Supply chain strategy, Strategic Supply Chain Management and Key components. Drivers of Supply Chain Performance – key decision areas – External Drivers of Change.

UNIT – IV

Modelling logistics systems - Simulation of logistic systems - Dimensions of Logistics & SCM – The Macro perspective and the macro dimension – Logistic system analysis strategy, Logistical Operations Integration, Customer service – Supply Chain Relationships

UNIT – V

Framework and Role of Supply Chain in e-business and b2b practices: Value of information in logistics & SCM - E-logistics, E-Supply Chains - International and global issues in logistics - Role of government in international logistics and Principal characteristics of logistics in various countries and regions

Text Books:

1. Supply Chain Logistics Management, Bowersox, Closs, Cooper, McGraw Hill. 5thEdition, (9th reprint), 2021, ISBN-0078096642
2. World Class Supply Management, Burt, Dobbler, Starling,TMH., 2019, ISBN-0070499330.

Reference Books:

1. Logistical Management, Donald J Bowersox, David J Closs, TMH,9th Edition, ISBN-9780070435544
2. Reguram G, Rangaraj N., Logistics and Supply Chain Management Cases and Concepts: Macmillan India Ltd., New Delhi, ISBN-9780070221635.

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105141/
2. https://www.youtube.com/watch?v=Nrl0CtS1m8Y

Logistics & Distribution Management

	L	T	P	C
Course Code: 2501MB18	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Explain the history and importance of Logistics
CO2: Explore the role of Logistics Management and its process.
CO3: Identify the need and scope of Distribution Management.
CO4: Examine different channels and policies of Distribution
CO5: Assess the strategies for Logistics and Distribution in global economy.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-		-	-	-	1	-	-	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-	-
CO3	-	1	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	1	1	-	-	-	-
CO5	-	1	-	-	-	1	1	-	-	-	-

UNIT I

Logistics:
Definition - History and Evolution- Objectives – Elements- Activities Importance- The wor k of logistics-Logistics interface with marketing- Retails logistics-
Emerging concept in logistics.

UNIT II

Logistics Management:
Achievement of competitive advantage through logistics Framework-
Role of Logistics managementIntegrated Logistics Management - Model Flow of process ac tivities (in brief).

UNIT-III

Distribution Management:
Introduction, need and scope of distribution management, marketing channels strategy, levels of channels, functions of channel partners, channel flows, Channel Intensity, classification of distribution channels, types of channel intermediaries, designing distribution channel strategy, factors affecting the design of marketing channels, Factors affecting selection of channel partners

UNIT-IV

Distribution Channel Systems: Designing channel systems, Channel Intensity, Selecting Channel Partners, Channel Management Channel Policies, Power Bases in managing channel partners, conflict management Channel Institutions - retailing &wholesaling.

UNIT- V

Logistics and Distribution in global economy:
Logistics vs Distribution, Importance of Logistics and Supply chain in global economy, distribution strategies by using logistic channels, Logistics and Distribution planning and control in global perspectives.

Reference Books:

1.Donald J. Bowersox & David J. Closs: Logistical Management, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. Krishna K. Havaldar, Vasant M. Cavale Sales & Distribution Management McGraw Hill Latest Edition.

Supply Chain Project Management

Course Code: 2501MB19	L	T	P	C
	3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Explain the types project selection models.
CO2: Describe project planning and organization.
CO3: Apply the networking techniques.
CO4: Examine the project control processes.
CO5: Assess the role of project auditing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	-	-	-	1	-	-	-	1	-
CO2	-	2	-	-	-	1	-	-	-	2	-
CO3	1	2	2	-	-	1	-	-	-	2	-
CO4	2	2	2	-	-	1	-	-	-	3	-
CO5	2	2		-	1	1	-	-	-	3	-

UNIT I

Introduction – Project life cycle – Project selection – Types of project selection models – Project manager – Selection of Project Manager.

UNIT II

Project Organization – types – Project planning. Sorting out the project – Work breakdown structure and Linear Responsibility charts – Conflict and Negotiation – Conflict and Project life cycle – some requirements and principles of negotiation.

UNIT III

Budgeting and cost estimation – Scheduling – Network techniques: PERT and CPM –Gantt charts – Resource allocation – Resource loading – Resource Leveling.

UNIT IV

Monitoring and Information Systems – Project Control – Types of control processes – Control as a function of Management.

UNIT V

Project auditing – Purposes of evaluation – Project Audit Life Cycle – Project termination – Termination process.

References:

1. Project Management – A Managerial Approach by Jack R. Meredith & Samuel J. Mantel,
2. Implementation and Review by Prasanna Chandra, Projects Planning, Analysis, Selection,
3. Textbook of Project Management by P. Gopalakrishnan & V.E. Ramamoorthy,
4. Operations and Supply Chain Management by Chase et al, Tata McGraw Hill education Pvt. Ltd, New delhi2010

Supply Chain Innovation & Trends

	L	T	P	C
Course Code: 2501MB20	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain the fundamental concepts of innovation and R&D, including types, models, processes, and managerial aspects
- **CO2:** Classify and analyze different innovation strategies and organizational structures for fostering creativity and managing innovation effectively.
- **CO3:** Evaluate financial aspects of R&D projects using appropriate tools and techniques for budgeting, forecasting, and project selection
- **CO4:** Design R&D organizational structures and formulate strategies to address leadership, HRM, and project management issues in innovation-driven environments.
- **CO5:** Assess the national and institutional frameworks supporting R&D in India and recommend policies for commercialization and promotion of R&D activities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	3		-	2	-	-	-	-	3	-
CO4	2	-	2	-	2	-	-	2	-	-	-
CO5	2	-	-	-	-	3	2	-	-	3	-

UNIT-I

Introduction & Managerial aspects of Innovation function Introduction, Components of Innovation, Types of Innovations, Models of Innovation Processes, Evolution and characteristics of Innovation Management, Key drivers of Innovation, Factors influencing Innovation, Organizing for Innovation, Factors influencing organizational design, Developing Innovation Strategy, Characteristics of creative of creative organization.

UNIT-II

Research and Development Management Introduction, Meaning, Objectives, Significance, Classification of R&D according to R&D type, process phase, measurement level, purpose of measurement and measurement perspective. Technology development approaches, Performance of R&D management in Indian scenario.

UNIT-III

Financial Evaluation of R&D Projects Introduction, Cost effectiveness of R&D, R&D financial forecasts, Project selection, Evaluating R&D ventures, Conflicting views of managers. Allocation of resources, R&D programme planning and control. Project management, Project Planning and Control Techniques.

UNIT-IV

Organization R&D and innovation, HRM issues in innovation and R&D, Leadership and R&D management, Organization Design and structure of R&D, R&D Project Management, Measurement, Evaluation and assessment of R&D.

UNIT-V

National R&D infrastructure and Institutional Framework, Fiscal and other incentives and Promotional /Support measures, Industry, Institutions and government cooperations. Other important issues in R&D management, Commercialization of R&D.

Text books:

1. The Management of Technology and Innovation- A Strategic Approach by White, Cengage Publication
2. Innovation Management by S Moikal, Sage Publication

Reference Books:

1. The New Age of Innovation by C.K Prahalad & M.S. Krishnan, Tata McGraw Hill Education Pvt. Ltd. New Delhi.

Supply Chain Analytics

	L	T	P	C
Course Code: 2501MB21	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain different of supply chain management by developing different strategies.
- **CO2:** Apply analytical tools to solve supply chain design and planning problems
- **CO3:** Identify the use of algorithms to solve partitioning and routing problems
- **CO4:** Analyze various applications and techniques of supply chain systems
- **CO5:** Be familiar with the broader trends in the area of supply chain analytics

Mapping of Course outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	-	-	-	1	-	-	-	-	-
CO2	2	2	1	-	-	1	1	-	-	-	-
CO3	2	2	2	-	-	1	-	-	-	-	-
CO4	1	1	1	-	-	1	1	-	-	-	-
CO5	-	2	-	-	-	1	1	-	-	-	-

UNIT-I

Basics of Supply Chain Management: Introduction to Supply Chain Management – Evolution Different Views of Supply Chain – Supply Chain Strategy – Supply Chain Drivers – Developing Supply Chain Strategy- Strategic Fit in Supply Chain. Analytics in Supply Chain Management.

UNIT-II

Supply Chain Analysis - Types of Supply Chains - Advanced Planning - Structure of Advanced - Planning Systems-Strategic Network Planning - Demand Planning - Master Planning - Demand Fulfilment and ATP - Production Planning and Scheduling Purchasing and Material Requirements Planning Distribution and Transport – Planning - Coordination and Integration - Collaborative Planning.

UNIT-III

Set Covering and Set Partitioning Problems, Travelling Salesman Algorithms, Advanced Vehicle Routing Problem Heuristics, Scheduling Algorithms-Deficit Function Approach and Linking Algorithms.

UNIT-IV

Fuzzy Logic and Techniques, Applications in SCM Recent Issues in SCM: Role of Computer/IT in Supply Chain Management, CRM vs SCM, Benchmarking concept, Features and Implementation, Outsourcing Basic Concepts, Value Addition in SCM – Concept of Demand Chain Management.

UNIT- V

Inventory Management in Supply Chain- Network Design in Supply Chain- Alternative Channels of Distribution- Location Decisions in Supply Chain-Implementing Advanced Planning Systems - The Definition of a Supply - Chain Project -The Implementation Process SCM in a Pharmaceutical – Company Food and Beverages - Computer Assembly Semiconductor – Manufacturing.

Reference Books:

1. Supply Chain Management: Strategy, Planning and Operations by Sunil Chopra and Peter Meindl, Prentice Hall; 6th Edition (2015). ISBN: 0133800202
2. Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain by Michael Watson, Sara Lewis, Peter Cacciopi, Jay Jayaraman. 1st Edition. ISBN: 0133017370

Demand Planning & Forecasting

	L	T	P	C
Course Code: 2501MB22	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Explain the concept of Demand Planning and how does it work.
CO2: Identify different steps involved in Demand Planning.
CO3: Analyze the different factors that influence Demand Forecasting.
CO4: Interpret various methods of Demand Forecasting.
CO5: Differentiate Demand Planning and Demand Forecasting.

Mapping Of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	-	-	1	-	-	-	-	-
CO2	1	2	-	-	-	1	-	-	-	-	-
CO3	1	1	-	-	-	1	1	-	-	-	-
CO4	1	2	-	-	-	1	2	-	-	-	-
CO5	1	1	2	-	-	1	2	-	-	-	-

UNIT- I

Introduction to Demand planning: Concept of Demand Planning, Objectives of Demand Planning, Need for Demand Planning, importance of Demand Planning, how does Demand Planning work,

UNIT- II

Process of Demand Planning: Elements of Demand Planning, key steps involved in Demand Planning, best practices for Demand Planning, benefits of Demand Planning in E-Commerce, Future Demand Planning.

UNIT- III

Demand Forecasting: Concept of Demand Forecasting, objectives and Factors influencing Demand Forecasting, different types of Demand Forecasting, advantages and disadvantages of Demand Forecasting.

UNIT- IV

Methods of Demand Forecasting: Need for Demand Forecasting, types of Demand Forecasting, different methods of Demand Forecasting.

UNIT- V

Demand Planning and Demand Forecasting: Characteristics of A Good Demand Planning and Forecasting Methods**,** Demand Planning vs Demand Forecasting, best tools for Demand Planning and Forecasting.

Reference Books:

1. Demand Forecasting Best Practices: Stories Beyond Boundaries
2. Fundamentals of Demand Planning and Forecasting, by Chaman L. Jain

Supply Chain Risk Management

	L	T	P	C
Course Code: 2501MB23	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Identify and assess potential risks in a supply chain, including operational, financial, and reputational risks.
CO2: Design and implement a supply chain risk management framework that aligns with industry best practices.
CO3: Assess the effects of natural disasters, pandemics, and climate change on supply chain operations.
CO4: Explain key risk management concepts, including risk assessment, mitigation, and transfer, with relevant examples.
CO5: Apply the key principles of designing a resilient supply chain, including flexibility, agility, and adaptability.

Mapping of Course Outcomes With Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	-	-	-	1	1	-	-	-	-
CO2	2	2	2	-	-	1	1	-	-	-	-
CO3	2	3	1	-	-	1	1	-	-	-	-
CO4	1	1	-	-	-	1	1	-	-	-	-
CO5	1	3	-	-	-	1	2	-	-	-	-

UNIT-I

Introduction of Risks Management:
Concept and Process, An Action-Based Framework for Supply Chain Risk, Identification of Operational Hazards, Risk Assessment and Valuation, Tactical Risk Decisions and Crisis Management, Strategic Risk Mitigation, Four Operational Hedging Strategies.

UNIT-II

Operational Strategy for Managing Supply Chain Risks: Introduction, Stockpile Inventory, Diversify Supply, Backup Supply, Manage Demand, Ambiguity in Risks. Decentralized Risks Management Strategy. Shared risks; Achieving an integrated approach; Identifying risks, Analyzing and responding to risks.

UNIT-III

Managing Supply Chain Disruption: Economic Risks to Supply Chain-Demand Shock, Currency Fluctuation, Supply Shock, Industrial Unrest, Impacts of Natural Disasters, pandemics and Climate Change, Societal Risks to Supply chain, Risks and Security in Air Cargo Supply chain, Time-Based Risk Management-Response Time and Impacts, Risk and Reward Considerations.

UNIT-IV

Approaches to Risk Management: Identifying Risks and its Types, Tools for Analysing Past Events, Tools to Collect Opinions, Tools to Analyse Operations, Problems with Risks Identification, Conceptual Explanations with Examples, Development of Risk Management Techniques, Supply Chain Risk Management (SCRM) and aims of SCRM.

UNIT-V

Creating Resilient Supply Chains: Concept of Resilient Supply Chain, Principles of Designing a Resilient Supply Chain, Physical Features of a Resilient Supply Chain, relationships within a Resilient Supply Chain, Risk Compensation and Business Continuity. Latest updates in Resilient Supply Chain.

Text Books:

1. Supply Chain Risks Management by Donald Water, (Kogan Pages), ISBN-970749448547.
2. Handbook for Supply Chain and Risks Management (MeriPustak) by Omra Khan & George Zsidisn, ISBN-9788131521878

Reference Books:

1. Supply Chain Risk Management: Advanced Tools, Models, and Developments by YacobKhojasteh, (Springer), ISBN-13:978-9811041051
2. Managing Supply Chain Risk: Integrating with Risk Management by Bret Wagner, SimeCurkovic, and Thomas Scannell, ISBN:9781040084625.

Web Links:

1. http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_110_108_110108056_video_1ec9
2. http://ndl.iitkgp.ac.in/he_document/nptel/courses_110_108_110108056_video_lec11

Inventory Management & Control

	L	T	P	C
Course Code: 2501MB24	**3**	**0**	**0**	**3**

Course Outcome:
At the end of the Course, Student will be able to:

- **CO1:** Apply the role of purchasing and materials planning in push and pull system.
- **CO2:** Simplify pricing models, negotiation techniques, and cost analysis.
- **CO3:** Analyze the purpose and significance of inventory within organizations.
- **CO4:** Explore the objectives and types of materials handling.
- **CO5:** Differentiate between packing and packaging.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	-	-	-	2	-	-	-	-	-
CO2	2	2	-	-	-	1	-	-	-	-	-
CO3	1	3	-	-	-	1	2	-	-	-	-
CO4	1	-	-	-	-	1	1	-	-	-	-
CO5	1	2	-	-	-	1	-	-	-	-	-

UNIT-I

Role of Purchasing and Materials Management:
objectives, organization and Inter relationships, Determination and Description of material Quantity, Material planning in push and pull system, MRP and JIT.

UNIT-II

Purchase system and procedures:
objectives, Purchasing function, Purchasing polices and decisions, make or Buy vender selection and Rating, Timing of purchase, price determination, purchase procedures and system public purchasing and tendering.

UNIT-III

Inventory Management:
Introduction of inventory system, Function of Inventory and Relevant cost concept, classification of Inventory systems, Inventory Models: Deterministic Discount, EOQ EBQ, MRP – I, selective Inventory Management ABC, VED, FSN, PQR.

UNIT-IV

Materials Handling:
Materials handling systems and objectives; Types of handling equipment; Selection of the most appropriate equipment in specific situations, Traffic and Transportation, Disposal of Scrap, waste management waste reduction approach, waste collection, Recycling waste disposal system, materials information system.

UNIT-V

Packing and Packaging:
Meaning, Functions and Essentials of Packing- Packaging: Meaning, Functions and Essentials of Packaging- Difference between Packing and Packaging-Packing for Storage-Packing for Overseas Shipment- Packing for Inland Transportation- Packaging for Product content Protection - Test of packaging: Mechanical, Climatic & Lab test- International Care labelling code - Packaging cost.

Text Books:

1. Integrated Materials Management, Putta, A.K, New McGraw Hill, ISBN-978-8120300279
2. Handbook of Materials Management by Gopala krishan P. and Sanderashan M New Delhi prentice Hall of India, ASIN: B00K7YGKRQ.

Reference Books:

1. Proactive Procurement, Burt, David N, Englewood Cliffs, New Jersey, Prentice Hall Inc, ISBN-0137114656.
2. Purchasing and Material Management, Dobler, D.W. etc., New York, McGraw Hill, ISBN-0070370478

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105095/
2. https://onlinecourses.nptel.ac.in/noc20_mg17/preview

E-Commerce & Supply Chain Management

	L	T	P	C
Course Code: 2501MB25	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

- **CO1:** Explain the concepts of E-commerce and internet terminology.
- **CO2:** Examine the benefits and issues related to EDI.
- **CO3:** Identify Various network security threats.
- **CO4:** Apply the process and functions of supply chain management.
- **CO5:** Analyse design and network in supply chain management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	-	-	1	1	-	-	-	-	-
CO2	1	1	1	-		1	-	-	-	-	-
CO3	1	3	-	-	2	1	-	-	-	-	-
CO4	1	2	-	-	1	1	-	-	-	-	-
CO5	1	3	2	-	-	1	1	-	-	-	-

UNIT-I

Introduction to E-Commerce:

Framework-Classification of electronic commerce -Anatomy of E-Commerce Applications- Components of the I way- Network Access Equipment-Internet Terminology.

UNIT-II

Electronic Data Interchange:

Benefits-EDI Legal, Security & privacy issues- EDI software implementation- Value added networks-Internal Information Systems- automization of Work flow and Coordination-Customization and Internal Commerce.

UNIT-III

Network security and firewalls:

Client Server Network Security- Emerging client server security threats- Firewalls and network security- Data and message security- Encrypted documents and electronic mail-Hypertext publishing- Technology behind the web- Security and the web.

UNIT-IV

Introduction to Supply Chain Management:
Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.

UNIT-V

Designing the Supply Chain Network:
Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact – distribution networks in practice – network design in the supply chain – role of network – factors affecting the network design decisions – modeling for supply chain.

Text Books:

1. Frontiers of Electronic Commerce by Ravi Kalakota &Andrew b.Whinston, Dorling Kindersley (India) Pvt.Ltd. ISBN-9788177583922.
2. Supply Chain Management – Strategy, Planning and Operation by Sunil Chopra and Peter Meindl, , PHI, 4th Edition.

Reference Books:

1. Web Commerce Technology Handbook by Daniel Minoli, Emma Minoli, Tata McGraw Hill Publishing, New Delhi. ISBN: 978-0074637425.
2. Principles of Supply Chain Management a Balanced Approach by Wisner, Keong Leong and Keah-Choon Tan, Thomson Press.

Operations Management

	L	T	P	C
Course Code: 2501MB26	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Explain the Relationship of Operations management with other functional areas and different types of Production Systems.
- **CO2:** Analyze the stages of the product design process, value analysis techniques, and facility location and layout decisions
- **CO3:** Apply the methods of forecasting, operation planning strategies, and capacity planning techniques including MRP and scheduling
- **CO4:** Analyze the factors affecting productivity, job design principles, and process flow charts and methods study
- **CO5:** Apply the techniques of Statistical Quality Control and Total Quality Management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	-	-	-	1	-	-	-	-	-
CO2	2	2	-	-	-	1	1	-	-	-	-
CO3	-	3	2	-	-	1	2	-	-	-	-
CO4	1	2	2	-	-	1	1	-	-	-	-
CO5	3	2	-	-	-	1	1	-	-	-	-

UNIT-I

Introduction to Operation Management:
Nature & Scope of Operation/ Production Management, Relationship with other functional areas, Recent trend in Operation Management, Manufacturing & Theory of Constraint, Types of Production System, Just in Time (JIT) & lean system.

UNIT-II

Product Design & Process Selection:
Stages in Product Design process, Value Analysis, Facility location & Layout: Types, Characteristics, Advantages and Disadvantages, Work measurement, Job design.

UNIT-III

Forecasting & Capacity Planning:
Methods of Forecasting, Overview of Operation Planning, Aggregate Production Planning, Production strategies, Capacity Requirement Planning, MRP, Scheduling, Supply Chain Management, Purchase Management, Inventory Management.

UNIT-IV

Productivity:
Factors, Affecting Productivity – Job Design – Process Flow Charts – Methods Study – Work Measurement – Engineering and Behavioral Approaches.

UNIT-V

Quality Management:
Quality- Definition, Dimension, Cost of Quality, Quality Circles Continuous improvement (Kaizen), ISO (9000&14000 Series), Statistical Quality Control: Variable & Attribute, Process Control, Control Charts -Acceptance Sampling Operating Characteristic Curve (AQL, LTPD, Alpha & Beta risk), Total Quality Management (TQM).

Text Books:

1. Krajewski & Ritzman. Operation Management -Strategy and Analysis. Prentice Hall of India, ISBN-9780201331189.
2. Panner Selvem, Production and Operation Management, Prentice Hall of India, ISBN-978-8120345553.

