D. Y. Patil Education Society

Deemed to Be University

School of Engineering and Management

KASABA BAWADA, KOLHAPUR

Accredited by NAAC with

'A++' Grade

Final Year B. Tech

Structure and Curriculum (as per NEP 2020)

Department of Data Science Engineering

w. e. f. A. Y. 2026-27

D. Y. PATIL DEEMED TO BE UNIVERSITY
SCHOOL OF ENGINEERING AND MANAGEMENT
Teaching and Evaluation Scheme from Year 2023-24 (as per NEP-2020)
B. Tech. Data Science Engineering (SEMESTER- VII)

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme				Theory			Practical		Total Marks
				Credits	Contact Hrs			ISE	MSE	ESE	INT	OE/ PoE	
					L	P	T						
1	23DSEU7P01	PCC	Deep Learning	**3**	3	-	-	20	30	50	-	-	100
2	23DSEU7P02	PCC	Deep Learning Lab	**1**	-	2	-	-	-	-	25	25	50
3	23DSEU7P03	PCC	Data Visualization	**2**	1	2	-	-	-	-	25	25	50
4	23DSEU7M04	MDM-V	Big Data Analytics	**2**	2	-	-	-	-