Reference Books:

1. Production and Operation Management- Concepts, Methods Strategy by Charry, S.N., MCGraw-hill education(india) pvt limited, ISBN-9780070583559 .
2. Production & Operations Management by K Aswathappa & Sridhar Bhatt,Himalaya, Mumbai, ISBN-13: 978-9350971888.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_me30/preview
2. https://archive.nptel.ac.in/courses/110/107/110107141/

Supply Chain Ethics & Corporate Social Responsibility (CSR)

	L	T	P	C
Course Code: 2501MB27	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Explain the concept of Business Ethics to provide best practices of business ethics.
CO2: Develop adequate knowledge in ethical issues in corporate governance.
CO3: Analyze the concepts of ethical decision making in business.
CO4: Evaluate the factors facilitating globalization.
CO5: Interpret various corporate social responsibilities and practice in professional life.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	-	-	-	**2**	**2**	-	-	-	-
CO2	-	1	-	-	-	2	3	-	-	-	-
CO3	-	2	-	-	-	2	3	-	-	-	-
CO4	2	3	-	-	-	2	1	-	-	-	-
CO5	1	3	-	-	-	2	2	-	-	-	-

UNIT-I

Introduction to Business Ethics: Definition – Principles of Personal Ethics – Principles of Professional Ethics – The Development of Business Ethics – Importance and Need for Business Ethics – Significance of Business Ethics – Values and Ethics in Business.

UNIT-II

Corporate Governance – Definitions – Historical Perspective of Corporate Governance – Significance of Corporate Governance in Developing Countries – Issues in Corporate Governance – Major thrust areas of Corporate Governance – Indian model of Corporate Governance.

UNIT-III

Ethical Decision making in Business – Ethical Decision making with Cross – holder conflicts and competition – Applying Moral philosophy to Ethical decision making – Kohlberg's Model of Cognitive Moral development – Influences on Ethical Decision making

UNIT-IV

Globalization and Business Ethics – Growth of Global Corporations – Factors Facilitating Globalization – Role of Multinational Corporations – International Business Issues – International Codes of Business conduct – Challenges of Globalization in the context of Growing market economies – Key Global issues for Business – Corporate Governance is a pre-requisite for Globalization.

UNIT-V

Corporate social responsibility:
Definitions of CSR – Models for implementation of CSR – CSR as a business strategy for sustainable development – Advantages of CSR – Scope of CSR – Understanding Social Responsibility of Business – Protecting and Promoting stake holder's interests.

Text Books:

1. Business Ethics by M.G. Velasquez, Prentice Hall India Limited, New Delhi, ISBN-13. 978-8120346475.
2. Business Ethics by Andrew Crane and Diark Matten, Oxford Publication, New Delhi, ISBN-13. 978-0198755968.

Reference Books:

1. Business Ethics – A Case perspective by O.C. Ferrell, John Fraedrich and Linda Ferrell Cengage LeacheryISBN-13. 978-8131511190.
2. Business Ethics- An Indian Perspective by A.C. Fernando, Pearson, *ISBN*-9789353437442.

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105079/
2. https://onlinecourses.swayam2.ac.in/cec19_mg24/preview

Sustainability											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501CE74	Introduction to Sustainable Development	FC	2			2	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE66	Natural Disaster Management & Mitigation	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE81	Waste Water Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE82	Integrated Solid Waste Management for a Smart City	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE83	Watershed Management	IC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE33	Energy Audit, Conservation & Management	IC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE53	Electric Power Generation, Transmission & Distribution Systems	AC	3			3	50	50	100	CE, ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501CE75	Sustainable Agriculture & Food Systems	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE76	Sustainable Supply Chain Management	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501CE77	Sustainable Production Excellence	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT,	-

										AIML, CSE(DS) PT,Min.E	
2501CE78	AI in Environmental Science and Sustainability	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
Total			**32**			**32**					

Introduction to Sustainable Development

Course Code: 2501CE74	L	T	P	C
	2	0	0	2

Course Outcomes:

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

CO1: Describe the concept, nature, and scope of sustainable development and relate it to economic growth and poverty.

CO2: Interpret the dimensions of social development including exclusion, human development indices, and participatory approaches.

CO3: Explain the stages of human development and assess the impact of deprivation across the life span.

CO4: Analyze the role of governance, decentralization, and local policies in sustainable development.

CO5: Summarize the contributions of CBOs, NGOs, legal systems, education, media, and international bodies in promoting sustainable and inclusive development.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	1	1	3	1	1	2	1	2
CO2	2	2	2	1	1	3	2	1	2	1	2
CO3	2	2	2	2	1	3	2	2	2	1	2
CO4	2	2	3	2	1	3	2	2	2	2	3
CO5	2	1	2	1	1	3	2	1	2	2	2

UNIT- I

Introduction to sustainable development Concept, mature and scope of Sustainable development. Globalisation and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty.

UNIT- II

Social Development Diversity and social exclusion: Concept and implications, human development of the socio-cultural and other ethinic groups of the society. Contemporary Issues of Development — Bottom of the pyramid approach; understanding the importance of social capital and social mobilization. Social security: Systems and role in development. People's participatory processes in development. Millenium Development Goals, Sustainable development Goals

UNIT- III

Individual, change and development Human development across the life span: Context and impact of deprivation. Conception and birth: issues of genetics and environment; birth processes; socio-cultural influences. Infancy, childhood, school years and middle childhood: Milestones of development, childhood deprivation and children at risk. Adolescence and adulthood: cultural construction and development deprivations. Old age: needs and impact of deprivation.

UNIT- IV

Society, change and development Government to governance: Democracy and development; decentralisation policies in India; local governance; shifting forms of governance in urban and rural regions, linkages between decentralisation, power and poverty

UNIT- V

Emerging of role of CBOs and NGO and human rights institutions. Role of law, education, media and international organisations.

Text Books:

1. Agrawal, A N . Indian Economy: Problems of development and planning. pune: Wishwa Prakashan. ISBN: 978-8122437959
2. Baldev Raj Nayar, Globalization and Nationalism: The Changing Balance Of India's Economic Policy. ISBN :978-0761995364

Reference Books:

1. Urbanization in Developing Countries Basic Services and community Participation, Bidyut Mohanty , Institute of Social Science, Concept Publishing House. ISBN-10. 8170224756
2. Development Experience in the Indian Economy: Inter-State Perspectives, Brahmananda, P.R. and V.R. Panchmukhi (Eds.),
   Bookwell, Delhi. ISBN: 81-85040-35-4

Natural Disaster Management & Mitigation

Course Code: 2501CE66	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Explain the aspects of disaster management and adopt remedial measures.
- **CO2:** Explain disaster risk assessment and coping measures.
- **CO3:** Explain the vulnerability conditions.
- **CO4:** Assess the impact of hazards on structures.
- **CO5:** Adopt the rehabilitation procedures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	-	-	-	-	-	-	2	-	-
CO2	-	1	-	-	-	-	3	-	2	-	-
CO3	-	1	-	-	-	-	-	-	2	-	-
CO4	2	-	-	-	-	-	3	-	2	-	-
CO5	2	-	-	-	-	-	3	-	2	-	-

UNIT – I

Introduction:

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

UNIT – II

Overview of Disaster Situations:

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmisstions -pandemic, endemic and epidemic.

UNIT – III

Flood:

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management-integrating technology and people.

UNIT – IV

Overview of Disaster Situations:

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

UNIT – V

Cyclone and Fire Disaster:

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

Text Books

1. Disaster Management, RB Singh (Ed), Rawat Publications. (ISBN: 13-978-8131600337).
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house. (ISBN: 13-978-8189866464).

Reference Books:

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill. (ISBN:13-9780074631881).
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose. (ISBN:13-978-0953614011).
3. Anthropology of Disaster management, Sachindra Narayan, Gyan Publishing house. (ISBN: 13-978-8121206839).

Web Links:

1. https://www.iare.ac.in/sites/default/files/lecture_notes/dm%20notes.pdf

Waste Water Management

Course Code: 2501CE81	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Explain the importance of sanitation and wastewater management.
- **CO2:** Explain the various methods of sewage flow estimation and pumping systems.
- **CO3:** Identify the various characteristics of sewage and the treatment system.
- **CO4:** Outline the various secondary treatment technologies for waste water
- **CO5:** Explain the different tertiary and effluent disposal methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	1	-	-	-	-	-
CO3	3	3	1	-	-	2	-	-	-	-	-
CO4	2	2	1	2	-	2	-	-	-	-	-
CO5	2	2	1	-	-	2	-	-	-	-	-

UNIT – I

Introduction:

Introduction to sanitation–systems of sanitation–relative merits and demerits –need for waste water management–basic terminology in waste water–generation of waste water–types – collection and conveyance of waste water– classification of sewerage systems.

UNIT – II

Sewage Flow and Pumping:

Estimation of sewage flow and storm water drainage–fluctuations. Types of sewers–hydraulics of sewers– appurtenances in sewerage. Pumping of waste water:pumping stations–location–components– typesofpumpsand their suitability with regards to waste waters.

UNIT – III

Sewage Analysis and Treatment Sewage characteristics-sampling and analysis of waste water– physical, chemical, and biological examination– measurement of BOD, COD. Preliminary and primary treatment– screens–grit chambers–grease traps–floatation–sedimentation.

UNIT – IV

Secondary Treatment:

Aerobic and anaerobic treatment process-comparison. Aerobic units: Activated sludge process, principles, modifications of activated sludge processes–Oxidation ponds– Trickling filters– Rotating biological contactors. Anaerobic units: UASB Reactor, principle and working.

UNIT – V

Tertiary Treatment and Disposal:

Removal of Nutrients–Nitrification and Denitrification–Ion exchange–membrane processes –MF, UF, NF, RO. Disposal of sewage–Methods of disposal–Effluent Standards. Need, Scope and demand for waste water recycling.

Text Books:

1. Wastewater Engineering: Treatment and Resource Recovery, Metcalf & Eddy, McGraw-Hill, New York, 5th Edition. (ISBN: 13-978-0073401188).
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill , 2018. (ISBN: 13-978-0070495395).

Reference Books:

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications. (ISBN:978-81-7409-230-4)
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi. (ISBN:13-9788120336001)
3. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi. (ISBN: 13-978-8121915472).
4. Wastewater Treatment for pollution control and Reuse, Soli J Areivala, Sham R Asolekar, Mc- GrawHill, New Delhi. (ISBN:9780070620995).

Web Links:

1. https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf
2. http://www.civil.iitm.ac.in/dwwm/sites/default/files/presentations
3. https://www.researchgate.net/publication/221911472_Wastewater_Management

Integrated Solid Waste Management for A Smart City

Course Code: 2501CE82	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Understand Fundamental Concepts of Solid Waste Management
- **CO2:** Analyze Municipal Solid Waste Management Practices
- **CO3:** Evaluate Disposal Methods and Technologies
- **CO4:** Apply Knowledge of Construction and Demolition (C&D) Waste Management
- **CO5:** Examine E-Waste and Hazardous Waste Management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	-	-	-	3	2	-	-	-	-
CO2	1	-	-	-	-	3	2	-	-	-	-
CO3	1	-	-	-	-	3	2	-	-	-	-
CO4	1	-	-	-	-	3	2	-	-	-	-
CO5	1	-	-	-	-	3	2	-	-	-	-

UNIT – I

Introduction:

Solid Waste Management- Definition, Concept of 4Rs (reduce, reuse, recycle and recover) of waste management, Elements of a waste management system, Issues in Solid Waste Management, Integrated Waste Management Hierarchy: Source reduction, Recycling, Waste-to-Energy and Landfilling, Review of waste management under Swachh Bharat Mission and Smart Cities Program.

UNIT – II

Municipal Solid Waste:

Waste Composition and Quantities, Collection, Transportation, Segregation, and Processing.

UNIT – III

Disposal of Municipal Solid Waste:

Landfill, Biochemical Processes and Composting, Energy Recovery from Municipal Solid Waste, Municipal Solid Waste (MSW) Rules 2016, Current Issues in Solid Waste Management and Review of MSW Management

UNIT – IV

Construction and Demolition (C&D) Waste Management:

Overview, Components; C&D Waste Management Rules 2016, Beneficial Reuse of C & D Waste Materials.

UNIT – V

Electronic Waste (E-Waste) Management:

Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges.

Hazardous Wastes:

Definition, Classification, Risk assessment, Transportation of hazardous waste, Current Management Practices: Environmental audit, Containment, Remedial alternatives.

Text Books:

1. Solid Waste Engineering, William A Worrell and P. AarneVeslind, Cengage Learning, 2nd Edition(SI Edition). (ISBN: 13-978-8131520420).
2. Integrated Solid Waste management, George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Tata McGraw Hill. (ISBN: 13-978-0070632370).

Reference Books:

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Construction and Demolition Waste Management Rules, 2016, MoEF&CC
4. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.

Web Links:

1. https://nptel.ac.in/courses/105/105/105105160/
2. http://swachhbharatmission.gov.in/sbmcms/index.html
3. http://swachhbharaturban.gov.in/

Watershed Management

Course Code: 2501CE83	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Explain the objectives and characteristics of watershed management.
- **CO2:** Classify the types of soil erosion and control methods.
- **CO3:** Explain different water harvesting techniques.
- **CO4:** Organize the land and drought management techniques.
- **CO5:** Create hydrological models

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	2	1	1	-	1	-	2	-
CO2	1	-	-	1	1	1	-	-	-	-	-
CO3	2	1	-	1	2	2	-	-	-	-	-
CO4	2	1	1	2	1	2	-	1	-	2	-
CO5	2	2	2	1	2	1	-	-	-	-	-

UNIT – I

Introduction:

Introduction - Concept of watershed development – objectives of watershed development – need for watershed development - integrated and multidisciplinary approach for watershed management. Characteristics of Watershed: Size – shape – physiography – slope – climate – drainage – land use – vegetation – geology and soils – hydrology and hydrogeology – socio-economic characteristics – Application of artificial intelligence technology for identification of watershed characteristics.

UNIT – II

Principles of Erosion: Types and causes of erosion – factors affecting erosion– estimation of soil loss due to erosion- Universal soil loss equation. Measures to Control Erosion: Contour techniques – ploughing – furrowing – trenching – bunding – terracing – gully control – check dams – rock-fill dams – brushwood dam – Gabion.

UNIT – III

Water Harvesting: Techniques of rainwater harvesting – rainwater harvesting from rooftop – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks.

UNIT – IV

Land Management: Land use and Land capability classification – management of forest – agricultural – grassland and wild land land grading operation –reclamation of saline and alkaline soils. Drought Management: Drought assessment and classification – drought analysis techniques – drought mitigation planning.

UNIT – V

Beyond BIM - Emerging Trends

Watershed Modelling: Data of watershed for modelling – application and comparison of watershed models – model calibration and validation – advances of watershed models.

Text Books:

1. Watershed Management, Das MM and M.D Saikia, PHI Learning Pvt. Ltd.(ISBN:13-978-8120346765).
2. Land and Water Management, Murthy.VVN, Kalyani Publications. (ISBN: 13-978-9327214659)

Reference Books:

1. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers. (ISBN: 13-978-8120321519).
2. Watershed Hydrology, Black P E, Prentice Hall. (ISBN: 13-978-1575040271).
3. Watershed Management, Murthy J V S, New Age International Publishers. (ISBN:13-978-8122435184).

Web Links:

1. https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654
2. http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html
3. https://yourstory.com/2017/11/watershed-management/

Energy Audit, Conservation & Management

Course Code: 2501EE33	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Explain energy efficiency, conservation, and various technologies.
- **CO2:** Design energy efficient lighting systems.
- **CO3:** Calculate power factor of systems and propose suitable compensation techniques.
- **CO4:** Explain energy conservation in HVAC systems.
- **CO5:** Calculate life cycle costing analysis and return on investment on energy efficient technologies. Calculate the Time value of Money.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-

UNIT – I

Basic Principles of Energy Audit: Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry - thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017).

UNIT – II

Energy Management: Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.

UNIT – III

Energy Efficient Motors and Lighting Energy efficient motors: factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

UNIT – IV

Power Factor Improvement and Energy Instruments Power factor: methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor – power factor motor controllers – Energy Instruments- watt meter – d.

UNIT – V

Economic Aspects and Their Computation: Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

Text Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth - Heinemann publications (ISBN: 9788131207383).
2. Energy management hand book by W.C. Turner - John wiley & sons (ISBN: 9781420088700).

Reference Books:

1. Energy efficient electric motors by John. C. andreas - Marcel Dekker Inc Ltd-2nd edition (ISBN: 9781489914675).
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition (ISBN: 9780077076788).

Web Links:

1. https://nptel.ac.in/courses/108106022/
2. https://nptel.ac.in/courses/112105221/
3. https://onlinecourses.nptel.ac.in/noc17_mm17/preview

Electric Power Generation, Transmission & Distribution Systems

Course Code: 2501EE53	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Identify the different components of various power plants.
- **CO2:** Analyze the performance of short, medium and long transmission lines.
- **CO3:** Identify various factors related to sag and corona.
- **CO4:** Distinguish between AC/ DC distribution systems and also estimate voltage drops of distribution systems.
- **CO5:** Analyze the different economic factors of power generation and tariffs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT – I

Power Stations: Principle of power generation, site selection and layout of Thermal, Nuclear, Hydro power plant, Components of Thermal and Nuclear power plant

UNIT – II

Performance of Transmission Lines: Classification of Transmission Lines –Short, medium, long and their model representations –End condenser method, Nominal-T– Nominal-Pie, and A, B, C, D Constants, Surge Impedance and SIL of Long Lines.

UNIT – III

Corona and Sag: Corona – Description of the phenomenon–Factors affecting corona– Critical voltages and power loss –Radio Interference. Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor

UNIT – IV

Distribution Systems: Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT – V

Economic Aspects of Power Generation and Tariff Methods: Types of load, Load curve, load duration and integrated load duration curves, Important terms and factors in Load Curve. Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Characteristics and types of Tariff.

Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar &, A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd (ISBN: 9788177000207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175).

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 9780070151413).

Web Links:

1. https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant
2. https://www.euronuclear.org/1-information/energy-uses.html
3. https://www.slideshare.net/9anku/electrical-distribution-system

Sustainable Agriculture & Food Systems

Course Code: 2501CE75	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Understand the principles and importance of sustainable agriculture in addressing environmental, social, and economic challenges.
- **CO2:** Apply ecological principles to develop sustainable and resilient farming practices.
- **CO3:** Acquire knowledge of soil health management, crop diversity, and rotation for sustainable agricultural productivity.
- **CO4:** Evaluate sustainable water management practices, irrigation techniques, and watershed management in agriculture.
- **CO5:** Analyse the interconnected components of food systems, from production to consumption and waste management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-		-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-		-	-	-	-	-

UNIT-I

Introduction to sustainable agriculture: understanding the principles, practices, and importance of sustainable agriculture in addressing environmental, social and economic Challenges.

UNIT-II

Agroecology: exploring the ecological principles underlying sustainable farming practices and their application.

UNIT-III

Soil health and management: learning about soil composition, fertility management, erosion control and the role of soil in sustainable agriculture.

Crop diversity and rotation: understanding the importance of crop diversity, crop rotation, and Intercropping in enhancing soil health, pest management and resilience to climate change.

UNIT-IV

Water management: Examining sustainable water use practices in agriculture, irrigation methods, water conservation and water shed management.

UNIT-V

Food systems and supply chains: analysing the inter connectedness of food production, distribution, consumption and waste management.

Text Books:

1. Sieglinde Snapp, Barry Pound (2017). Agricultural Systems: Agroecology and Rural Innovation for Development: Agroecology and Rural Innovation for Development. Elsevier Science

Sustainable Supply Chain Management

Course Code: 2501CE76	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Understand the concepts, principles, benefits, and challenges of Sustainable Supply Chain Management (SSCM) in a global context.
- **CO2:** Apply sustainable procurement strategies, supplier management, and regulatory compliance in sourcing decisions.
- **CO3:** Evaluate sustainable production, closed-loop supply chains, and environmental management practices in operations.
- **CO4:** Assess green logistics, eco-friendly packaging, and sustainable distribution practices in supply chains.
- **CO5:** Measure supply chain sustainability performance, enhance transparency, and analyze emerging trends and innovations in SSCM.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

Introduction to Sustainable Supply Chain Management (SSCM)

Concepts and Definitions: Definition of Supply Chain Management (SCM), Introduction to Sustainability in SCM, Triple Bottom Line (TBL) in SCM: Economic, Environmental, and Social aspects, Key principles of sustainability in supply chains.

Sustainable Supply Chain vs Traditional Supply Chain, Differences between conventional and sustainable supply chains, Benefits of sustainable practices in supply chain management.

Drivers and Barriers to SSCM: Internal and external drivers for SSCM, Challenges and barriers in implementing sustainability

Global Trends in SSCM: Case studies of leading companies implementing SSCM, International regulatory frameworks for sustainable supply chains

Assignments:

- Case Study: Analyzing SSCM practices of a global company
- Group Discussion: Barriers to implementing sustainable supply chains in emerging markets

UNIT-II

Sustainable Procurement and Sourcing

Green Procurement and Sourcing: Definition and importance of sustainable procurement, Sourcing from environmentally responsible suppliers, Ethical and fair-trade sourcing

Supplier Relationship Management: Collaboration with suppliers for sustainable practices, Supplier selection criteria based on sustainability, Supplier evaluation and monitoring for sustainability compliance

Sustainable Materials and Resource Efficiency: Use of renewable and sustainable materials in the supply chain, Life Cycle Assessment (LCA) in sourcing decisions, Circular economy in sourcing strategies

Regulatory Requirements in Sustainable Sourcing: Overview of regulations such as REACH, RoHS, and Dodd-Frank Act, Compliance and reporting

Assignments:

- Research Project: Evaluate the sustainable procurement strategy of a specific company
- Individual Assignment: Develop a sustainable supplier selection criteria

UNIT-III

Sustainable Production and Operations

Eco-friendly Production: Green manufacturing and lean operations, Reduction of environmental impacts in production processes, Energy efficiency and waste reduction techniques in production

Closed-Loop Supply Chains: Definition and importance of closed-loop supply chains, Reverse logistics and remanufacturing, Design for Environment (DfE) and end-of-life product management,

Sustainable Facility Management: Green buildings and eco-friendly warehousing, Environmental Management Systems (EMS) like ISO 14001, Water and energy conservation practices

Carbon Footprint in Production: Measuring and reducing carbon footprints, Carbon accounting and management,

Assignments:

- Case Study: Analyze the closed-loop supply chain of a company
- Group Activity: Propose a sustainable production improvement for a manufacturing plant

UNIT-IV

Sustainable Distribution and Logistics

Green Logistics: Role of transportation in sustainability, Strategies for reducing environmental impact in logistics, Use of alternative fuels and electric vehicles in logistics

Sustainable Packaging: Eco-friendly packaging materials and design, Reducing packaging waste in the supply chain, Innovations in sustainable packaging (e.g., biodegradable packaging)

Warehousing and Distribution Center Sustainability: Energy-efficient warehousing, Waste management in distribution centers, Sustainable inventory management practices
Urban Logistics and Last-Mile Delivery: Challenges and solutions for sustainable urban logistics, Sustainable practices in last-mile delivery
Assignments:

- Research Paper: Sustainable packaging trends in a specific industry
- Case Study: Evaluate the green logistics strategy of a company

UNIT-V

Performance Measurement and Future Trends in SSCM
Key Performance Indicators (KPIs) for SSCM: Metrics for evaluating supply chain sustainability, Environmental, social, and economic KPIs, Sustainability scorecards and dashboards.
Supply Chain Transparency and Traceability: Importance of transparency in supply chains, Technology solutions for traceability (e.g., blockchain, RFID), Ethical supply chains and corporate social responsibility (CSR)
Future of SSCM: Trends in digital transformation and sustainability (e.g., AI, IoT), The role of innovation in advancing sustainability in SCM, Future regulatory and market drivers for sustainable supply chains
Global and Local Perspectives: Local adaptation of global sustainability strategies, Impact of globalization on SSCM
Assignments:

- Group Project: Develop a sustainability scorecard for a company's supply chain
- Final Exam: Comprehensive evaluation of SSCM principles and practices.

Text Books:

1. Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy, Yann Bouchery, Charles J. Corbett, Jan C. Fransoo, and Tarkan Tan ,Springer ISBN: 978-3319297911.
2. Sustainable Logistics and Supply Chain Management David B. Grant, Alexander Trautrims, and Chee Yew Wong, Kogan Page(2nd Edition), ISBN: 978-0749478278.
3. Greening the Supply Chain, Joseph Sarkis, Springer ISBN: 978-1846282982.

Reference Books:

1. Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice, Joëlle Morana, Wiley ISBN: 978-1848218224.
2. The Circular Economy and the Global Supply Chain, Lydia Bals, Wendy Tate, and Lisa Ellram, Kogan Page, ISBN: 978-0749482473.
3. Sustainable Supply Chains: Strategies, Issues, and Performance, Tonya Boone, Vaidyanathan Jayaraman, and Ram Ganeshan, Springer, ISBN: 978-1441944909.

Sustainable Production Excellence

Course Code: 2501CE77	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Understand the principles, importance, and triple bottom line dimensions of sustainable production in achieving global sustainability goals.
- **CO2:** Apply lean, green, and circular economy strategies to improve resource, energy, and material efficiency in production systems.
- **CO3:** Evaluate the role of advanced technologies, life cycle assessment, and innovations in promoting sustainable production.
- **CO4:** Implement environmental management systems, sustainability reporting, and CSR initiatives in production environments.
- **CO5:** Analyse future trends, global challenges, and climate-responsive strategies for advancing sustainable production practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

Introduction to Sustainable Production

Concepts and Definitions: Overview of production systems and sustainability, Principles of sustainable production, Differences between traditional and sustainable production, Importance of sustainability in the production life cycle.

Sustainable Development Goals (SDGs) and Production: Role of production in achieving SDGs, Case studies of industries aligning with SDGs

Economic, Environmental, and Social Dimensions: Balancing the triple bottom line in production, Economic benefits of sustainable production, Environmental and social impacts of production processes

Assignments:

- Case Study: Evaluate the sustainability approach of a selected manufacturing company
- Discussion: The role of sustainable production in global climate goals

UNIT-II

Resource Efficiency and Lean Manufacturing

Lean and Green Manufacturing: Principles of lean manufacturing and its relationship with sustainability, Waste reduction (muda) in sustainable production systems, Techniques for improving resource efficiency (5S, Six Sigma)

Energy and Water Efficiency in Production: Energy-efficient manufacturing practices, Reducing water usage in production processes

Material Efficiency and Circular Economy: Waste minimization and resource recovery, Circular economy principles in sustainable production

Assignments:

- Group Activity: Propose a lean and green transformation plan for a company
- Research Project: Evaluate material efficiency practices in a specific industry

UNIT-III

Sustainable Technology and Innovation

Role of Technology in Sustainable Production: Advanced manufacturing technologies (Industry 4.0, IoT, AI) for sustainability, Automation and robotics in reducing waste and emissions, Additive manufacturing (3D printing) and its role in sustainable production

Life Cycle Assessment (LCA): Tools for analyzing environmental impact over a product's life cycle, Incorporating LCA in the design and production phases

Innovations in Sustainable Production: Green manufacturing technologies, Renewable energy integration in production, Sustainable material innovation (biodegradable, recyclable materials)

Assignments:

- Case Study: Use of Industry 4.0 technologies for sustainable production in a real-world case
- LCA Project: Conduct a life cycle assessment for a product

UNIT-IV

Environmental Management Systems and Certifications

Environmental Management Systems (EMS): ISO 14001 and its implementation in production environments, Continuous improvement in EMS, Auditing and monitoring for environmental compliance

Sustainability Reporting and Certifications: Key certifications: LEED, Energy Star, ISO 50001, etc. Importance of sustainability reporting (GRI, CDP, etc.), Regulatory frameworks and standards for sustainable production

Corporate Social Responsibility (CSR) and Production: Role of CSR in promoting sustainability in production, social responsibility of companies toward stakeholders

Assignments:

- Report: Implementing an EMS in a hypothetical production unit

- Certification Research: Overview of major sustainability certifications for manufacturers

UNIT-V

Future Trends and Global Challenges in Sustainable Production

Sustainable Product Design and Innovation: Eco-design principles in product development, Designing for disassembly and recyclability, Sustainable packaging innovations.

Climate Change and Sustainable Production: Impact of climate change on global production systems, Strategies for mitigating carbon footprints in production

Emerging Trends: Digital transformation in production for sustainability (smart factories), Renewable energy adoption in industrial production, Global supply chain integration for sustainable production

Assignments:

- Group Project: Propose a sustainable production plan for a company looking to reduce its carbon footprint
- Final Exam: Comprehensive evaluation of sustainable production concepts

Textbooks:

1. Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives, Gunther Seliger, Springer, ISBN: 978-3642425371
2. Sustainability in Manufacturing: Recovery of Resources in Product and Material Cycles, Günther Seliger, Springer, ISBN: 978-3540420782

Reference Books:

1. Green Manufacturing: Fundamentals and Applications, David A. Dornfeld, Springer, ISBN: 978-1441960169
2. Sustainable Manufacturing: Shaping Global Value Creation, Thomas Bauernhansl, Stefan Dais, and Eberhard Westkämper, Springer, ISBN: 978-3642346188
3. Handbook of Sustainable Engineering, Joanne Kauffman and Kun-Mo Lee, Springer, ISBN: 978-14020855.

AI in Environmental Science and Sustainability

Course Code: 2501CE78	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Understand the fundamentals of AI and its applications in addressing global sustainability challenges.
- **CO2:** Apply AI techniques for climate prediction, environmental monitoring, and pollution control.
- **CO3:** Develop AI-based solutions for sustainable agriculture, natural resource management, and food security.
- **CO4:** Evaluate AI applications in optimizing renewable energy, smart grids, and carbon footprint reduction.
- **CO5:** Analyse the ethical, social, and policy implications of AI applications in environmental sustainability.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

Introduction to Artificial Intelligence and Sustainability

Overview of Artificial Intelligence (AI): Basic concepts of AI and machine learning, Types of AI: Narrow AI, General AI, and Artificial Superintelligence, Overview of AI tools and technologies (neural networks, deep learning, reinforcement learning).

Role of AI in Sustainability: Introduction to sustainability and environmental science, Intersection of AI with sustainability goals (SDGs), Examples of AI applications in environmental science (climate modeling, resource optimization).

Sustainability Challenges Addressed by AI: AI for sustainable development, AI in global environmental governance, AI's potential and limitations in addressing climate change, biodiversity loss, and pollution.

Assignments:

- Research paper: Review of AI applications in sustainability.
- Case Study: Analysis of a successful AI-driven sustainability initiative.

UNIT-II

AI for Climate Science and Environmental Monitoring

AI in Climate Prediction: AI models for predicting climate change patterns, Role of AI in improving the accuracy of climate models, Case studies: AI for early warning systems (extreme weather events, floods, droughts)

Remote Sensing and AI: Use of AI in processing satellite data for environmental monitoring, AI for deforestation, desertification, and urbanization monitoring, Tools for data analysis (Google Earth Engine, AI-based satellite data tools)

AI in Pollution Detection and Control: AI models for air and water quality monitoring, Real-time data analysis for pollution management, Examples of AI in industrial pollution control and waste management

Assignments:

- Project: Developing an AI model for predicting a specific environmental event (e.g., floods, fires)
- Case Study: Remote sensing and AI applications for deforestation detection

UNIT-III

AI for Sustainable Agriculture and Resource Management

AI in Precision Agriculture: Smart farming techniques using AI (drones, IoT sensors, predictive analytics),AI models for crop yield prediction, soil health monitoring, and pest control, Water management using AI (efficient irrigation systems, AI-driven water conservation)

AI in Natural Resource Management: AI for monitoring and managing freshwater resources, AI for optimizing energy and water usage in agriculture, AI applications in forestry and biodiversity conservation

Food Security and AI: AI for addressing food security issues (crop optimization, sustainable farming techniques), AI-driven models for minimizing food waste and improving supply chains

Assignments:

- Group Project: Develop an AI-based solution for sustainable farming or resource management
- Research: The impact of AI on water management in a specific region

UNIT-IV

AI in Renewable Energy and Smart Grids

AI for Renewable Energy Optimization: Role of AI in optimizing renewable energy sources (solar, wind, hydro), AI for energy demand forecasting and grid management, AI models for integrating renewable energy into power grids

AI in Smart Grids: AI-driven technologies for efficient grid management (demand-response systems, load balancing) Role of AI in reducing energy losses and improving grid efficiency

Case studies: AI applications in renewable energy (smart grid, microgrid management)

AI in Carbon Footprint Reduction: AI in carbon emissions monitoring and reduction strategies, Predictive models for optimizing energy consumption, Role of AI in creating energy-efficient buildings and industries

Assignments:

- Research Paper: AI-driven energy optimization strategies
- Case Study: AI in a smart grid or renewable energy project

UNIT-V

Ethical, Social, and Policy Implications of AI in Sustainability

Ethics of AI in Environmental Science: Ethical challenges in using AI for environmental management, Bias, fairness, and transparency in AI models for sustainability, Ethical considerations in AI-driven conservation efforts

Social Impacts of AI in Sustainability: Impact of AI on jobs in agriculture, energy, and resource management, AI-driven social inequalities in environmental management, Public perception of AI in environmental decision-making

Policy and Governance in AI for Sustainability: Regulatory frameworks for AI in environmental management, Role of international organizations and governments in AI governance, Future directions for AI and sustainability policy

Assignments:

- Final Project: Develop an AI-driven solution to a sustainability challenge (climate change, agriculture, pollution, etc.)
- Debate: Ethical and social implications of AI in addressing environmental challenges

Textbooks:

1. Artificial Intelligence and Machine Learning for Business for Dummies, Steven Holzner, For Dummies, ISBN: 978-1119467656.
2. AI for Earth: Artificial Intelligence and the Environment, Rebecca Herold and Melanie Cook, CRC Press, ISBN: 978-1138554260.

Reference books:

1. Artificial Intelligence for a Sustainable Future: From Environmental Informatics to Green AI, Henrik Skaug Sætra, Espen Moe, Routledge, ISBN: 978-0367436492.
2. AI for Climate: The Role of Artificial Intelligence in Fighting Climate Change, David Rolnick, Priya Donti, Springer, ISBN: 978-3030591303.
3. AI for Good: Using Artificial Intelligence to Address Climate Change, Environmental Sustainability, and Global Crises, Laurent Alexandre, CRC Press, ISBN: 978-1138339843.

Security											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501CS32	Cybersecurity Essentials	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT35	Security in Software Development	FC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS28	Ethical Hacking	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS69	Cloud Security	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT36	Security &Compliance in Business	IC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT37	Cryptography & Data Security	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT38	Security Awareness & Social Engineering	AC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT39	Cybersecurity Policy & Strategy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT40	Security in Emerging Technologies	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS30	Information Security Analysis & Audit	AC	2			2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT41	Financial Information Security & Privacy	AC	3			3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
Total			**25**		**7**	**32**					

Cybersecurity Essentials

Course Code:2501CS32	L	T	P	C
	2	0	1	3

Course Outcomes:

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

CO1: Describe the basic concepts of Cyber security issues and challenges
CO2: Analyze the cybercrimes and cyber laws.
CO3: Demonstrate various privacy and security concerns on social media
CO4: Illustrate the concepts related to E-Commerce and digital payments.
CO5: Summarize tools and technologies to protect communication devices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	2	-	-	-	-
CO2	2	3	-	2	1	-	-	1	1	-	-
CO3	1	2	-	2	1	1	-	1	1	-	1
CO4	1	2	3	1	1	-	1	1	-	1	1
CO5	2	1	-	-	-	-	3	-	-	-	-

UNIT – I

Introduction to Cyber security:

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Practice:

1. Study on how to register a Cyber Crime Complaint through online.(https://cybercrime.gov.in/Webform/Crime_AuthoLogin.aspx)

UNIT – II

Cyber crime and Cyber law:

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India.

Practice:

1. Reporting on types of phishing emails.
2. Demonstration of email phishing attack and preventive measures

UNIT – III

Social Media Overview and Security

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Laws regarding posting of inappropriate content.

Practice:

1. Basic checklist, privacy and security settings for popular Social media platforms.

UNIT – IV

E-Commerce and Digital Payments

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best Practices, Introduction to digital payments, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures.

Practice:

1. Configuring security settings in Mobile Wallets and UPIs

UNIT – V

Digital Devices Security , Tools and Technologies for Cyber Security

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best **Practice**s, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Practice:

1.
    a. Setting and configuring two factor authentication in the Mobile phone.
    b. Security patch management and updates in Computer and Mobiles.

Text Books:

1 Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2 Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.

Reference Books:

1 Data Privacy Principles and **Practice** by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
2 Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, Wiley Publication, 1st Edition,.
3 Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, Jones Bartlett Learning, 2nd Edition.

Web Links:

1 https://www.coursera.org/specializations/cyber-security.
2 https://www.nptel.ac.in/courses/106105031/.

Security in Software Development

Course Code:2501IT35	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Describe the basic concepts of Cyber security issues and challenges
CO2: Analyze the cybercrimes and cyber laws.
CO3: Demonstrate various privacy and security concerns on social media
CO4: Illustrate the concepts related to E-Commerce and digital payments.
CO5: Summarize tools and technologies to protect communication devices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	1	1	-
CO2	2	2	-	1	2	-	-	-	1	1	-
CO3	2	2	-	2	-	-	-	-	1	1	-
CO4	2	2	-	-	1	-	-	-	1	1	-
CO5	2	2	-	-	-	-	-	2	1	1	-

UNIT – I

Introduction to Software Security

Importance of security in software development,Common security threats (e.g., viruses, worms, malware, ransomware),Secure software development lifecycle (SDLC), Principles of secure coding.

UNIT – II

Threat Modeling and Risk Analysis

Threat modeling approaches ,Identifying vulnerabilities, Risk analysis and managemen, Security requirements gathering.

UNIT – III

Secure Coding Practices

Common vulnerabilities (e.g., SQL injection, buffer overflow, cross-site scripting), Secure coding standards (e.g., OWASP), Input validation and data sanitization, Code reviews and static analysis tools

UNIT – IV

Application Security Testing

Types of security testing (static, dynamic, penetration testing),Automated testing tools, Vulnerability scanning and patch management ,Secure code review technique

UNIT – V

Security in DevOps and Cloud

Integrating security into DevOps practices (DevSecOps), Security automation and continuous integration, Cloud security principles and challenges, Securing APIs and microservices in cloud environments

Text Books:

1. Software Security: Building Security In" by Gary McGraw
   ISBN: 978-0321356703
2. The CERT® C Coding Standard: 98 Rules for Developing Safe, Reliable, and Secure Systems by Robert C. Seacord
   ISBN: 978-0321984043

Reference Books:

1. Threat Modeling: Designing for Security by Adam Shostack
   ISBN: 978-1118809990
2. Web Application Security, A Beginner's Guide by Bryan Sullivan and Vincent Liu
   ISBN: 978-0071776165
3. Securing DevOps: Security in the Cloud by Julien Vehent
   ISBN: 978-1617294136

Web Links:

1. https://www.coursera.org/specializations/cyber-security.
2. https://www.nptel.ac.in/courses/106105031/.
3. CERT-In Guidelines- http://www.cert-in.org.in/

Ethical Hacking

	L	T	P	C
Course Code:2501CS28	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Describe the concepts and types of Ethical hacking
- **CO2:** Apply tools and techniques for Social Engineering.
- **CO3:** Illustrate concepts of data security for various networking systems
- **CO4:** Analyze techniques to protect Web servers and Communication Systems
- **CO5:** Demonstrate ethical laws and tests related to ethical hacking

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	1	1	-
CO2	2	2	-	1	2	-	-	-	1	1	-
CO3	2	2	-	2	-	-	-	-	1	1	-
CO4	2	2	-	-	1	-	-	-	1	1	-
CO5	2	2	-	-	-	-	-	2	1	1	-

UNIT – I

Ethical Hacking

Types of Data Stolen From the Organizations, Elements of Information Security, Authenticity and NonRepudiation, Security Challenges, Effects of Hacking, Hacker – Types of Hacker, Ethical Hacker,Hacktivism - Role of Security and Penetration Tester, Penetration Testing Methodology, Networking &Computer Attacks – Malicious Software (Malware), Protection Against Malware, Intruder Attacks on Networks and Computers, Addressing Physical Security – Key Loggers and Back Doors.

Practice:

1. Create a social networking website login page using phishing techniques
2. Sniffing tools to analyze traffic on a network and dissect information.

UNIT – II

Foot Printing And Social Engineering

Web Tools for Foot Printing, Conducting Competitive Intelligence, Google Hacking, Scanning, Enumeration, Trojans & Backdoors, Virus & Worms, Proxy & Packet Filtering, Denial of Service, Sniffer,Social Engineering – shoulder surfing, Dumpster Diving, Piggybacking.

Practice:

1. Social Engineering Countermeasures
2. Tools for Foot Printing

UNIT – III

Data Security

Physical Security – Attacks and Protection, Steganography – Methods, Attacks and Measures, Cryptography– Methods and Types of Attacks, Wireless Hacking, Windows Hacking, Linux Hacking.

Practice:

1. Write a code to demonstrate DoS attacks
2. Windows ,Linux OS hacking

UNIT – IV

Network Protection System & Hacking Web Servers

Routers, Firewall & Honeypots, IDS & IPS, Web Filtering, Vulnerability, Penetration Testing, Session Hijacking, Web Server, SQL Injection, Cross Site Scripting, Exploit Writing, Buffer Overflow, Reverse Engineering, Email Hacking, Incident Handling & Response, Bluetooth Hacking, Mobiles Phone Hacking.

Practice:

1. Write a script or code to demonstrate SQL injection attacks
2. Setup a honey pot and monitor the honey pot on network

UNIT – V

Ethical Hacking Laws And Tests

An introduction to the particular legal, professional and ethical issues likely to face the domain of ethical hacking, ethical responsibilities, professional integrity and making appropriate use of the tools and techniques associated with ethical hacking – Social Engineering, Host Reconnaissance, Session Hijacking, Hacking - Web Server, Database, Password Cracking.

Practice:

1. Study of Techniques uses for Web Based Password Capturing
2. Study on how to register a Cyber Crime Complaint through online.(https://cybercrime.gov.in/Webform/Crime_AuthoLogin.aspx)

Text Books:

1. Corley, Hands-On Ethical Hacking and Network Defense ,Michael T. Simpson, Kent Backman, James E., CENGAGE Learning
2. Penetration Testing and Network Defense ,Whitaker & Newman , Cisco Press, Indianapolis.

Reference Books:

1. Official Certified Ethical Hacker Review Guide,Steven DeFino, Barry Kaufman, Nick Valenteen,CENGAGE Learning.
2. The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy ,Patrick Engebretson, Syngress Basics Series – Elsevier.

Web Links:

1. https://www.springboard.com/blog/cybersecurity/7-free-sources-to-learn-ethical-hacking-from-scratch/
2. https://hackernoon.com/top-resources-to-learn-ethical-hacking3
3. https://onlinecourses.nptel.ac.in/noc22_cs13/preview

Cloud security

	L	T	P	C
Course Code:2501CS69	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Explain basic cloud security principles, attack vectors, and access control methods in cloud environments.
- **CO2:** Illustrate IAM roles, policies, and resource-based permissions used to secure cloud infrastructure.
- **CO3:** Apply AWS security services and configurations to monitor, protect, and manage cloud network resources.
- **CO4:** Implement data protection methods and access controls to secure cloud storage and network resources using AWS services.
- **CO5:** Analyze monitoring, vulnerability assessment, and threat protection techniques to secure applications and resources in AWS.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	2	1	-	-	1	-	2
CO2	2	1	-	-	2	1	-	-	1	-	2
CO3	3	2	2	-	3	-	-	-	1	-	2
CO4	3	2	2	-	3	-	-	-	1	-	2
CO5	3	3	2	-	3	-	-	-	2	-	2

Practice:

1. a. Analyze cloud security design principals
   b. Implementation of shared responsibility model in cloud
2. a. Understanding attack vectors on cloud resources
   b. Case studies on Cloud security and compliance
3. a. Securing access to cloud resources.
   b. Configuring IAM Authentication
4. a. Authorize with Identity and Access Management
   b. Amazon S3 Cross-Account Resource-Based Policy
5. a. Using Resource-Based Policies to Secure an S3 Bucket
   b. Implementing IAM assume role in AWS.
6. a. Securing infrastructure in cloud.
   b. Testing IAM policies with IAM policy simulator
7. a. Using AWS Cloud Trail to log and track actions.
   b. Threat Intelligence with Amazon guard Duty
8. a. Setting up private and public subnets.
   b. Securing VPC Resources by Using Security Groups
9. a. Working with Network Access Control Lists

b. Best practices for protecting data in Amazon S3

10. a. Understanding client-side and server-side encryption
    b. Encrypting Data at Rest by Using AWS KMS
11. a. Monitoring and Alerting CloudWatch
    b. Using Amazon Inspector to assess application vulnerabilities.
12. a. Securing web applications in AWS using Web Application Firewall
    b. Protecting cloud resources from DDoS attacks using AWS Shield

Additional Practice:

1. Remediating an Incident by Using AWS Config and Lambda
2. Best practices for handling an incident
3. Responding to and Managing an Incident

Textbooks:

1. AWS Certified security study guide, Marcello Zillo Neto, Gustavo AA Santana, by Sybex Press.

Reference Books:

1. AWS Certified Security exam guide, Stuart Scott, by O'REILLY press

Web Links:

1. https://skillbuilder.aws/
2. https://aws.amazon.com/training/awsacademy/

Security & Compliance in Business

	L	T	P	C
Course Code:2501IT36	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1:** Identify the fundamentals of business security and compliance frameworks.
- **CO2:** Analyze various security risks and compliance requirements in business environments.
- **CO3:** Implement strategies for business data protection and risk management.
- **CO4:** Evaluate business compliance with global standards and regulatory frameworks.
- **CO5:** Develop an organizational security and compliance plan.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	1	2	-	-	-	-	-	2
CO2	2	3	2	2	2	-	-	-	-	-	2
CO3	3	2	3	2	3	-	-	-	-	-	2
CO4	2	3	2	2	2	-	-	-	-	-	2
CO5	2	2	3	2	3	-	-	-	-	-	2

UNIT – I

Introduction to Business Security and Compliance

Fundamentals of business security, Overview of business compliance frameworks (e.g., GDPR, HIPAA, PCI-DSS),Importance of security in business environments, Key regulatory bodies and laws

UNIT – II

Risk Management and Threats in Business

Understanding security threats to businesses (e.g., cyberattacks, insider threats), Risk management frameworks (ISO 31000, NIST), Risk assessment and analysis, Incident response planning and mitigation strategies.

UNIT – III

Data Protection and Privacy in Business

Business data protection strategies, Encryption and data masking techniques, Privacy requirements under various compliance frameworks, Best practices for ensuring data privacy in businesses.

UNIT – IV

Regulatory Compliance and Standards

Understanding global regulatory frameworks (e.g., GDPR, SOX, FISMA), Auditing and compliance assessments, Reporting and documentation for compliance, Case studies on regulatory compliance failures.

UNIT – V

Developing a Security and Compliance Plan

Steps to create a comprehensive security and compliance plan, integrating security in business operations, Continuous monitoring and auditing, Aligning business goals with security and compliance

Text Books:

1. Building a Comprehensive IT Security Program: Practical Guidelines and Best Practices by Jeremy Wittkop, ISBN: 978-1484220529
2. Data Protection and Privacy: The Age of Big Data" by Ronald Leenes, Rosamunde Van Brakel, ISBN: 978-1509923195

Reference Books:

1. Regulatory Compliance Fundamentals by M.L. Leathers, ISBN: 978-0814436342
2. Risk Management and Corporate Governance" by Marijn van Daelen, Christa Hopt ISBN: 978-0857930571

Cryptography & Data Security

	L	T	P	C
Course Code:2501IT37	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Discuss the fundamental principles of cryptography and its role in data security
- **CO2:** Analyze various cryptographic algorithms and their applications.
- **CO3:** Implement encryption techniques to secure data in transmission and storage.
- **CO4:** Evaluate modern cryptographic protocols and their strengths and vulnerabilities.
- **CO5:** Develop solutions for ensuring data security in real-world applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	1	2	-	-	-	-	-	2
CO2	3	3	2	2	2	-	-	-	-	-	2
CO3	3	2	3	2	3	-	-	-	-	-	2
CO4	3	3	2	3	3	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	-	-	2

UNIT – I

Introduction to Cryptography

History and evolution of cryptography, Key concepts: Encryption, decryption, and cryptographic keys, Symmetric vs. asymmetric cryptography, Importance of cryptography in securing data

UNIT – II

Symmetric Cryptography

Symmetric encryption algorithms (DES, AES, RC4), Block ciphers vs. stream ciphers, Modes of operation (CBC, CFB, OFB, CTR), Key management and distribution

Practice:

Implement AES encryption in Python

UNIT – III

Asymmetric Cryptography

Public-key cryptography (RSA, Diffie-Hellman), Key exchange protocols, Digital signatures and certificates, Cryptographic hash functions (SHA, MD5)

Practice:

1. Implement MD5 algorithm

UNIT – IV

Cryptographic Protocols and Applications

Secure Socket Layer (SSL) and Transport Layer Security (TLS), Cryptography in blockchain and crypto currencies, Public Key Infrastructure (PKI), Application of cryptography in secure email, e-commerce, and VPNs

Practice:

Implement SSL handshake simulation in Python

UNIT – V

Modern Cryptographic Challenges and Future Trends

Quantum cryptography and post-quantum cryptography, Zero-knowledge proofs, Cryptanalysis: Attacks on cryptosystems (brute-force, side-channel attacks), Future trends in cryptography.

Text Books:

1. Cryptography and Network Security: Principles and Practice by William Stallings ISBN: 978-0134444284
2. Network Security Essentials: Applications and Standards by William Stallings ISBN: 978-0134527338

Reference Books:

1. Understanding Cryptography: A Textbook for Students and Practitioners by Christof Paar, Jan Pelzl ISBN: 978-3642041006
2. Applied Cryptography: Protocols, Algorithms, and Source Code in C by Bruce Schneier ISBN: 978-1119096720
3. Post-Quantum Cryptography by Daniel J. Bernstein, Johannes Buchmann ISBN: 978-3540887027

Web Links:

1. https://www.openssl.org
2. https://cryptography.io
3. https://www.nist.gov

Security Awareness and Social Engineering

	L	T	P	C
Course Code:2501IT38	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Identify basic security concepts and terminologies related to cybersecurity.
- **CO2:** Analyze common security threats, vulnerabilities, and their impact on information systems.
- **CO3:** Identify various social engineering techniques used by attackers.
- **CO4:** Apply defensive measures against common social engineering attacks.
- **CO5:** Develop strategies to raise awareness of security threats among individuals and organizations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	-	1	1	-	-	-	-	2
CO2	3	3	2	2	2	2	-	-	-	-	2
CO3	2	1	-	-	1	2	-	-	-	-	2
CO4	3	2	2	1	2	2	-	-	-	1	2
CO5	2	2	3	-	2	2	-	-	-	2	2

UNIT – I

Introduction to Security Awareness

Security fundamentals, Common cyber threats: Malware, phishing, ransomware, etc., Importance of information security in organizations, Overview of security controls.

Practice:

Design a security awareness training module for employees of an organization, considering different types of social engineering attacks and how to mitigate them.

UNIT – II

Understanding Social Engineering

What is social engineering, Types of social engineering attacks: Pretexting, baiting, phishing, etc., Psychological principles behind social engineering, Real-life case studies of social engineering attacks.

UNIT – III

Mitigating Social Engineering Threats

Defensive strategies against social engineering, Awareness training and education, The role of policies and procedures in prevention, Using technology to defend against social engineering.

UNIT – IV

Security Awareness Programs

Importance of creating a culture of security, Designing security awareness campaigns, Monitoring and improving security awareness in organizations, Evaluating the effectiveness of security training programs.

Practice:

Simulate a phishing attack on a fictional organization and track how many employees fall victim. Analyze the results and propose improvements to their awareness training program.

UNIT – V

Ethical and Legal Aspects

Ethics in cyber security, Laws and regulations governing cyber security, Data protection laws (GDPR, CCPA, etc.), Handling sensitive data responsibly

Practice:

Perform a risk assessment for a small business, identifying potential security threats and designing mitigation strategies.

Text Books:

1. Security Awareness: Applying Practical Security in Your World Author: Mark Ciampa, Publisher: Cengage Learning, ISBN: 978-1305500372.
2. The Art of Deception: Controlling the Human Element of Security Author: Kevin, D. Mitnick, Publisher: Wiley, ISBN: 978-0764542800.

Reference Books:

1. Social Engineering: The Science of Human Hacking, Author: Christopher Hadnagy, Publisher: Wiley, ISBN: 978-1119433385.

Cyber Security Policy and Strategy

	L	T	P	C
Course Code: 2501IT39	**3**		**0**	**3**

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

- **CO1:** Understand the key elements of cybersecurity policies and strategies.
- **CO2:** Analyze global cybersecurity frameworks, laws, and regulations
- **CO3:** Develop a cybersecurity risk management strategy for an organization.
- **CO4:** Propose policies for safeguarding critical infrastructure.
- **CO5:** Evaluate legal, ethical, and privacy issues in the context of cybersecurity.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	1	1	-	-	-	-
CO2	2	2	-	2	-	2	2	-	-	-	2
CO3	2	2	2	-	-	-		-	-	-	-
CO4	2	2	1	-	-	-	2	-	-	-	-
CO5	2	2	1	-	-	-	2	-	-	-	-

UNIT-I

Introduction to Cybersecurity Policies and Strategies: History and evolution of cybersecurity policies, Key concepts: threat landscape, vulnerabilities, risk, and controls, Cybersecurity governance models, Role of stakeholders: governments, organizations, and international bodies.

UNIT-II

Cybersecurity Governance and Risk Management: Frameworks for cybersecurity governance (NIST, ISO 27001, etc.),Enterprise risk management and cybersecurity, risk assessment, risk tolerance, and risk mitigation strategies**,** Role of leadership and organizational culture.

UNIT-III

National and International Cybersecurity Strategies: National cybersecurity strategies: US, EU, India, and other regions**,** International organizations in cybersecurity: UN, ITU, NATO**,** Cyber norms and diplomatic strategies**,** Cyber warfare and state-sponsored cyber activities

UNIT-IV

Legal, Regulatory, and Compliance Frameworks: Data protection laws (GDPR, CCPA, etc.), Regulatory frameworks: HIPAA, PCI-DSS, SOX, Cybersecurity compliance challenges, Legal implications of cyber incidents.

UNIT-V

Emerging Issues in Cybersecurity Policy: Ethical issues in cybersecurity**,** The role of Artificial Intelligence (AI) and Machine Learning (ML)**,** Cyber insurance and financial risks.

Text Books:

1. Cybersecurity and Cyberwar: What Everyone Needs to Know, P.W. Singer and Allan Friedman, Oxford University Press,2014, 978-0199918119
2. Cybersecurity Policy Guidebook, Jennifer L. Bayuk, Jason Healey, Paul Rohmeyer, John Wiley & Sons,2012, 978-1118027806

Web Links:

1 https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2 https://www.kdnuggets.com/
3 https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/

Security in Emerging Technologies

	L	T	P	C
Course Code:2501IT40	**3**	**0**	**0**	**3**

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

- **CO1:** Explain the security implications of emerging technologies such as IoT, AI, blockchain, and quantum computing.
- **CO2:** Analyze and address security challenges in IoT ecosystems, including device and data protection.
- **CO3:** Apply AI and ML technologies to improve cybersecurity measures and detect threats.
- **CO4:** Evaluate the security risks in blockchain and cryptocurrencies and propose solutions to mitigate vulnerabilities.
- **CO5:** Explore the impact of quantum computing on modern cryptography and assess the future of quantum-resistant security techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	1	-	-	-	-	-	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-
CO3	3	2	1	2	1	-	-	-	-	-	-
CO4	2	-	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	1	-	-	-	-	-	-

UNIT – I

Introduction to Emerging Technologies and Security
Overview of Emerging Technologies: Definition and scope: IoT, AI, Blockchain, Cloud Computing, Quantum Computing, Impact of emerging technologies on industries and society.
Security Challenges in Emerging Technologies: New attack vectors and vulnerabilities, Security threats and risks associated with adoption of new technologies, Regulatory and compliance considerations.

UNIT – II

Internet of Things (IoT) Security
Architecture and Components of IoT: IoT devices, sensors, and networks, Communication protocols in IoT (Zigbee, Bluetooth, MQTT).

IoT Security Issues: Common vulnerabilities and risks in IoT ecosystems, Authentication and access control for IoT devices, Secure communication and data encryption in IoT systems.

UNIT – III

Artificial Intelligence (AI) and Machine Learning (ML) Security
AI and ML in Cybersecurity: Role of AI and ML in detecting cyber threats and enhancing security, AI-driven security solutions for real-time threat detection.
Security Challenges in AI/ML Systems: Adversarial attacks on AI models, Data poisoning and model tampering risks, Ethical concerns and privacy issues in AI-driven systems.

UNIT – IV

Blockchain and Cryptocurrency Security
Blockchain Technology Overview: Structure and functioning of blockchain technology, Consensus algorithms (Proof of Work, Proof of Stake), Applications of blockchain beyond cryptocurrency.
Blockchain Security Challenges: 51% attacks and double-spending risks, Smart contract vulnerabilities, Privacy and scalability challenges in blockchain networks.

UNIT – V

Quantum Computing and Security Implications
Quantum Computing Basics: Fundamentals of quantum computing and its potential applications, How quantum computers differ from classical computers.
Quantum Cryptography and Post-Quantum Security: Threats posed by quantum computing to current cryptographic methods, Quantum-resistant cryptographic algorithms, Quantum key distribution (QKD) and its security benefits

Text Books:

1. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, Fei Hu, CRC Press, ISBN: 978-1498768874.
2. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, Apress, ISBN: 978-1484226032

Reference Books:

1. Quantum Computing for Computer Scientists, Noson S. Yanofsky, Mirco A. Mannucci, Cambridge University Press, ISBN: 978-0521879965

2. AI in Cybersecurity, Leslie F. Sikos, Springer, ISBN: 978-3030459729
3. Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, Packt Publishing, ISBN: 978-1788839044

Web Links:

1. https://www.nist.gov/cyberframework
2. https://owasp.org/www-project-internet-of-things/
3. https://quantumcomputingreport.com

Information Security Analysis & Audit

	L	T	P	C
Course Code: 2501CS30	2	0	0	2

Course Outcomes:

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

CO1: Demonstrate fundamental concepts of information security and systems auditing
CO2: Analyze latest trend in management control framework
CO3: Identify security operations in management control framework.
CO4: Distinguish data evidence collection techniques.
CO5: Analyze data evidence evaluation in audit.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	-	-	-	-	-	-	-	1
CO2	2	2	-	3	-	-	2	-	-	-	2
CO3	1	3	-	-	1	-	-	-	-	-	2
CO4	1	2	-	2	-	-	1	-	-	-	1
CO5	1	3	1	-	-	-	2	-	-	-	-

UNIT – I

Overview of Information System Auditing- Effect of Computers on Internal Controls, Effects of Computers on Auditing, Foundations of information Systems Auditing, Conducting an Information Systems Audit.

UNIT – II

The management Control Framework-I- Introduction, Evaluating the planning Function, Leading Function, Controlling Function, Systems Development Management Controls, Approaches to Auditing Systems Development,Programming Management Controls, Data Resource Management Controls.

UNIT – III

The Management Control Framework-II- Security Management Controls, Operations management Controls Quality assurance Management Controls, Case Studies.

UNIT – IV

Evidence Collection- Audit Software, Code Review, Test Data, and Code Comparison, Concurrent Auditing techniques, Interviews, Questionnaires, and Control Flowcharts. Performance Management tools- Case Studies.

UNIT – V

Evidence Evaluation- Evaluating Asset Safeguarding and Data Integrity, Evaluating System, Effectiveness, Evaluating System Efficiency, Information Systems Audit and Management: Managing the Information Systems Audit Function.

Text Books:

1. Information Systems Control and Audit, Ron Weber, Pearson Education, 1st Edition .
2. Cryptography Engineering: Design Principles and Practical Applications ,Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons.

Reference Books:

1. Information System Audit and Assurance, D P Dube, TMH, New Delhi.
2. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.

Web Links:

1. https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks
2. https://computersecurity.stanford.edu/free-online-video[Free Online Videos]
3. CERT-In Guidelines- http://www.cert-in.org.in/

Financial Information Security & Privacy

	L	T	P	C
Course Code:2501IT41	**3**	**0**	**0**	**3**

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

- **CO1:** Analyze the financial information security landscape and identify major challenges.
- **CO2:** Apply regulatory and legal standards to ensure the protection of financial data.
- **CO3:** Design and implement effective cybersecurity measures in financial institutions.
- **CO4:** Utilize technologies such as encryption, blockchain, and cloud security for financial data protection.
- **CO5:** Develop risk management strategies to mitigate security threats and ensure compliance in financial systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	1	1	-	-	-	-	-	-	-
CO2	2	2	1	2	-	-	-	-	-	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-
CO4	2	-	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-

UNIT – I

Introduction to Financial Information Security:
Overview of Financial Information Systems, Introduction to Financial Data Privacy, Financial Data Security Needs and Risks, Financial Information Security Landscape: Key Challenges and Issues, Legal and Regulatory Requirements for Financial Information Protection (e.g., GDPR, PCI DSS, GLBA), Role of Cryptography in Financial Systems Security

UNIT – II

Cybersecurity Threats and Attacks in Financial Systems:
Common Cybersecurity Threats: Malware, Phishing, Ransomware, Types of Attacks on Financial Systems (e.g., Denial of Service, Man-in-the-Middle, SQL Injection), Cybersecurity Incident Management and Response, Case Studies of Cybersecurity Breaches in Financial Institutions.

UNIT-III

Financial Data Privacy: Concepts and Frameworks
Understanding Privacy: Definitions and Importance, Privacy Laws and Regulations (e.g., GDPR, CCPA), Privacy by Design in Financial Systems, Data Anonymization and Masking Techniques, Privacy Risk Assessments.

UNIT – IV

Technologies for Securing Financial Information
Encryption Techniques for Financial Data Protection, Secure Access Controls: Authentication and Authorization, Security of Mobile and Online Banking Platforms, Role of Blockchain in Financial Information Security, Cloud Security for Financial Institutions.

UNIT – V

Risk Management and Compliance in Financial Information Security
Financial Risk Management in Information Security, Regulatory Compliance Frameworks: PCI DSS, SOX, and others, Implementing Information Security Policies and Procedures, Role of Auditing and Monitoring in Financial Systems, Developing an Information Security Management System (ISMS).

Text Books:

1. Financial Cryptography and Data Securityby Rainer Böhme (Editor), Springer, ISBN: 978-3642026923.
2. Cybersecurity in Banking and Financial Institutions by Felix I. Lessambo, Palgrave Macmillan, ISBN: 978-3030723006.

Reference Books:

1. Security and Privacy in Financial Cloud" by Kuan-Ching Li, CRC Press, ISBN: 978-0367337420.
2. Cybersecurity for Financial Services" by Siraj A. Shaikh, George Loukas, and David Haynes, Springer, ISBN: 978-1119569369.

Web Links:

1. https://www.nist.gov/cyberframework
2. https://owasp.org
3. https://www.pcisecuritystandards.org

Others											
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	**Offered to Programs**	**Pre-requisite**
2501CE80	Remote Sensing & GIS Applications	FC	3			3	50	50	100	EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EE36	Electric Energy Storage Systems	FC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE43	Electrical safety	IC	3			3	50	50	100	CE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501EE54	Hybrid & Electric Vehicles	IC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE
2501ME73	Organizational Behaviour	FC	3			3	50	50	100	CE,EEE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME36	Sustainable Energy Systems	FC	3			3	50	50	100	CE, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME37	Solar Energy Systems	FC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501ME60	Composite Materials	IC	3			3	50	50	100	CE,EEE,ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	SSP/MP
2501EC82	Communication Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC83	Electronic Measurements & Instrumentation	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	BEEE

2501EC84	Introduction to Embedded Systems	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC85	Fundamentals of Image Processing	FC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
2501EC77	Sensors and Transducers	IC	3			3	50	50	100	CE,EEE,ME, CSE,IT, AIML, CSE(DS) PT,Min.E	
2501CS03	Data Structures	FC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS65	Computer Organization	FC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS13	Operating Systems	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT05	Database Management Systems	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS07	Computer Networks	IC	2		1	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT06	Java Programming	IC	2		2	4	50	50	100	CE,EEE,ME, ECE, PT,Min.E	PPSC
2501CS68	Fundamentals of RedHat Enterprise Linux	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS67	AWS Cloud Foundations	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS66	AWS Cloud Development	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501CS70	Continuous integration & delivery using DevOps	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT24	Fundamentals of Salesforce Administration	FC			2	2	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-

2501IT34	Advanced Salesforce Administration	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT23	Principles of Pega Systems	IC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501IT26	Pega System Architecture & Design	AC			3	3	50	50	100	CE,EEE,ME, ECE, PT,Min.E	-
2501MB04	Entrepreneurship Development & Incubation	IC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB05	Business Ethics & Corporate Governance	AC	3			3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501MB06	Entrepreneurship Development & Business Management	AC	1		2	3	50	50	100	CE,EEE,ME, ECE, CSE,IT, AIML, CSE(DS) PT,Min.E	-
2501EC29	SoC Design	AC	3			3	50	50	100	CE, EEE, ME, CSE, IT, AIML, CSE (DS), PT, Min.E.	MPMC
2501CS23	Cloud Computing	FC	2		2	4	50	50	100	CE, EEE, ME, ECE, PT, Min.E.	-

Remote Sensing & GIS Applications

	L	T	P	C
Course Code:2501CE80	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Classify the information content of remotely sensed data.
CO2: Explain the energy interactions in the atmosphere and earth surface features.
CO3: Interpret the images for preparation of thematic maps.
CO4: Analyse spatial and attribute data for solving spatial problems.
CO5: Apply remote sensing and GIS data for engineering applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	2	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	-	2	1	-	-	-	-	-
CO4	2	3	-	-	2	-	-	-	-	-	-
CO5	2	-	-	-	2	-	-	-	-	-	-

UNIT – I

Basic concepts of Photogrammetry:

Principles& types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducial points, parallax measurement using fiducial line.

Introduction and Basic Concept of Remote Sensing:

Introduction to remote sensing: Basic concepts of remote sensing, electromagnetic radiation, electromagnetic spectrum, interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems

UNIT – II

Sensors and platforms:

Introduction, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification.

UNIT – III

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data. Coordinate.

Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections

UNIT – IV

Spatial data analysis:

Introduction, data models, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing

UNIT – V

Applications of Remote Sensing and GIS:

Application of Remote Sensing and GIS in civil engineering, groundwater prospecting and identification of potential zones for artificial recharge, transportation, agriculture, Forestry, Land cover and land use, geology and geomorphology, floodplain delineation

Text Books:

1. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers. (ISBN: 978-0199496648).
2. Remote Sensing and GIS, Thomas M.Lillesand and Kiefer, John Willey.(ISBN:13-978-1118343289).

Reference Books:

1. Concepts & Techniques of GIS , C. P. Lo Albert, K.W. Yonng, Prentice Hall (India) Publications. (ISBN: 13- 978-9332581883).
2. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers. (ISBN: 13-978-0198742845)
3. Basics of Remote sensing & GIS , S. Kumar, Laxmi Publications. (ISBN: 13- 978-8170087960).

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg
3. https://nptel.ac.in/downloads/105108077/

Electric Energy Storage Systems

	L	T	P	C
Course Code:2501EE36	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Analyze the characteristics of electrical energy storage technologies.
CO2: Analyze the needs for electrical energy storage.
CO3: Analyze the needs for electrical energy storage.
CO4: Underst& the various types of electrical energy storage systems.
CO5: Identify various real time applications of energy storage systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	-	-	-	-	-	-
CO4	3	1	1	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-

UNIT – I

Electrical Energy Storage (EES) Technologies: Characteristics of electricity, Electricity & the roles of EES, High generation cost during peak-dem& periods, Need for continuous & flexible supply, Long distance between generation & consumption, Congestion in power grids, Transmission by cable.

UNIT – II

Needs for Electrical Energy Storage: Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

UNIT – III

Features of Energy Storage Systems: Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel

energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG)

UNIT – IV

Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, St&ards for EES, Technical comparison of EES technologies.

UNIT – V

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management & control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems & distributed generation (Virtual Power Plant), Battery SCADA aggregation of many dispersed batteries.

Text Books:

1 Energy Storage Benefits & Market Analysis, by James M. Eyer, Joseph J. Iannucci & Garth P. Corey Sandia National Laboratories.

2 The Electrical Energy Storage by IEC Market Strategy Board.

Reference Boks:

1 Energy Storage for the Electricity Grid: Benefits & Market Potential Assessment Guide, Jim Eyer, Garth Corey, Sandia National Laboratories.

2 Energy Storage by Mullick & Garg (ISBN: 9789027719300)

Web Links:

1 https://nptel.ac.in/courses/112/105/112105221/

2 https://nptel.ac.in/courses/112/107/112107283/

3 https://nptel.ac.in/content/storage2/courses/108103009

Electrical Safety

		L	T	P	C
Course Code:	**2501EE43**	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO 1: Describe electrical hazards & safety equipment.
CO 2: Analyze and apply various grounding & bonding techniques
CO 3: Select appropriate safety method for low, medium equipment's and high voltage equipment.
CO 4: Participate in a safety team &Carry out proper maintenance of electrical equipment by understanding various Standards.
CO 5: Analyze the safety method for high voltage equipment's.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-
CO5	1	3	1	-	-	-	-	-	-	-	-

UNIT-I

Hazards of Electricity and Electrical Safety Equipment: Primary and secondary hazards- arc, blast, shocks causes and effects-safety equipment flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags, locking devices- voltage measuring instruments- proximity and contact testers-safety electrical one line diagram- electrician's safety kit.

UNIT-II

Grounding of Electrical Systems and Equipment: General requirements for grounding and bonding- definitions grounding of electrical equipment-bonding of electrically conducting materials and other equipment connection of grounding and bonding equipment- system grounding- purpose of system grounding-grounding electrode system-grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage and high voltage systems.

UNIT-III

Safety Procedures and Methods: The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation and approach distances-calculating the required level of arc protection-safety equipment, procedure for low, medium and high voltage systems- the one-minute safety audit

UNIT-IV

Safety Management and Organizing Structure: Electrical safety program structure, development- company safety team- safety policy program implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

UNIT-V

Electrical Maintenance and Legal Safety Requirements and Standards: Safety related case for electrical maintenance- reliability centred maintenance (RCM) - eight step maintenance program- frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code standard for electrical safety in work place- occupational safety and health administration standards, Indian Electricity Acts related to Electrical Safety

Text Books:

1. Electrical Safety Handbook by John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4th Edition (ISBN: 9780071745130)
2. Electric Safety Practice and Standards, Khaled Ismail, CRC Press, Taylor and Francis (ISBN: 9781138073999).

Reference Books

1. 'Electrical Safety- a guide to the causes and prevention of electric hazards', Maxwell Adams.J, The Institution of Electric Engineers, IET (ISBN: 9780852968062).
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones and Bartlett Learning (ISBN: 9780877655800).

Web Links:

1. http://nptel.ac.in/courses/103106071/5
2. https://www.electricalsafetyfirst.org.uk

Hybrid & Electric Vehicles

	L	T	P	C
Course Code:2501EE54	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Describe the History of Hybrid Electric vehicles
CO2: Classify the various electric drivetrain topologies
CO3: Articulate the Energy Storage Requirements in Hybrid & Electric Vehicles
CO4: Illustrate the Charging Infrastructure
CO5: Evaluate Energy Management Strategies used in hybrid & electric vehicle

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	1	-	-	1	-	-	-	-	1
CO2	1	1	1	-	1	1	-	-	-	-	1
CO3	3	2	3	2	2	2	-	-	-	-	1
CO4	2	1	2	1	1	2	-	-	-	-	1
CO5	3	3	3	3	3	2	-	-	-	-	1

UNIT – I

Introduction:

Introduction to Hybrid Electric Vehicles: History of hybrid & electric vehicles, social & environmental importance of hybrid & electric vehicles, impact of modern drive-trains on energy supplies-Challenges & Key Technologies of EVs – Challenges for EV Industry in India.

UNIT – II

Electric Drive-trains:

Basic concept of electric traction - introduction to various electric drivetrain topologies - Power flow control in electric drive-train topologies - fuel efficiency analysis

Electric Propulsion unit:

Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, configuration and control of Induction Motor drives,

configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.

UNIT – III

Energy Storage:

Introduction to Energy Storage Requirements in Hybrid & Electric Vehicles -Battery based energy storage & its analysis - Fuel Cell based energy storage & its analysis - Super Capacitor based energy storage- Flywheel based energy storage & its analysis.

UNIT – IV

Sizing the drive system:

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

UNIT – V

Energy Management Strategies

Introduction to Energy Management Strategies used in hybrid & electric vehicle, Classification of different Energy Management strategies - Comparison of different Energy Management Strategies - Implementation issues of energy strategies - Effect of charging infrastructure on grid protection & control.

Text Books:

1 Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley-Blackwell (ISBN: 9781119942733).
2 Energy Management Strategies for Electric & Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer (ISBN: 9781493955237).

Reference Books:

1 Electric Vehicle Battery Systems, Sandeep Dhameja, Elsevier (ISBN: 9780750699167).
2 Advanced Electric Drive Vehicles, Ali Emadi, CRC Press (ISBN: 9781138072855).
3 Hybrid electric Vehicles Principles & applications with practical perspectives, Chris Mi,M. Abul Masrur, D. Wenzhong Gao, A Dearborn, John Wiley & Sons Ltd (ISBN: 9781118970560).

Web Links:

1 https://nptel.ac.in/courses/108102121

2 https://nptel.ac.in/courses/108103009
3 https://www.nrel.gov/research/transportation-hybrid-electric.html

Organizational Behaviour

Course Code: 2501ME73

L	P	T	C
3	0	0	3

Course Outcomes:

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

CO1: Explain the roles, approaches of organizational behaviour models.
CO2: Summarize the behaviour of individuals and groups in organizations in terms of organizational behaviour.
CO3: Illustrate various stress and emotional organizational behaviour concepts, models and theories to real life management situations.
CO4: Analyze the functions of organizational communication and culture for effective communication and managing cultural diversity
CO5: Organize different groups and teams in the organization for better results.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	1	3	2	-	-
CO2	-	-	-	-	-	-	1	3	2	-	-
CO3	-	-	-	-	-	-	1	2	3	-	-
CO4	-	-	-	-	-	-	1	2	3	-	-
CO5	-	-	-	-	-	-	1	3	2	-	-

UNIT – I

Organizational Behaviour: Concept of Organizational Behaviour (OB)- Importance of Organizational Behaviour- Key Elements of Organizational Behaviour, Role of Managers in OB- Interpersonal Roles-Informational Roles- Decisional Roles, Approaches to Organizational Behaviour

UNIT – II

Interpersonal Behaviour: Nature and meaning of Interpersonal Behaviour, Concept of Self, Transaction Analysis (TA), Benefits and uses of Transactional Analysis, Johari Window Model

Personality: Definition and Meaning of Personality - Importance of Personality, Determinants of Personality, Theories of Personality, Personality Traits Influencing OB.

UNIT – III

Emotions: Nature and Meaning of Emotions - Characteristics of Emotions, Theories of Emotions, Emotions in the Context of OB. Organizational Stress: Definition and Meaning, Sources of Stress, Types of Stress, Impact of Stress on Organizations, Stress Management Techniques.

UNIT – IV

Organizational Communication: Meaning and Importance of Communication, Functions, process, types, Interpersonal Communication, Organizational Communication, Tips for Effective Communication.

Organization Culture: Meaning and Nature of Organization Culture – Origin of Organization Culture, Functions of Organization Culture, Types of Culture, Creating and Maintaining Organization Culture, Managing Cultural Diversity

UNIT – V

Groups and Teams: Meaning and Importance of Groups, Reasons for Group Formation, Types of Groups, Stages of Group Development, Meaning and Importance of Teams, Types of Teams, Creating an Effective Team.

Text Books:

1. Organizational Behaviour, K. Ashwathappa, Himalaya Publishing House, ISBN-13. 978-8184889390.
2. Management and Organizational Behaviour - (Text and Cases), Dr.P.Subba Rao and Prof. N.Sambasiva Rao, Himalaya Publishing House, Mumbai, ISBN: 978-93-5024-951-2.

Reference Books:

1. Understanding Organisational Behaviour, Udai Pareek, Oxford Higher Education, 2nd Edition, ISBN-13: 978-0195690866
2. Mc Shane & Von Glinov, Organisational Behaviour, Tata McGraw Hill, 4th Edition, ISBN-13, 978-1259927676.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_mg51/preview

2. https://www.udemy.com/course/organisational-behaviour/

Sustainable Energy Systems

Course Code:2501ME36	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Demonstrate the various components of solar thermal energy systems.
CO2: Describe the working of Wind turbines.
CO3: Explain the principle and working of Biomass and Geothermal Energy systems
CO4: Explain the Ocean, Tidal, Wave and hydro energy conversion systems.
CO5: Illustrate working of hybrid energy systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	3	-	-	-	-	-
CO2	2	-	-	-	-	3	-	-	-	-	-
CO3	2	-	-	-	-	3	-	-	-	-	-
CO4	2	-	-	-	-	3	-	-	-	-	-
CO5	2	-	-	-	-	3	-	-	-	-	-

UNIT – I

Introduction to Renewable energy sources: Energy demand and availability, energy crisis, renewable and non-renewable energy resources, environmental impact of conventional energy usage.

Solar Energy: Overview of the fundamental physics of solar radiation. Solar energy collectors.

Solar energy storage: Stratified storage, well mixed storage, comparison, Hot water system, solar ponds, non-convective solar pond, extraction of thermal energy and application of solar ponds.

Solar PV systems and its applications. Solar cell, module, and array.

UNIT – II

Wind Energy: Wind data and energy estimation – Betz limit - Site selection for windfarms. Horizontal and vertical axis wind mills, Wind farms- offshore, Onshore, various methods of control, and Environmental issues - Applications

UNIT – III

Biomass: Bio-resources, Conversion process, Biomass gasifier - Types of biomass gasifiers, Biodiesel production – Ethanol production -Applications.

Geothermal Energy: Origin and types of geothermal energy and utilisation, Power generation from Geothermal energy, Environmental impact.

UNIT – IV

Ocean, Wave & Tidal Energy: Introduction - Resource Assessment - Power generation through OTEC systems. Wave and Tidal energy- Working principle, Availability, and energy conversion systems.

Mini & Micro Hydropower: Introduction, Power from water, System components of Mini and Micro Hydropower, Micro Hydropower plant in India, Potential Hydropower plant projects identified in India.

UNIT – V

Hybrid Energy Systems: Systems for processes and power applications – solar – wind – Biomass hybrid technologies

Fuel cell: Working principle- types - construction and applications. Solar – Fuel cell hybrid systems.

Text Books:

1. Renewable Energy: Power for a Sustainable Future, Boyle, G, Oxford University Press, 3rd Edition,2012, ISBN : 9780199681273.
2. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, 6th edition, ISBN : 9788174090737.

Reference Books:

1. Renewable Energy Resources, John Twidell, Tony Weir, and Anthony D. Weir,Taylor & Francis,3rd edition,2015, ISBN : 9780415584388.
2. Non-Conventional Energy Resources, B H Khan, TMH Publishers, 3rd Edition,2017, ISBN : 9789352601882.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.energy.gov/eere/renewable-energy

Solar Energy Systems

Course Code: 2501ME37	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Explain the concept of solar radiation and its measurement
CO2: Describe the working principle of different types of collectors and its types
CO3: Explain the various solar thermal energy technologies and their applications
CO4: Analyze the various solar PV cell materials and conversion techniques.
CO5: Apply solar passive building techniques for cooling and heating applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	3	-	-	-	-	-
CO2	2	1	-	-	-	3	-	-	-	-	-
CO3	2	1	-	-	-	3	-	-	-	-	-
CO4	2	1	-	-	-	3	-	-	-	-	-
CO5	2	1	-	-	-	3	-	-	-	-	-

UNIT – I

Solar Radiation and its measurement: Solar angles, Sun path diagrams, Radiation, extraterrestrial characteristics, Solar energy measuring instruments: Pyranometer, Pyrheliometer, Sunshine recorder. Estimation of average solar radiation and estimation on horizontal and tilted surfaces

UNIT – II

Solar Collectors for Industrial process heat: Flat plate collector, Materials for flat plate collector and their properties, classification, evacuated tubular collectors, concentrator collectors, tracking systems, compound parabolic concentrators, parabolic trough concentrators, concentrators with point focus, Heliostats.

UNIT – III

Solar Thermal Technologies: Working principle, types, design, and operation, Solar heating and cooling systems, Thermal Energy storage systems, Solar Desalination, Solar cooker, Solar Pond, Solar drying, Solar chimney, Solar water disinfection (SODIS), Solar furnaces.

UNIT – IV

Solar Cells: Semiconductor materials, Doping, PN junction and characteristics, Photovoltaic effect, Photovoltaic material, Parameters of solar cells, Effects of cell temperature on cell efficiency, Types of solar cells, Solar modules and arrays, Solar cell power plant, Silicon, thin film and polymer processing, Silicon wafer based solar cells, Hybrid organic- inorganic solar cells.

UNIT – V

Solar Passive Architecture: Thermal comfort, bioclimatic classification.

Passive heating concepts: direct heat gain, indirect heat gain, isolated gain and sunspaces

Passive cooling concepts: evaporative cooling, Radiative cooling, shading - paints and cavity walls for cooling, roof radiation traps, thermal comfort.

Text Books:

1. Solar Energy-Principles of Thermal Collection and Storage, S P Sukhatme & J K Nayak, McGraw Hill Education, 3rd Edition,2009, ISBN : 9780070142961.
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Krieth and Jan F. Kreider Taylor and Francis, 2nd Edition,2000, ISBN : 9781560327141.

Reference Books:

1. Solar Energy- Fundamentals, Design, Modelling and Applications, G.N.Tiwari, Narosa publishing house. 1st Edition, 2002, ISBN : 9780849324093.
2. Solar Energy and Non-conventional Energy Sources, Domkundwar, Dhanpat Rai & Co, (P) Ltd., 2nd Edition, ASIN : B0BQWR83GF

Web Links:

1. https://archive.nptel.ac.in/courses/115/103/115103123/
2. https://www.nrel.gov/research/re-solar.html

Composite Materials

Course Code: 2501ME60	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Classify the composites with types of fibers and matrices, and applications of composites

CO2: Evaluate mechanical properties of composite materials using macro and micro mechanics

CO3: Develop suitable Metal Matrix Composites

CO4: Explain Polymer Matrix Composites with applications

CO5: Discuss various Ceramic Matrix Composites for high temperature applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	1	-	-	-	-	-
CO2	2	3	-	-	2	-	-	-	-	-	-
CO3	3	-	2	-	-	1	-	-	-	-	-
CO4	2	-	2	2	-	3	-	-	-	-	-
CO5	3	-	1	2	-	2	-	-	-	-	-

UNIT – I

Introduction to composites

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Types of Reinforcement and Matrix, Carbon and Glass. Reinforcements – particles – fibres. Effect of reinforcement - volume fraction – rule of mixtures

UNIT – II

Evaluation of Mechanical Properties

Micromechanical analysis of lamina –Volume and mass fraction, density and void content – Evaluation of Elastic modulii, Ultimate strength of unidirectional lamina. Macro mechanical analysis of laminates – Laminate code, Stress strain relations – In plane and Flexural modulu.

UNIT – III

Metal Matrix Composites (MMC)

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Processing of MMC – powder metallurgy process- diffusion bonding – stir casting – squeeze casting, In-situ reactions-Interface-measurement of interface properties applications of MMC in aerospace, automotive industries

UNIT – IV

Polymer Matrix Composites

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. Processing of thermoset matrix composites, thermoplastic matrix composites, structure and properties, structural defects, mechanical properties and applications

UNIT – V

Ceramic Matrix Composites (CMC)

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres, whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing), applications of CMC in aerospace, automotive industries-Carbon /carbon composites

Text Books:

1. Composite Material Science and Engineering, Krishan K , Chawla, Springer, 2nd Edition, 2015, ISBN 9788132233442 : .
2. Composite Materials: Engineering and Science , Mathews F. L. and Rawlings R. D, Chapman and Hall, London, England, 1st Edition, ISBN : 9781855734739.

Reference Books:

1. Composite Materials Science and Applications, Deborah D.L. Chung, Springer London Ltd, 2nd Edition, 2010, ISBN9781848828308 : .
2. Composite Materials Design and Applications, Daniel Gay, Suong V. Hoa & Stephen W. Tsai, CRC Press, 1st Edition, 2002, ISBN : 9781587160844.

Web Links:

1. https://nptel.ac.in/courses/112104229
2. https://www.coursera.org/learn/ceramics-and-composites.

Communication Systems

	L	T	P	C
Course Code:2501EC82	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Summarize the functional blocks of a communication system.
CO2: Illustrate the working principle of amplitude modulation and demodulation.
CO3: Compare different types of amplitude modulation.
CO4: Analyse the generation and detection of FM and PM signals.
CO5: Classify the radio transmitter and receivers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT- I

Introduction: Definition of Signal, Types of signals, Fourier Transform (FT), Inverse Fourier Transform (IFT) and their properties, Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing (FDM).

UNIT-II

Amplitude Modulation: Introduction to Amplitude Modulation (AM), Square law modulation, Envelope detector, Spectrum of AM Signals, Power and Power Efficiency of AM, Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Balanced modulator, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation and VSB modulation.

UNIT-III

Angle modulation: Introduction, Phase Modulation, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Direct Method of FM generation, Phase locked loop, Comparison of FM and AM.

UNIT-IV

Radio Transmitters and Receivers: Introduction, Classification of Transmitters, AM Transmitter, Variable Reactance type FM Transmitter, Radio Receiver types, TRF Receiver, Super heterodyne Receiver, FM receiver, Comparison of AM and FM receivers.

UNIT-V

Pulse Modulation: Need for Digitizing Analog information, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Time Division Multiplexing, Introduction to Pulse Code Modulation and Delta Modulation.

Text Books:

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, TMH, 3rd Edition, ISBN: 0070648115.
2. Communication Systems: Analog and Digital, R P Singh and S D Sapre, McGraw Hill India, Third Edition, ISBN: 1259004600.
3. Communication Systems – B. P. Lathi, BS Publication, ISBN: 8178000156.

Reference Books:

1. Principles of Communication Systems, Simon Haykin, John Wiley, 2nd Edition, ISBN: 0471178691.
2. Electronics & Communication System, George Kennedy and Bernard Davis, TMH, ISBN: 0071077820.
3. Analog and Digital Communications: Theory and Lab Work- Abhay Gandhi, Cengage, ISBN: 9788131525876.

Web Links:

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/
2. https://onlinecourses.nptel.ac.in/noc21_ee74/previewAnalog

Electronic Measurements & Instrumentation

	L	T	P	C
Course Code: 2501EC83	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Outline the performance characteristics of measuring Instruments.
CO2: Select signal generators for the given application.
CO3: Interpret the working principle of oscilloscopes.
CO4: Choose a suitable bridge for parameter measurement.
CO5: Make use of transducers for physical parameter measurement.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT-I

Performance Characteristics of Instruments:
static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, errors in measurement, Dynamic characteristics- speed of response, fidelity, lag, dynamic error, DC voltmeters, multi range, range extension/Solid state and differential voltmeters, AC voltmeters- multi range, range extension, shunt, thermocouple type RF ammeter, Ohmmeters series type, shunt type, multi-meter for voltage, current, and resistance measurements.

UNIT-II

Signal Generators &Wave Analysers:
Fixed and variable, AF oscillators, standard and AF sine and square wave signal generators, Function generators, square, pulse, Random noise, sweep, arbitrary wave form, Wave Analysers, Harmonic distortion analysers, spectrum analysers, Digital Fourier analysers.

UNIT-III

Oscilloscopes:
CRT features, Vertical amplifiers, Horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits. Simple CRO, triggered sweep CRO, dual beam CRO, dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital

storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO, active and passive, attenuator type.

UNIT-IV

AC Bridges:
Measurement of Inductance, Maxwell's bridge, Anderson bridge, Measurement of Capacitance, Schering bridge, Wheatstone bridge, Wein bridge, Errors and precautions in using bridges, Q meter.

UNIT-V

Transducers:
Active and passive transducers, resistance, capacitance, inductance, strain gauges, LVDT, piezo electric transducers, Resistance thermometers, thermocouples, thermistors, Measurement of physical parameters-force, pressure, velocity, humidity, moisture, speed, proximity and displacement, data acquisition systems

Text Books:

1. Electronic Instrumentation, H.S.Kalsi, Tata MC Graw Hill, 2nd Edition, ISBN: 9780070702066.
2. Modern electronic Instrumentation and measurement techniques, A.D.Helfric, W.D.Cooper, PHI, 5th Edition, ISBN: 9332556067.

Reference Books:

1. Electronic Instrumentation and measurements, David A Bell, PHI, 2nd Edition, ISBN: 8120323602 .
2. Electronic test Instruments, Analog and digital measurements, Robert A.Wittie, Pearson Education, 2nd Edition, ISBN: 817758748X.
3. Electronic measurements and Instrumentations, K.Lal Kishore, Pearson education, ISBN: 978-8131721995.

Web Links:
1. https://www.allaboutcircuits.com/textbook/alternating-current/chpt-12/ac-bridge-circuits/
2. https://www.science-ebooks.com/bridge-circuit.html

Introduction to Embedded Systems

	L	T	P	C
Course Code: 2501EC84	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1:** Summarize the building blocks of an Embedded system.
- **CO2:** Interpret the hardware modules required to design an Embedded system.
- **CO3:** Infer the firmware design approaches for an Embedded system.
- **CO4:** Examine to integrate hardware and firmware for an Embedded system.
- **CO5:** Design and program Embedded systems based on their applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	-	-	1	-	-	1	1	-	-
CO2	3	2	1	1	1	-	-	1	1	-	-
CO3	3	2	-	-	1	-	-	1	1	-	-
CO4	2	3	-	-	2	-	-	1	1	-	-
CO5	2	3	2	1	1	-	-	1	1	-	-

UNIT – I

Introduction:
Embedded System-Definition, History of embedded system, Characteristics of an embedded system, classification of embedded systems, Embedded System Architecture Quality attributes of embedded systems, Challenges in Embedded System Design, Examples of an embedded system.

UNIT – II

Designing Embedded Computing Platform:
Introduction to Processors & Controllers, Sensors, Actuators, Analog and digital electronic components, I/O types and examples, Memory Classification, Timer and counting devices, Watchdog Timers, RTC, Wireless Protocols.

UNIT – III

Embedded Firmware:
Classification of OS, Embedded Firmware design approaches & development languages, POSIX Thread Programming,Pre-processors, Interpreters, Compilers and Linkers, Debugging tools , C versus Embedded C, ALP Programming.

UNIT – IV

Real-Time Operating Systems:
Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.
Hardware Software Co-Design:
Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

UNIT – V

Embedded System Development:
The IDE, Types of files generated on cross- compilation, Deassembler/ Decompile, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.
Various wireless protocols and its applications: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. CAN, Programming in Embedded C, Embedded system design using Arduino.

Text Books:

1. Embedded Systems, Shibu.K.V, Tata McGraw Hill Education Private Limited, ISBN: 978-8131721995.
2. Computers as Components – Principles of Embedded Computing System Design, Marilyn Wolf, Morgan Kaufmann Publisher (An imprint from Elsevier), 3rd Edition, ISBN: 978-8131721995.

Reference Books:

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, ISBN: 0471386782 .
2. The Designer's Guide to the Cortex-M Processor Family - A Tutorial Approach, Trevor Martin, 1st Edition, Elsevier Science, ISBN: 032385494X.

Web Links:

1. http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf
2. http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf
3. http://www.vtt.fi/inf/pdf/publications/2004/P526.pdf

Fundamentals of Image Processing

Course Code: 2501EC85	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Infer the fundamental components of digital image processing.
CO2: Illustrate image Enhancement and Restoration techniques.
CO3: Infer the color image processing methods.
CO4: Illustrate various Morphological operations on images.
CO5: Interpret image segmentation techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT-I

Introduction: Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

UNIT-II

Image Enhancement and Restoration: Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods, A model of the image degradation/restoration process, Noise models, Inverse filtering, Minimum mean square error (Wiener) filtering.

UNIT-III

Color image processing: color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, noise in color images.

UNIT-IV

Morphological Image Processing: Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds

UNIT-V

Image segmentation: Fundamentals, point, line, edge detection, thresholding, and region – based segmentation, Image segmentation based on color.

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 3rd Edition, ISBN: 013168728X.
2. Fundamentals of Digital Image Processing, Anil K.Jain, Prentice Hall of India, Indian Reprint,9th Edition, ISBN: 013168728X.

Reference Books:

1. Digital Image Processing Jayaraman, S. Esakkirajan, and T. Veerakumar, Tata McGraw-Hill Education, ISBN: 013168728X.
2. Digital Image Processing and Analysis, B.Chanda, D.Dutta Majumder, PHI, ISBN: 9788120343252.

Web Links:

1. http://www.imageprocessingplace.com/.
2. http://nptel.ac.in/courses/117105079/
3. https://sisu.ut.ee/imageprocessing/avaleht
4. https://www.coursera.org/learn/digital#ratings
5. https://www.coursera.org/courses?languages=en&query=image+processing

Sensors & Transducers

	L	T	P	C
Course Code: 2501EC77	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1:** Illustrate the fundamental concepts of energy transformation in Sensors.
- **CO2:** Infer the thin film physics, deposition techniques and Photolithography.
- **CO3:** Summarize the design and fabrication process of Micro sensors.
- **CO4:** Outline the Characteristics of Transducers.
- **CO5:** Summerize the Basic Knowledge different types of Transducers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	1
CO2	3	1	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	1
CO4	2	2	3	-	-	-	-	-	-	-	1
CO5	1	1	3	-	-	-	-	-	-	-	1

UNIT – I

Basics of Energy Transformation: Transducers,Sensors, Understanding of thin film physics: Application in MOSFET and its variants. Thin Film Deposition Techniques: Chemical Vapor Deposition (PECVD, MOCVD), Physical Vapor Deposition (Thermal Deposition, Sputtering, Pulsed Laser Deposition).

UNIT – II

Basic understanding of Photolithography for pattering layer. Detailed overview of Etching methods. Understanding various gas sensors: Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor.

UNIT – III

Micro sensors:s
Force Sensors, Pressure Sensors, Strain gauges and practical applications. Working principles of Actuators. Piezoelectric, Piezo resistive actuators.

UNIT – IV

Characteristics Of Transducers:
Static characteristics, dynamic characteristics, mathematical model of transducer, zero, first order and second order transducers – response to step, ramp and sinusoidal inputs.

UNIT – V

Resistive, Inductive and Capacitance Transducers- Potentiometer, Strain gauge, LVDT, variable reluctance transducers, Proximity transducers, capacitive transducer, Capacitor microphone.

Text Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN:9780471332329.
2. Sensors and Transducers, D. Patranabis , 2nd Edition, ISBN:9788120321984.

Reference Books:

1. Sensors and Signal Conditioning , Ramon Pallàs – Areny and John G. Webster, Wiley-Blackwell, 2nd Edition, ISBN:9780471332329.
2. Instrument transducers, H.K.P. Neubert, Oxford University press. 2nd Edition, ISBN:9780195629972.

Web Links:

1. https://nptel.ac.in/courses/108108147
2. https://nptel.ac.in/courses/108102191

Data Structures

	L	T	P	C
Course Code:2501CS03	**2**	**0**	**2**	**4**

Course Outcomes:

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

CO1: Utilize structure, union and file operations to handle heterogeneous data.
CO2: Illustrate Time and Space complexities for different searching and sorting Algorithms
CO3: Demonstrate various operations on Linked Lists
CO4: Explain different operations on Stack and Queue with applications.
CO5: Demonstrate the importance and various operation on non-linear data structures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	2	-	-	-	-	-	1	1	-
CO2	1	1	2	2	-	-	-	-	1	1	-
CO3	1	2	2	1	-	-	-	-	1	1	-
CO4	1	1	2	1	-	-	-	-	1	1	-
CO5	1	1	2	2	-	-	-	-	1	1	-

UNIT – I

Structures and Unions: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files.

Practice:

1. Write a C program to find the total, average of n students using structures
2. Copy one structure variable to another structure of the same type.
3. Read student name and marks from the command line and display the student details along with the total.

UNIT – II

Introduction to Linear Data Structures: Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.

Sorting Techniques: Quick sort, Merge sort, Radix sort.

Practice:

1. Implement Merge sort using arrays.
2. Implement Quick sort using arrays

3. Implement Radix Sort using arrays

UNIT – III

Linked Lists: Singly linked lists: representation and operations, doubly linked lists and its operations and circular linked lists and its operations, Comparing arrays and linked lists, Applications of linked lists

Practice:

1. Single Linked List: Perform different operations in single linked list.
2. Reversing a single linked list
3. Perform different operations in double linked list
4. Circular Linked List

UNIT – IV

Stacks: Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

Queues: Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

Practice:

1. Stack and its operations using arrays and Linked List
2. Implement a program to evaluate a postfix expression.
3. Queue and its operations using arrays and Linked List
4. Implement Circular Queue using Arrays

UNIT – V

Non-linear Data Structures:

Trees: Difinition of tree, Tree Terminology, types of trees, Binary tree traversals, Binary Search Tree – Insertion, Deletion.

Graphs: Definition and Terminology – Representation of Graphs-Adjacency Matrix and Linked list, Graph Traversals (BFT & DFT)

Practice:

1. Implement Binary search tree (BST).
2. Implement Binary search Tree (BST) Traversals.
3. Graph Traversal using Breadth First Search (BFS)
4. Graph Traversal using Depth First Search (DFS)

Additional Practice:

1. Using a structure for transporting some boxes through a tunnel
2. Delete duplicate-value nodes from a sorted linked list
3. Convert an infix expression into postfix expression
4. De Queue Implementation

Text Books:

1. Programming in C, Rema Theraja, Oxford, 3rd Edition. ISBN: 978-9354979453
2. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

Reference Books:

1. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407
3. Data Structures Using C,Reema Thareja, Oxford University Press, 2nd Edition. ISBN:978-0198099307

Web Links:

1. https://nptel.ac.in/courses/106102064
2. https://archive.nptel.ac.in/courses/106/105/106105225/
3. https://www.udemy.com/topic/data-structures/
4. https://www.coursera.org/specializations/data-structures-algorithms
5. https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html

Computer Organization

	L	T	P	C
Course Code:2501CS65	**2**	**0**	**1**	**3**

Course Outcomes:

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

CO1: Differentiate types of computers by their functionalities and performances.
CO2: Demonstrate number representations and I/O operations performed in Computer.
CO3: Illustrate types of various memory devices.
CO4: Implement arithmetic operations.
CO5: Simulate basic CPU operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	1	1	-	-	1	-	-	1
CO2	2		1	-	-	-	-	1	1	-	-
CO3	2	1	1	-	-	-	-	1	-	-	-
CO4	2	1	1	-	-	-	-	1	1	-	1
CO5	2	1	1	-	-	-	-	1	1	-	-

UNIT – I

Basic Structure of Computers: Types of computers, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance, Multiprocessors and Multi-computers, Historical Perspective.

Practice:

1.Exploring various types of Computers and their functional Units.

UNIT – II

Machine instructions and Programs: Numbers, Arithmetic Operations and Characters, Memory Locations and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes.

Input/output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces.

Practice:

1.Design of Registers and counters.

UNIT – III

The Memory System: Some Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed Size and Cost, Cache Memories, Performance Considerations, Virtual Memories, Memory Management Requirements.

Practice:

1.Design of memory on simulator

UNIT – IV

Secondary Storage Arithmetic: Addition and Subtraction of Signed Numbers, Multiplication of Positive Numbers, Signed-Operand Multiplication, Integer Division, Floating Point Numbers and Operations, Implementing Floating Point Operations.

Practice:

1.Design Booth's Multiplier.

UNIT – V

Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control.

Microprogrammed Control Pipelining: Basic Concepts, Data Hazards, Instruction Hazards, Influence on Instruction Sets, Data Path and Control Considerations, Super Scalar Operation.

Practice:

1.Simulate basic operation on CPU.

Text Books:

1. Computer Organization ,Carl Hamacher, McGraw Hill Publishers, 5th Edition., ISBN-13: 978-1259005275
2. Computer System Architecture, M. M. Mano, Prentice Hall of India,3rd Edition, ISBN-13. 978-8131700709.
3. Computer Organization and Architecture Designing for Performance, Wiiliam Stallings, Pearson Education, 8th Edition, ISBN-13. 978-0136073734.

Reference Books:

1. Computer Architecture and Organization, John P Hayes, McGraw-Hill, 3rd revised Edition, ISBN-13. 978-1259028564.
2. Computer Organization and Architecture, Ghosh T. K., Tata McGraw-Hill, Third Edition, ISBN: 9780071329071.

Web Links:

1. https://www.classcentral.com/course/swayam-computer-organization-andarchitecture-a-pedagogical-aspect-9824
2. https://www.udemy.com/course/introduction-to-computer-organization/
3. https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials
4. http://vlabs.iitkgp.ac.in/coa/#

Operating Systems

	L	T	P	C
Course Code:2501CS13	**2**	**0**	**1**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Describe the basic concepts of operating system and their structures.
CO2: Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
CO3: Interpret the issues and challenges of memory management.
CO4: Synthesize the concepts of Disk management and file system implementation.
CO5: Explain the issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	1	-	-
CO2	1	3	-	1	-	-	-	-	2	-	1
CO3	1	3	-	1	-	-	-	-	2	-	1
CO4	1	3	-	1	-	-	-	-	1	-	1
CO5	2	2	-	-	-	-	-	-	1	-	-

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.

Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication.
Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.
Multithreaded Programming: Multithreading models, Thread libraries, Threading issues
Case Study: The above topics are discussed as case study in Windows/ Unix OS
Practice:

1. Simulate the following CPU scheduling algorithms: FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.
Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.
Case Study: The above topics are discussed as case study in Windows/ Unix OS
Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.
Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.
File Systems: Files, Directories, File system implementation, management and optimization.
Case Study: The above topics are discussed as case study in Windows/ Unix OS
Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm

4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.
System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.
System Security: Introduction, Program threats, System and network threats.
Practice:

1. The above topics are discussed as case study in Windows/ Unix OS.

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725
2. William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 7th Edition. ISBN: 978-93325018803

Reference Books:

1. Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition.ISBN: 978-0136006633
2. Operating Systems A Concept Based Approach, Dhamdhere D M, Tata McGraw-Hill, 3rd Edition.ISBN: 978-1259005589
3. Operating Systems, Nutt G,Pearson Education, 3rd Edition,. ISBN: 978-8131723593

Web Links:

1. https://archive.nptel.ac.in/courses/106/106/106106144/
2. https://archive.nptel.ac.in/courses/106/105/106105214/
3. https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems
4. http://www.geeksforgeeks.org/operating-systems/
5. https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923

Database Management Systems

	L	T	P	C
Course Code: 2501IT05	**2**	**0**	**2**	**4**

Course Outcomes:

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

CO1: Describe the Fundamental concepts of DBMS.
CO2: Interpret relational database using SQL.
CO3: Make use of normalization techniques for database design.
CO4: Illustrate the mechanisms of transaction management.
CO5: Optimize database performance with advanced indexing, query optimization, and robust backup and recovery strategies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	3	-	1	-	-	1	-	-	-
CO2	3	3	3	2	2	1	-	1	-	-	-
CO3	3	3	3	3	3	2	-	-	-	-	1
CO4	3	3	3	1	2	1	-	-	-	-	
CO5	3	3	3	3	3	2	-	-	-	-	2

UNIT – I

Introduction to DBMS: History and Architecture, Data Independence, Data Models, Levels of abstraction, structure of DBMS.

Data Models : Concepts of Schema, Instance and data independence, Three tier schema architecture for data independence, Database system structure, environment, Centralized and Client Server architecture for the database.

Practice

1. Familiarization with installation of any DBMS.

2. Implementing a University Database System.

UNIT – II

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance.

BASIC SQL: Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).

Practice

1. Querying and modifying the database using Data Manipulation Language commands -select, insert, update, delete.

2. Implementation of Aggregate Functions – sum, avg, min, max, count. Use group-by and having clause.

UNIT – III

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

SQL: Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updatable and non updatable), relational set operations.

Practice

1. Perform join operations – natural join, equi-join, outer join, left outer join, right outer join, inner join and assess the impact of query plans on the performance of join heavy queries.

2. Perform set operations - union, intersection, set difference.

3. Implementation of corelated sub-queries and nested queries.

4. Creating and querying views and materialized views.

UNIT – IV

Normalization: Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF), Fifth Normal Form (5NF).

Transaction Concept: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Storage, Recovery and Atomicity, Recovery algorithm.

Practice:

1.Implement SQL queries on a normalized database schema based on the provided schema. For this example: use the schema for a university database, which includes:

- Students (StudentID, StudentName, Major)
- Courses (CourseID, CourseName, Credits)
- Enrollments (StudentID, CourseID, EnrollmentDate)
- Instructors (InstructorID, InstructorName, Phone)
- Course_Instructors (CourseID, InstructorID)

2. (A)Implementation of Data Control Language commands – grant and revoke.

(B)Implementation of Transaction Control Language commands - commit, save point, and rollback.

UNIT – V

Indexing Techniques: Introduction, B+ Trees: Search, Insert, delete algorithms, File Organization and Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing: Tree base Indexing, Comparison of File Organizations.

Database Tuning: Introduction, Database Performance Tuning, Query Optimization: Introduction, Query Optimization algorithms, Backup and Recovery.

Practice

1. Create a Primary, Secondary Index on a Column.
2. Retrieve Data Using an Index.
3. Insert Data and Update Indexes.
4. Delete Data and Impact on Indexes.

*** Note: The student must Complete & Submit a Database Foundations Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

1 Database System Concepts ,Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill , 8th Edition., ISBN-13: 978-1260230508.

2 Database Management Systems, Raghurama Krishnan, Johannes Gehrke, Mc Graw-Hill, 4th Edition, ISBN: 978-1260091195.

Reference Books:

1 Database Systems, Ramez Elmasri, Shamkant B. Navathe, 7th Edition, Pearson, ISBN: 978-0137504277.

2 Database Systems, Carlos Coronel, Steven Morris, Peter Rob, 10th Edition, Cengage, ISBN: 978-0357517864.

3 Introduction to Database Systems, C J Date, Pearson, 9th Edition, ISBN: 978-0133970777.

Web Links:

1 https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Database%20Foundations%20Course%20Description.pdf

2 https://www.w3schools.com/sql/

3 https://onlinecourses.nptel.ac.in/noc22_cs91/

Agile Software Engineering

	L	T	P	C
Course Code: 2501IT007	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
- **CO2:** Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
- **CO3:** Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.
- **CO4:** Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
- **CO5:** Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	2	-	-	-	-	-	-
CO2	3	2	1	1	-	-	-	2	2	2	1
CO3	2	1	1	-	-	-	-			2	1
CO4	3	2	2	1	-	-	-	2	2	2	1
CO5	1	2	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths

Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.

Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.

Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation

Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring ,Refactoring Techniques, Continuous Integration, Automated build tools, Version control.

Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Text Books:

1 Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.

2 Agile Software Development, Current Research and Future Directions‖, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

1 Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.

2 Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results‖, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609

Web Links:

1 https://www.tutorialspoint.com/software_engineering/

2 https://www.sciencedirect.com/science/article/pii/S0950584916303329

Computer Networks

	L	T	P	C
Course Code:2501CS07	**2**	**0**	**1**	**3**

Course Outcomes:

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

CO1: Describe network topologies, reference models and media for data transmission
CO2: Analyze error and flow control issues in data link layer
CO3: Classify MAC protocols and channelization techniques
CO4: Apply routing algorithms and congestion control techniques for effective data transmission
CO5: Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	1	1	
CO4	1	2	2	-	-	-	-	-	2		1
CO5	-	1	-	-	1	-	-	-	-	-	1

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:

1. Study of Network devices in detail and connect the computers in Local Area Network

UNIT – II

Data Link Protocols: framing and data transparency, error detection & correction, flow control.

Practice:

1. Write a Program to implement the data link layer farming methods such as i) Character stuffing ii) bit stuffing.

UNIT – III

Media Access Control: Random Access: ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA).

Practice:

1. Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

Congestion Control algorithms: General principles of congestion control, Congestion prevention polices, Approaches to Congestion Control, Traffic Aware Routing, Admission **Control, Traffic Throttling:**Load Shedding

Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implements routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP.

Capstone project:

Simulate and implement data link layer protocols and network routing strategies using NS2 (Network Simulator 2). It includes configuring network topologies, setting up routing protocols like AODV, DSDV, and OLSR, and analyzing their performance through metrics such as throughput, delay, and packet delivery ratio. Additionally, explore the simulation of data link layer functionalities, including MAC addressing and error detection. You may use NS2's capabilities, that insights into the behaviour of

network protocols, aiding in the design and optimization of efficient communication systems.

Text Books:

1	Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
2	Data Communications and Networking – Behrouz A.Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

Reference Books:

1	Data Communications and Networks- Achut S Godbole, AtulKahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7
2	Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

1	https://nptel.ac.in/courses/106105081
2	https://www.coursera.org/learn/fundamentals-network-communications

Java Programming

	L	T	P	C
Course Code:2501IT06	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1:** Apply Java features for problem solving.
- **CO2:** Build applications using principles of OOPs, interfaces and Packages.
- **CO3:** Develop programs using Exception Handling to handle run-time errors.
- **CO4:** Develop applications using multithreading for inter thread communication.
- **CO5:** Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	-	1	-	-	-	1	2	1
CO2	2	1	3	-	1	-	-	-	1	2	1
CO3	2	3	2	-	1	-	-	-	1	2	1
CO4	2	2	2	-	1	-	-	-	1	2	1
CO5	2	2	3	-	1	-	-	-	1	2	1

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. **Control Statements**

   a. Select all the prime numbers within the range of 1 to 100.
   b. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
   c. Check whether a given number is Armstrong or not.

2. Arrays

a. Sort an array of integers in ascending order.
b. Find the maximum and minimum element in an array.
c. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor.

Keywords: this, static and final, String Class and its Methods, StringTokenizer, StringBuffer and StringBuilder.

Practice:

1. Class Mechanism

a. Display the details of a person. Personal details should be given in one method and the qualification details in another method.
b. Implement constructor and constructor overloading.
c. Implement method overloading.

2.Strings

a. Check if a given string is a pangram (contains every letter of the alphabet at least once).
b. Find the most frequently occurring character in a string.
c. Find all permutations of a given string.
d. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super( ), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch.**Interfaces:** Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

a. Implement multi-Level Inheritance.
b. Implement multiple Inheritance.
c. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferReader and BufferWriter, Wrapper Classes.

Practice:

1. Packages & java.io

a. Import and use user defined package.
b. Illustrate the use of protected members in a package.

c. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

a. ArrayList and LinkedList
b. Iterator and Iterable
c. Comparator and Comparable
d. HashMap and TreeMap
e. HashSet and TreeSet
f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.
Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.
Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.
Practice:

1. Exception Handling

a. Illustrate exception handling mechanism using multiple catch clauses.
b. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

a. Creates threads by extending Thread class. First thread display "Good Morning "every 1 sec, the second thread displays "Hello "every 2 seconds and the third display "Welcome" every 3 seconds, (Repeat the same by implementing Runnable).
b. Solve Producer-Consumer problem using synchronization.

3. JDBC

a. CRUD operations.

Additional Practice:

1. Student Management
2. Inventory Management
3. Phone book Management

*** Note: The student must Complete & Submit a Java Programming Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition, ISBN 978-1260440232.
2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition. ISBN: 9780199459643.

Reference Books:

1. Introduction to java programming, by Y Daniel Liang, Pearson, Seventh Edition. ISBN: 978-8131729588
2. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press.ISBN: 978-9351199250

Web Links:

1. https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf
2. https://nptel.ac.in/courses/106/105/106105191/
3. http://java.sun.com/docs/books/tutorial/

Fundamentals of RedHat Enterprise Linux

	L	T	P	C
Course Code:2501CS68	**0**	**0**	**2**	**2**

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

CO1: Apply basic and advanced Linux commands to install RHEL, manage files, and edit text using the command line.
CO2: Explain how to manage users, processes, services, and network settings in a Linux environment.
CO3: Describe how file permissions work and how software packages are managed in a Linux system.
CO4: Analyze system performance and configure basic network services in a Linux environment.
CO5: Implement remote administration and system maintenance tasks to ensure security and stability in a Linux environment.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	2	-	3	-	-	-	-	-	2
CO2	3	2	2	-	2	-	-	-	-	-	2
CO3	3		2	-	2	-	-	-	-	-	1
CO4	3	3	2	2	2	-	-	-	-	-	2
CO5	3	2	2	-	3	-	-	-	-	-	2

Practice:

1. **Installation and Basic Commands**
   a. Install RHEL: Set up RHEL on your system, configure installation options, and create user accounts.
   b. Execute Basic Commands: commands like `ls`, `cd`, `pwd`, and `man
2. **File Management and Text Editing**
   a. File and Directory Management: Explore `mkdir`, `cp`, `mv`, and `rm`.
   b. ext Editing: Use `nano` or `vim` to create and modify text files.
3. **Advanced Command Line Operations**

a) Redirection and Pipes: Understand `>`, `>>`, `|`.

b) Wildcards: Learn about `*`, `?`.

4. **User and Group Management**

   a. User Accounts: Create, modify, and delete users.

   b. Groups and Permissions: Understand ownership and permissions.

5. **Process and Service Management**
    a. Process Management: Explore `ps`, `top`, and `kill`.
    b. Services**: Start, stop, and manage services (daemons).
6. **Network Configuration and Security**
    a. Network Interfaces: Configure network settings (`ifconfig`, `ip`).
    b. Firewalls and Security: Learn about `firewalld` and network services.
7. **File System Permissions**
    a. File Permissions: Master `chmod`, `chown`.
    b. Access Control Lists (ACLs): Understand extended permissions.
8. **Software Packages and Updates**
    a. Package Management: Use `yum` or `dnf` to install, update, and remove software.
    b. Repositories and Dependencies: Explore package sources.
9. **Server Analysis and Support**
    a. Performance Analysis: Use tools like `top`, `htop`, and system logs.
    b. Seeking Support: Understand how to get help from Red Hat or the community.
10. **Network Services Configuration**
    a. Static IP Addresses: Configure networking.
11. **Remote Administration with SSH**
    a. SSH: Secure remote access using key-based authentication.
    b. Secure Communication: Understand encryption.
12. **System Maintenance and Security**
    a. Maintenance Tasks: Perform backups, log rotation, and routine maintenance.
    b. Security Updates: Regularly apply patches and keep the system secure.

Additional Practice

1. **Basic Shell Commands Practice**

Objective: Familiarize yourself with basic shell commands by performing file operations, navigating directories, and manipulating text files.

Skills: Command-line proficiency, file management, text processing.

2. **User and Group Management**

Objective: Learn to manage users and groups on a Linux system by adding, modifying, and removing users, and setting permissions.

Skills: User account management, permission setting, group policies.

3. **Package Management**

Objective: Learn to use the package manager of your Linux distribution to install, update, and remove software packages.

Skills: Familiarity with apt, yum, or pacman, software lifecycle management.

Text books:

1 Redhat Enterprise Linux 9, Vishesh kumar, Gitanjali Mehra

Reference Books:

1 The Linux Command Line: A complete Introduction 1st Edition by William E. Shotts
2 Linux command Line and Shell Scripting Bible 4th Edition by Richard Blum, Christine Bresnahan
3 Linux Administration: A Beginner's Guide, Eighth Edition by Wale Soyinka
4 Red Hat System Administration I (RH 124) by Red Hat Press

Web Links:

1 https://www.redhat.com/en/topics/linux
2 https://www.freecodecamp.org/news/manage-users-and-groups-in-rhel/
3 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html-single/configuring_and_managing_networking/index
4 https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/9/html/configuring_basic_system_settings/managing-file-system-permissions_configuring-basic-system-settings
5 https://www.cyberciti.biz/faq/redhat-network-interface-configuration/
6 https://www.koenig-solutions.com/red-hat-enterprise-linux-diagnostics-troubleshooting-training-certification

AWS Cloud Foundations

	L	T	P	C
Course Code:2501CS67	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Apply cloud cost estimation, user management, and security concepts using AWS tools and services.
- **CO2:** Explain the components and configuration of Virtual Private Cloud (VPC) and its security features in AWS.
- **CO3:** Describe how network access control, EC2 instances, and VPC peering are used to manage and secure cloud networks
- **CO4:** Implement serverless functions, website deployment, and storage services using AWS tools.
- **CO5:** Apply AWS services like EC2 snapshots, autoscaling, load balancing, and CloudFormation to manage cloud infrastructure.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	2	-	3	1	-	-	1	-	2
CO2	2	-	-	-	2	-	-	-	1	-	2
CO3	2	1	2	-	2	-	-	-	1	-	2
CO4	2	-	3	-	3	-	-	-	1	-	2
CO5	3	2	3	-	3	-	-	-	1	-	2

Practice:

1. a. Calculate Total Cost of Ownership
   b. Use AWS Pricing calculator to estimate multiple pricing models.
2. a. Differentiate between AWS and customer responsibilities using Shared Responsibility Model
   b. User Management using Identity and Access Management
3. a. Securing IAM user accounts.
   b. IPv4 and IPv6 implementation in cloud
4. a. Design Virtual Private Cloud
   b. Configure NAT gateway.
5. a. Implementing Internet Gateway in AWS Cloud
   b. Working with bastion host.

6. a. Create and manage Private & Public subnets.
   b. Secure VPC using Security Groups
7. a. Implement Network Access Control lists to control traffic.
   b. Build VPC and launch a web server.
8. a. Launch EC2 instances in two different regions and connect.
   b. Create multiple VPCs and peer them using VPC peering.
9. a. Create and trigger AWS Lambda functions.
   b. Use AWS lambda to automate EC2 instance behaviour.
10. a. Website deployment using AWS Elastic Beanstalk
    b. Working with Elastic Block Storage
11. a. Creating and working with EC2 snapshots.
    b. Configure autoscaling for application deployed in AWS Cloud
12. a. Load balance application deployed in AWS Cloud
    b. Basic implementation of Infrastructure as Code using AWS CloudFormation.

Additional Practice:

1. Working with Elastic File System
2. Working with S3 Buckets and Objects
3. Build a database server

Textbooks:

1 AWS Certified Cloud Practitioner study guide, Ben Piper & David Clinton.

Reference Books:

1 AWS Certified Cloud Practitioner cert guide, Anthony J Sequeira, by Pearson Education.

Web Links:

1 https://skillbuilder.aws/

2 https://aws.amazon.com/training/awsacademy/

AWS Cloud Development

	L	T	P	C
Course Code:2501CS66	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Explain the fundamentals of AWS CLI, SDKs, IAM, and core services like S3 and DynamoDB.
- **CO2:** Apply IAM policies, user/group management, and SDK tools to configure secure AWS environments.
- **CO3:** Develop RESTful APIs using API Gateway and Lambda functions in AWS.
- **CO4:** Deploy containerized applications using Docker and AWS managed services.
- **CO5:** Implement caching and content delivery solutions using Elasti Cache and CloudFront.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	-	3	-	-	-	1	-	2
CO2	3	3	3	-	3	-	-	-	2	1	2
CO3	3	3	3	2	3	1	-	1	2	2	3
CO4	3	3	3	2	3	1	-	1	2	2	3
CO5	3	3	3	2	3	1	-	1	2	2	3

Practice:

1. AWS CLI installation
2. Working with the AWS SDKs
3. Working with Amazon S3
4. Authenticating and Authorizing with IAM
5. Creating IAM Users and IAM Groups
6. Working with DynamoDB
7. Deploying an API
8. Monitoring a REST API
9. a. Developing REST APIs with API Gateway
   b. Creating Lambda Functions Using the AWS SDK for Python
10. a. Migrating a Web Application to Docker Containers
    b. Running Containers on a Managed Service
11. a. Caching Application Data with ElastiCache
    b. Implementing CloudFront for Caching and Application Security

Additional Practice:

1. Implementing a Messaging System Using Amazon SNS and Amazon SQS
2. Orchestrating Serverless Functions with Step Functions
3. Implementing Application Authentication Using Amazon Cognito
4. Automating Application Deployment Using a CI/CD Pipeline

Continuous Integration & Delivery using DevOps

	L	T	P	C
Course Code:2501CS70	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Recall basic concepts of Git workflows, Jenkins pipelines, and Docker image creation.
- **CO2:** Explain Docker and Kubernetes networking, storage, and orchestration of multi-container applications.
- **CO3:** Describe Helm, monitoring, and Ansible tools used in Kubernetes deployment and automation.
- **CO4:** Apply DevOps practices using Ansible, CI/CD pipelines, and Infrastructure as Code tools like Terraform.
- **CO5:** Implement centralized logging with ELK stack, visualize data using Grafana, and manage blue-green and canary deployments.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	2	-	-	-	-	-	2
CO2	3	2	2	-	3	-	-	-	-	-	2
CO3	3	2	2	-	3	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	2	2	2

Practice:

1. a. Working with Git branching strategies
   b. Handling Git merging and pull requests
2. a. Creating and managing Jenkins pipelines
   b. Building and deploying applications using Jenkins
3. a. Pipeline as code with Jenkins
   b. Docker file and image creation
4. a. Docker networking and storage
   b. Working with Docker compose for multi-container applications
5. a. Container orchestration with Docker swarm
   b. Kubernetes networking and storage
6. a. Deploying Helm package manager for Kubernetes

b. Monitoring and logging in Kubernetes

7. a. Working with roles and modules in Ansible
   b. Writing and managing Ansible playbooks
8. a. Integrating Ansible with other tools
   b. Cloud native DevOps practices
9. a. Setting up CI/CD pipelines in cloud
   b. Managing Infrastructure as Code with Terraform
10. a. Install and configure ELK stack for logging
    b. Centralized logging with ELK stack

11. a. Configuring Grafana for data visualization
    b. Blue-green and canary deployments

Additional Practice:

1. Monitoring applications with Prometheus
2. Container security best practices
3. Automated testing in DevOps

Textbooks:

1. Practical DevOps tools, Gilbert Fongan Toussido

Reference Books:

1. Practical DevOps tools, Gilbert Fongan Toussido

Web Links:

1. https://learning.lpi.org/en/

2.https://learning.lpi.org/en/learning-materials/all-materials/#devops-version-10

Fundamentals of Salesforce Administration

	L	T	P	C
Course Code: 2501IT24	**0**	**0**	**2**	**2**

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

- **CO1:** Describe custom object creation, formula fields, validation rules, and data relationships in Salesforce to support business logic and reporting.
- **CO2:** Recall basic workflow automation tools in Salesforce, including Workflow Rules and Flow Builder.
- **CO3:** Explain lead import using Data Loader and demonstrate user account setup and deactivation in Salesforce.
- **CO4:** Manage user roles, profiles, and permission sets in Salesforce to control data access and sharing
- **CO5:** Configure sharing rules and create reports in Salesforce to manage data visibility and support decision-making

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	-	3	-	-	-	-	-	2
CO2	3	2	-	-	2	-	-	-	-	-	2
CO3	3	2	-	-	3	-	-	-	-	-	2
CO4	3	2	3	-	3	-	-	-	1	2	2
CO5	3	3	3	2	3	-	-	-	1	2	2

Practice:

1. Customization of Object

a) Create a custom object "Position" to store all the open positions information and add below custom fields to the object.

Object Name: Position
Fields:

1. Position Name: Standard Field
2. Location: Picklist (Mandatory)
(LOV's: Hyderabad, Bangalore, Chennai, Pune, Mumbai, Noida, Delhi, Kochi).
3. Number Of Vacancies: Number (Max. of 2) (Mandatory)
4. Position Status: Picklist (Default : New Position)
(LOV's: New Position, Open Approved, In Progress, Recruited, On Hold, Closed)
5. Open Date: Date
6. MileStone Date : Date (Mandatory)
7. Minimum Pay : Currency
8. Maximum Budget : Currency (Mandatory)
9. HR Email ID : Email (Mandatory)
10. HR Contact Number : Phone
11. Travel Required : CheckBox
12. Passport Required : CheckBox
13. Position Description: Text Area Long
14. Skills Required: Text Area Rich
15. Reference ID : (PID-400001) Auto Number.

b) Create a custom object “Hiring Manager” with required custom fields.

2. Formula Field & Validation Rules

a) Create a Formula field, to Calculate the 7% of Service Tax based on the Annual Revenue.

b) Create a Formula Field in the Position object, to indicate the position record can be remove or not. (**Note:** Positions whose Mile Stone Date is over, those records should be removed from the object)

c) Create a Validation Rule on the Account object, to make sure the Annual Revenue should be more than 400000.

d) Create a Validation rule on the Opportunity object if the stage is equal to prospecting then the probability should be greater than 50.

3. Data Modeling

a) Configure the Lookup Relationship between "Hiring Manager" and "Position" objects and list out all the observations / features.

b) As a sales manager in a company, you want to track the total revenue generated from all related Opportunity records for each Account. You need a way to automatically calculate and display this total revenue on the Account record without manual data entry.

[**Note:** Use Rollup Summary Field]

4. Workflow Rules

a) Configure a Workflow rule on the Hiring Manager Object, to send an Email Notification to the HR Manager upon creating a new HR Manager Record inside the object.

b) Configure a Process on the Lead Object, to Notify the Lead Person Upon Creating a New Lead Record for Hyderabad Location and with "Banking" Industry. Notify the Lead upon updating the Lead record also.

5. Flow Builder

a) Configure a flow to display the Message on the home page screen.

b) Configure a flow to display the Current User Name on the home page screen.

c) Configure a flow that populate the Shipping address with billing address while creating an account record.

6. Flow Builder

a) Configure a flow to send the Email notification to the Hiring Manger upon creating a new HR Manager Record.

7. Data Management

a) Your marketing team has launched a new campaign and generated a list of leads from various sources, such as web forms, events, or advertisements. You need to import these leads into Salesforce for further nurturing and conversion using data loader tool.

8. User Management

1.The university's IT department needs to set up new users in their Salesforce org with specific licenses. As a Salesforce administrator, you are responsible for creating the following users with the given licenses:

a) Development User (with Salesforce License)

b) Testing User (with Salesforce Platform License)

c) Manager User (with Salesforce Platform License)

d) Customer User (with Salesforce Platform License)

2. An employee is leaving the company, and you need to deactivate their user account in Salesforce to prevent unauthorized access and ensure data security.

9. **Role Hierarchy & Profile Management**

a) The university's IT department has added new users with specific licenses to their Salesforce org. To establish clear reporting lines and ensure appropriate data access, the IT department needs to set up a role hierarchy as follows

CEO [System Administer]

| ---> CFO [Manager User]

| ---> COO [Testing User]

|---> CTO [Development User]

|---> VP [Customer User]

b) Configure the Profile Level Permissions to the Development User as below.

Account : Grant R, C, E, D

Lead : Grant R

Case: Grant R, C.

Hiring Manager : R C E

10.Permission Set

a) Create an Account Record inside the object by using "Development User" account, and Share the Record to "Manager User" with "ReadOnly" access.

b) Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.

c) Login into the Development User Account, and share the above Account record to the Testing User with "Read/Write" access.

11. Sharing Rules

Configure a Sharing Rule on the Account object, which is used to share the Account Records to the "Bangalore Sales Group", if the Account record matching with the below conditions. Grant Read/Write access.

1. Account: Rating == 'Hot'

2. Account: Industry == 'Finance'

3. Account: Active == 'Yes'

4. Account: Customer Priority == 'High'

12. Reports and Dashboards

Configure a Tabular Report, to represent only Hot Rating Customers Data in the Tabular format along with Grand Total.

Additional Practice:

1. Create a Screen Flow to guide HR through the process of onboarding a new Hiring Manager.

Description: When a new Hiring Manager is onboarded, HR needs to input various details such as Name, Email, Phone Number, Department, and Location into Salesforce.

Create a Screen Flow that guides HR through entering this information step-by-step.

2.Importing New Records

Objective: Import new Hiring Manager records into Salesforce.

Description:

1. You have a CSV file with a list of new Hiring Managers that needs to be imported into Salesforce.
2. The CSV file contains fields: Name, Email, Phone Number, Department, Location, Number of Open Positions.

3.Creating a Hiring Managers Report

Objective: Create a detailed report on Hiring Managers and their activity.

Description: You need to generate a report that shows all Hiring Managers along with the number of job applications they have processed in the last month. The report should include fields such as Hiring Manager Name, Email, Department, and Number of Job Applications

Text Books:

1. Salesforce CRM Administration Handbook: A comprehensive guide to administering, configuring, and customizing Salesforce CRM by Krzysztof Nowacki and Mateusz Twarożek, Packt Publishing Ltd, April 2024.
2. Salesforce CRM - The Definitive Admin Handbook by Paul Goodey, Packt Publishing Ltd., 5th Edition, April 2019.

Reference Books:

1. Salesforce for Beginners, Sharif Shaalan, Timothy Royer, Packt Publishing Ltd, 2nd Edition.

Web Links:

1. https://trailhead.salesforce.com/help?article=Salesforce-Certified-Administrator-Exam-Guide
2. https://developer.salesforce.com/docs/atlas.enus.salesforce1appadmin.meta/salesforce1appadmin/s1_admin_guide_actions_intro.html
3. https://help.salesforce.com/s/articleView?id=sf.printabledoc_admin.htm&type=5
4. https://trailhead.salesforce.com/search/learning?keywords=journey+2+salesforce
5. https://www.salesforcetutorial.com/
6. https://www.tutorialspoint.com/salesforce/index.html
7. https://api.pageplace.de/preview/DT0400.9781782170532_A24166039/preview-9781782170532_A24166039.pdf
8. https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PLgW8Fj5TGrqr9oCcfX1MWcoh2oluUHI9
9. https://www.youtube.com/watch?v=THbIw8hgW0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn

Advanced Salesforce Administration

	L	T	P	C
Course Code: 2501IT034	**0**	**0**	**3**	**3**

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

- **CO1:** Explain the purpose and core features of Salesforce user, profile, and license management.
- **CO2:** Configure enterprise-grade security by applying password policies, resetting credentials, and enforcing compliance requirements.
- **CO3:** Design an appropriate role hierarchy and sharing model to meet complex data-access scenarios.
- **CO4:** Evaluate and optimize record-level access using profiles, permission sets, manual sharing, and escalation rules to balance security with usability.
- **CO5:** Build end-to-end service and sales processes—including Web-to-Lead, Web-to-Case, and analytics—in order to deliver actionable insights through reports and dashboards

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	3	-	-	-	2	-	2
CO2	3	2	1	-	3	-	2	-	-	-	2
CO3	3	3	3	2	3	-	-	2	1	2	2
CO4	2	3	2	2	3	-	2	2	3	2	2
CO5	3	3	3	2	3	-	-	2	3	2	3

Practice:

1. User Management

1.1) The university's IT department needs to set up new users in their Salesforce org with specific licenses. As a Salesforce administrator, you are responsible for creating the following users with the given licenses:

a. Development User (with Salesforce License)

b. Testing User (with Salesforce Platform License)

c. Manager User (with Salesforce Platform License)

d. Customer User (with Salesforce Platform License)

2. Activation and Deactivation of a User

2.1) Your organization hires new employees who need access to Salesforce to perform their job duties. You need to onboard these employees efficiently and provision user accounts in Salesforce with appropriate permissions and access levels.

2.2) An employee is leaving the company, and you need to deactivate their user account in Salesforce to prevent unauthorized access and ensure data security.

3. Password Policies

3.1) Paul, an employee has forgotten his Salesforce password and cannot log in. As the Salesforce administrator, how can you reset his password.

3.2) The university's IT department mandates stricter password policies for Salesforce users to enhance security. As the Salesforce administrator, you need to configure these policies.

To increase security, the university requires all Salesforce user passwords to meet the following criteria:

• Minimum length of 12 characters
• At least one uppercase letter
• At least one lowercase letter
• At least one number
• At least one special character
• Passwords must expire every 90 days
• Users must not reuse their last 3 passwords

4. Role Hierarchy

4.1) The university's IT department has added new users with specific licenses to their Salesforce org. To establish clear reporting lines and ensure appropriate data access, the IT department needs to set up a role hierarchy as follows

CEO [System Administer]

| ---> CFO [Manager User]

| ---> COO [Testing User]

|---> CTO [Development User]

|---> VP [Customer User]

5. Profile Management

5.1) Configure the Profile Level Permissions to the Development User as below.

Account : Grant R, C, E, D

Lead : Grant R

Case: Grant R, C.

Hiring Manager : R C E

5.2) Create an Account Record inside the object by using "Development User" account, and Share the Record to "Manager User" with "ReadOnly" access.

6. Permission Set

6.1) Create a Permission Set to grant the "Edit and Delete" permissions on the Account Object to the Manager User.

6.2) Login into the Development User Account, and share the above Account record to the Testing User with "Read/Write" access.

7. Public Groups

7.1) Create an Account Record by login with "Manager User" and Share the Account Record to "Hyderabad Sales Group" with Read/Write access.

Hyderabad Sales Group

| ---> Testing User (R/W)

| ---> Customer User (R/W)

8.Sharing Rules

8.1) Configure a Sharing Rule on the Account object, which is used to share the Account Records to the "Kakinada Sales Group", if the Account record matching with the below conditions. Grant Read/Write access.

1. Account: Rating == 'Hot'
2. Account: Industry == 'Finance'
3. Account: Active == 'Yes'
4. Account: Customer Priority == 'High'

9. Web to Lead

Implement the use of Web to Lead in a Salesforce Org with suitable example.

10. Web to Case

Create a Web to case form for raising a ticket in your organization.

11. Case Escalation Rule

The customer support team handles a high volume of cases daily, ranging from simple inquiries to complex technical issues. To ensure timely resolution and efficient case management, you need to implement case escalation rules in your salesforce org.

12. Reports and Dashboards

12.1) Configure a Tabular Report, to represent only Hot Rating Customers Data in the Tabular format along with Grand Total.

Additional Practice:

1. Restricting Object Access with Profiles

Objective: Restrict access to certain objects for specific profiles to enforce data security.

Description:

Interns in your organization should have very limited access and should not be able to view or edit the Account and Contact objects. Modify the Intern profile to restrict access to these objects.

2. Permission Sets for Temporary Access

   Objective: Use permission sets to grant temporary or additional permissions without modifying profiles.

   Description:

   A Hiring Manager needs temporary access to edit the "Budget" field on the Project object for a special project. Create a permission set to grant this access and assign it to the Hiring Manager.

3. Creating a Hiring Managers Report

   Objective: Create a detailed report on Hiring Managers and their activity.

   Description:

   You need to generate a report that shows all Hiring Managers along with the number of job applications they have processed in the last month. The report should include fields such as Hiring Manager Name, Email, Department, and Number of Job Applications.

References:

1. https://trailhead.salesforce.com/help?article=Salesforce-Certified-Administrator-Exam-Guide
2. https://developer.salesforce.com/docs/atlas.en-us.salesforce1appadmin.meta/salesforce1appadmin/s1_admin_guide_actions_intro.html
3. https://help.salesforce.com/s/articleView?id=sf.printabledoc_admin.htm&type=5
4. https://trailhead.salesforce.com/search/learning?keywords=journey+2+salesforce
5. https://www.salesforcetutorial.com/

Web Links:

1. https://www.youtube.com/watch?v=mc5cQ1vHcr0&list=PL-gW8Fj5TGrqr9oCcfX1MWcoh2oluUHI9
2. https://www.youtube.com/watch?v=THbIw8hg-W0&list=PL1qNeQdVTMhGS6MI6gJsZFgYDRUUnjYpn

Principles of Pega Systems

	L	T	P	C
Course Code:2501IT23	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Recall basic concepts of Pega case types, life cycle stages, and case management features.
- **CO2:** Identify basic features of case and data management in Pega, including properties, validations, and data pages.
- **CO3:** Explain how decision rules, routing, and user interface elements are used to guide case behavior and user interaction in Pega.
- **CO4:** Apply Pega tools and rules to build reusable components and test applications effectively
- **CO5:** Summarize how reports, security features, and access controls are handled in Pega applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	2	-	2	-	-	-	-	-	-
CO2	3	-	2	-	2	-	-	-	-	-	-
CO3	3	2	2	-	2	-	-	-	-	-	-
CO4	3	2	3	2	3	-	-	-	-	-	2
CO5	3	2	2	-	2	-	-	-	-	-	-

Practice:

1. Pega Infinity Overview

a) Perform a lab to how to create a case type

b) Perform a lab on how to configure a case type and stages and steps to it

2.Case life cycle design & Gathering Business Requirements

a) Configure a lab to Create the career candidate case type

b) Perform a lab to Add processes and steps to stages

3.Case management

a) Perform a lab to configure “Service level agreements”

b) Configure a lab to create a child case

4.Case management

a) Perform a lab for creating a wait step.

b) Perform a lab on Process Design for Insurance Application

5.Data management

a) Configure a lab to create properties for a car selling company to collect the customer information.

b) Perform a lab on Creating field values in Employee onboarding.

6.Data management

a) Perform a lab to check the data validation.

b) Perform a lab for Creating a data relationship

c) Perform a lab for Creating Data pages in pega

7.Decision Approval and Routing

a) Perform a lab for Skipping a process in a case type

b) How to configure common decision rules for a decision shape and unit test the various configurations.

8.User Interface

a) Configure the views for those steps with fields that gather and display the information for a home load application

b) Configure a lab on user interface to meet the requirements:

The UI team at Wind has asked you to style Calendar controls to simplify the Calendar appearance.

9.Pega platform

a) Perform a lab on this requirement: You want to create a section that will be usable by multiple case types in your Hire Me application in App Studio and Dev Studio.

b) Perform a lab on this requirement: You want to create a few properties both manually and using a wizard to understand the importance of the context when creating a rule.

10.Tools and Testing

a) Perform a lab on Debugging application errors

b) Perform a lab on Scenario testing

11.Reporting

a) Perform a lab for Creating an Insight for one month resolved cases

b) Perform a lab to meet the following requirements: A manager at the company will want to be able to run out-of-the-box reports from the system. Run a report.

12. Security and Localization

a) Perform a lab on Managing application access to different users

b) Perform a lab to Configuring security policies

Additional Practice:

1. Create a Car rental Application for a travel agency for car booking.
2. Create a vehicle manufacturing application to obtain the customer's requirements and needs to design a new car for him.
3. Create an Application for Housing loan application

Web links:

1. www.pegaacademy.com
2. https://academy.pega.com/mission/introduction-pega-platform/v4
3. https://academy.pega.com/topic/case-life-cycle-design/v2
4. https://academy.pega.com/topic/requirements-portal/v1
5. https://academy.pega.com/module/case-management/v1
6. https://academy.pega.com/topic/designing-approval-process/v1
7. https://academy.pega.com/module/user-interface/v3

Pega System Architecture & Design

	L	T	P	C
Course Code:2501IT26	**0**	**0**	**3**	**3**

Course Outcomes:

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

- **CO1:** Recall basic Pega configuration tasks such as skimming rulesets, rule resolution, and versioning.
- **CO2:** Explain case management tasks including urgency overrides, routing, locking, and relevant records
- **CO3:** Apply data validation, SOAP connector creation, and integration techniques in Pega applications
- **CO4:** Analyze reporting structures using class joins, sub-reports, and local data management.
- **CO5:** Design secure and intelligent Pega applications using RBAC, ABAC, and Gen AI tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	2	-	-	-	-	2
CO2	3	2	2	2	-	2	-	-	-	-	2
CO3	3	3	3	3	2	3	-	-	1	2	2
CO4	3	3	3	3	3	3	-	-	1	2	2
CO5	3	3	3	2	2	3	2	1	2	3	3

Practice:

1.Application Development.

a) Perform a lab on how to configure skimming a ruleset.

b) Perform a lab on how to configure a Application ruleset versions.

c) Configuring a Automation actions when a property value changes.

2.Application Development.

a) Perform a lab on how to merge a branch application.

b) Perform how to create a circumstancing rule for a single variable of the application

3.Application Development.

a) Perform a lab on how to create a circumstancing rule for multiple variables of the application

b) Perform a lab on how to configure a Rule Resolution.

4.Application Development

a) Perform a lab to configure lock a ruleset version.

b) Perform a lab on how to configure to saving an existing rule in a new version.

c) Perform a lab on how to configure a Lower rule to Latest ruleset version.

5.Case management

a) Perform a lab on how to configure to override a Case Urgency.

b) Perform a lab on how to configure a Parallel Processing.

6.Case management.

a) Perform a lab on how to configure a case locking

b) Perform a lab on how to configure flow action pre- and post-processing

c) Configuring a lab on how to update a Assignment Routing.

7.Case management

a) Perform a lab to configure designate a relevant record.

b) Perform a lab to configure Pega Rules Analyzer (PLA).

8.Data and Integration

a) Perform a lab and how to configure validating data against pattern.

b) Perform a lab on how to source a page property using a keyed date page.

c) Perform a lab on how to configure a snapshot pattern.

9.Data and Integration

a) Perform a lab on how to Create a SOAP Connector.

b) Perform a lab on how to manage application settings.

c) Perform a lab on how to configure an Alias Pattern using Referencing properties.

10. Reports.

a) Perform a lab on how to create a report that combine data from multiple Classes.

b) Perform an activity to manage a local data storage.

c) Perform a lab on how to use Class Joins in Reports.

d) Perform a lab on how to use sub reports.

11.Security.

a) Configure how to secure an application using Role Based Access Control(RBAC)

b) Configure how to secure an application using Attribute Based Access Control(ABAC)

c) Configure how to organizing and Managing Access to Case Attachments.

12.Gen AI.

a) Perform a lab on how to create a case type through pega gen AI

b) Perform a lab on how to configure pega self study buddy.

c) Perform a lab on how to sizing a pega platform project.

d) Perform a mission Innovation with Pega Gen AI.

Additional Practice:

1. Create and Design a Banking application by configuring case locking, overriding case urgency, and implementing data encryption.
2. Create and Design a Hospital management application with saving data in to a system of Records.
3. Create and Design any Insurance application.

Web Links:

1. https://academy.pega.com/
2. https://academy.pega.com/challenge/skimming-ruleset/v1
3. https://academy.pega.com/module/application-development/v2
4. https://www.pega.com/case-management
5. https://academy.pega.com/topic/reports/v3
6. https://academy.pega.com/topic/understanding-security-basics/v1
7. https://www.pega.com/technology/generative-ai
8. https://www.pega.com/retail-banking-solutions
9. https://www.pega.com/insurance-software
10. https://www.pega.com/healthcare-management

Entrepreneurship Development and Incubation

Course Code: 2501MB04	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Describe the meaning and concepts of entrepreneurship development

CO2: Apply the business plan for preparation and evaluation of project.

CO3: Explain about Institutional Support to Entrepreneur and MSMEs

CO4: Explain about the Opportunities of Entrepreneurship Internationally.

CO5: Explain about Informal Risk Capital, Venture capital and Social responsibility for entrepreneurship

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	2	-	-	1	-	-
CO2	-	-	-	-	-	2	-	-	1	-	-
CO3	-	-	-	-	-	2	-	-	1	1	-
CO4	-	-	-	-	-	2	-	-	1	1	-
CO5	-	-	-	-	-	2	-	3	-	-	-

UNIT – I

Entrepreneur &Entrepreneurship:

Entrepreneur &Entrepreneurship: Meaning of entrepreneur - Evolution of the concept - Functions of an Entrepreneur - Types of Entrepreneur - Intrapreneur- an emerging class - Concept of Entrepreneurship - Evolution of Entrepreneurship - Development of Entrepreneurship - Entrepreneurial Culture - Stages in entrepreneurial process.

UNIT – II

Business Planning Process:

Meaning of business plan - Business plan process - Advantages of business planning - Marketing plan - Production/operations plan - Organization plan - Financial plan - Final Project Report with Feasibility Study - preparing a model project report for starting a new venture.

UNIT – III

Institutions supporting Entrepreneurs:

Small industry financing institutions in developing countries - A brief overview of financial institutions in India - Central level and state level institutions - SIDBI - NABARD - IDBI - SIDCO - Indian Institute of Entrepreneurship - DIC - Single Window - Latest Industrial Policy of Government of India.

UNIT – IV

International Entrepreneurship Opportunities:

The nature of international entrepreneurship - Importance of international business to the firm - International versus domestic entrepreneurship - Stages of economic development - Entrepreneurship entry into international business - exporting - Direct foreign investment - barriers to international trade.

UNIT – V

Informal Risk Capital and Venture Capital:

Informal risk capital market - venture capital - nature and overview - venture capital process - locating venture capitalists - approaching venture capitalists. Social Entrepreneurship: Social enterprise-need - types - characteristics and benefits of social enterprises-Social entrepreneurship - Rural entrepreneurship, MSME Policies. Make-In India, Start-Up India, Stand-Up India.

Text Books:

1. Entrepreneurship by Arya Kumar, Pearson, Publishing House, New Delhi, ISBN: 9789353066499
2. Entrepreneurship by VSP Rao, Kuratko,Cengage Learning, New Delhi.ISBN: 978-8131516140

Reference Books:

1. Entrepreneurship Development by B.Janakiram, M Rizwana,Excel Books, NewDelhi,ISBN-13:9788174469588.
2. Entrepreneurship Development by P.C.Shejwalkar, Everest Publishing House, New Delhi,ISBN: 8176601942.

Web Links:

1. https://archive.nptel.ac.in/courses/107/101/107101092/
2. https://www.tutorialspoint.com

Business Ethics & Corporate Governance

Course Code:2501MB005	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Demonstrate a solid understanding of the purpose and nature of corporations.

CO2: Explain confirming the value, impact and contribution the Board of Directors makes to the success of the Organization.

CO3: Analyze different Corporate Governance Forums.

CO4: Use the acquired skill for proper sustainable Corporate Social Responsibility.

CO5: Demonstrate ethical awareness, the ability to do ethical reflection, and the ability to apply ethical principles in decision-making.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	2	-	-	1	-
CO2	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	2	-	-	-	-
CO4	-	-	-	-	-	-	1	-	1	-	-
CO5	-	-	-	-	-	1	3	-	-	-	-

UNIT – I

Corporate Governance:

Corporate governance – meaning – objectives – need - importance – principles – corporate governance and organisation success. Corporate governance in India

UNIT – II

Levels of Governance Structure:

Corporate governance and role, responsibilities and powers - Board of Directors, Corporate Management Committee and Divisional Management Committee.

UNIT – III

Corporate Governance Forums:

CII code on corporate governance – features - Various Corporate Governance forums – CACG, OECD, ICGN AND NFCG.

UNIT – IV

Corporate Social Responsibility:

Corporate Social Responsibility – definition – nature – levels – phases and approaches, principles, Indian models – dimensions. Corporate social reporting - Objectives of Corporate Social Reporting and case studies.

UNIT – V

Business Ethics:

Business ethics – meaning, significance, scope – factors responsible for ethical and unethical business decision. Unethical practices in Business – Business ethics in India – Ethics training programme.

Text Books:

1. Corporate Governance values and ethics, Dr. Neeru Vasishth and Dr. Namita Rajput ,Taxmann Publications Pvt Ltd, New Delhi, ISBN-13:9789388266192.
2. International Business & Environment, S.Sanakaran, Margham Publication,Chennai. ISBN: 978-9381430255

Reference Books:

1. Business Ethics and Corporate Governance, Dr.S.S. Khanka, S.Chand Publication,ISBN:9788121942867
2. Business Ethics and Value, Sundar.K, Vijay Nichole Prints, Chennai, ISBN:9788182094994.

Web Links:

1. https://elearningindustry.com
2. https://essentialskillz.com

Entrepreneurship Development and Business Management

Course Code:2501MB06	L	T	P	C
	1	0	2	3

Course Outcomes:

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

CO1: Demonstrate that challenges have been undertaken, developing new skills in the process

CO2: Analyze marketing opportunities using environmental scanning market data, measurement, and analysis.

CO3: Explain the objectives of Financial Statement Analysis.

CO4: Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.

CO5: Develop global vision and management skills both at strategic level and interpersonal level.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-		3	-	-	-
CO4	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	1	-	-	-	-	-

UNIT – I

Development of Entrepreneurship:

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development.

Practice:

1.Initiation and preparation of project proposal for funding by different agencies.

UNIT – II

Environment scanning and opportunity:

Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development.

Practice:

1.Visit to small scale industries/agro-industries

UNIT – III

Role of financial institutions:

Role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Practice:

1.Interaction with successful entrepreneurs/ Agric entrepreneurs.

UNIT – IV

Planning of an Enterprise:

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control.

Practice:

1.Visit to financial institutions and support agencies

UNIT – V

Personal Management:

Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, bookkeeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management, market types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practice:

1.Project report submission

Text Books:

1. Entrepreneurship Development and Small Business Enterprises, Charantimath P.M., Pearson Publications, New Delhi,ISBN:978-9332586930.
2. Entrepreneurship: Development and Management, Desai V , Himalaya Publishing House ISBN: 978-9350978757

Reference Books:

1. Entrepreneurship Development & Management, Singhal R.K.,Katson Books,ISBN-13: 9788189757007
2. Principles of Management by Tripathi P C & Reddy P N,Tata McGraw Hill,ISBN-13: 9780071333334.

Web Links:

1. https://archive.nptel.ac.in/courses/110/106/110106141/
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/03_lec/

SoC Design

Course Code: 2501EC29	L	T	P	C
	3	0	0	3

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

CO1: Explain all the building blocks of SoC.
CO2: Classify the concept of processors and instruction handling.
CO3: Analyze vector, VLIW and superscalar processors.
CO4: Develop a Memory as part of SoC.
CO5: Illustrate the concepts of interconnect optimization and configuration in SoC.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									1
CO2	3	2									1
CO3	2	2	1								1
CO4	2	2	2								1
CO5	2	2	1								1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

UNIT – I

Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT – II

Processors:

Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

UNIT – III

Memory Design for SOC:

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation , SOC Memory System, Models of Simple Processor – memory interaction.

UNIT – IV

Interconnect Customization:

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

UNIT – V

Interconnect Configuration:

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

Text Books:

1. Computer System Design System-on-Chip, Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, ISBN: 978-0470643365.
2. ARM System on Chip Architecture, Steve Furber, Addison Wesley Professional, 2nd Edition, ISBN : 9780201675191 .

Reference Books:

1. Design of System on a Chip: Devices and Components, Ricardo Reis, Springer 1st Edition, ISBN: 978-1441954541.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Jason Andrews, Newnes, BK and CDROM, ISBN: 978-0750677301.
3. System on Chip Verification–Methodologies and Techniques, Prakash Rashinkar, Peter Paterson and Leena Singh L, Kluwer Academic Publishers, ISBN: 978-0792372790.

Web Links:

1. https://www.peterindia.net/System-On-ChipLinks.html
2. https://www.ieee-socc.org/
3. http://nptel.ac.in/courses/108102045/10 (Prof. Santanu Chaudhary, IIT Delhi)

Cloud Computing
(Common to CSE, IT, AIML & CSE (DS))

	L	T	P	C
Course Code: 2501CS23	2	0	2	4

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

CO1: Explain basic concepts and terminologies of Cloud Computing and Virtualization.
CO2: Demonstrate Cloud deployment models, Service models and Architectures.
CO3: Analyze Cloud services, Applications and Capacity Planning.
CO4: Use different PaaS application frameworks to construct Cloud applications.
CO5: Develop web applications through Google, Microsoft and Amazon web services for Realtime application.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2			1			1	1		1
CO2	2	2			1			1	1		1
CO3	3	1			1			2	1		1
CO4	2	2			1			2	1		1
CO5	2	2			1			2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	2	
CO4	2	
CO5	2	

UNIT – I
Fundamental Cloud Computing and Virtualization Cloud Computing: Origin and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges, Roles and boundaries and Cloud characteristics.
Introduction to Virtualization: Characteristics, Taxonomy of virtualization technologies, Pros and cons of virtualization, Virtualization Technologies: Xen, VMware and Hyper-V.

Practice:
1. Introduction to Cloud Computing.
2. Overview of cloud computing concepts.
3. Hands-on: Setting up a free-tier account on AWS/Azure/GCP.

UNIT - II
Understanding Cloud Models and Architectures Cloud Models: NIST model, Cloud Cube model, Deployment models: Public, Private, Hybrid and Community; Service models: IaaS, PaaS and SaaS. Understanding Cloud Architecture: Exploring the Cloud Computing Stack,

Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications; Connecting to the Cloud: The Jolicloud Netbook OS and Chromium OS - The Browser as an Operating System.

Practice:

1. Virtual Machines and Computer Services.
    a. Creating and managing virtual machines.
    b. Hands-on: Launching and configuring EC2 instances on AWS.

UNIT – III

Understanding Cloud Services, Applications and Capacity Planning: Understanding Cloud Services and Applications Infrastructure as a Service (IaaS): IaaS workloads, Pods, aggregation, and silos; Platform as a Service (PaaS), Software as a Service (SaaS): SaaS characteristics, Open SaaS and SOA, Salesforce.com and CRM SaaS; Identity as a Service (IDaaS): Identity, Networked identity service classes, Identity system codes of conduct, IDaaS interoperability; Compliance as a Service (CaaS). Capacity Planning: Defining Baseline and Metrics: Baseline measurements, System metrics, Load Testing, Resource ceilings, Server and instance types; Network Capacity and Scaling.

Practice:

1. Storage Solutions.
    a. Exploring different storage options (S, EBS, Glacier).
    b. Hands-on: Implementing S3 buckets and managing data.

UNIT – IV

Exploring Platform as A Service (PaaS): PaaS Application Frameworks: Drupal, Eccentex AppBase 3.0, Long Jump, Squarespace, Wavemaker and Wolf Frameworks. Exploring Platform as a Service using Google Web Services: Surveying the Google Application Portfolio, Google Toolkit and Working with the Google App Engine. Exploring Platform as a Service using Microsoft Cloud Services: Exploring Microsoft Cloud Services, Microsoft Azure- Live Essentials, Live Home and Live for Mobile.

Practice:

1. Networking in the Cloud.
    a. Configuring virtual private clouds (VPC), subnets, and security groups.
    b. Hands-on: Setting up a VPC and deploying instances within it.

UNIT -V

Exploring Infrastructure As A Service (Iaas): Understanding Amazon Web Services, Amazon Web Service Components and Services, Working with the Elastic Compute Cloud (EC2): Amazon Machine Images, Pricing models, System images and software, Creating an account and instance on EC2; Working with Amazon Storage Systems: Amazon Simple Storage System (S3), Amazon Elastic Block Store (EBS) and CloudFront; Understanding Amazon Database Services: Amazon Simple DB, Amazon Relational Database Service (RDS) and Choosing a database for AWS.

Practice:

1. Database Services
    a. Understanding cloud-based database services (RDS, DynamoDB).
    b. Hands-on: Setting up and querying a relational database in AWS RDS.

Text Books:

1 Cloud Computing Bible, Barrie Sosinsky, Wiley India Pvt Ltd, ISBN-10. 0470903562 ; ISBN-13. 978-0470903568.
2 Cloud Computing- Concepts, Technology and Architecture, Thomas Erl and Ricardo Puttini, Pearson, ISBN 10: 0133387526 - ISBN 13: 9780133387520.

Reference Books:

1 Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola and S Thamarai Selvi, McGraw Hill Education. ISBN: 978-0-12-411454-8.
2 Cloud Application Architectures, George Reese, O'Reilly. ISBN: 978 0596156367.
3 Enterprise Cloud Computing Technology Architecture Applications, Gautam Shroff, Cambridge university press; 1st edition. ISBN: 978-0521137355.

Web Links:

1 https://onlinecourses.nptel.ac.in/noc24_cs17/preview
2 https://docs.aws.amazon.com/
3 https://learn.microsoft.com/en-us/training/azure/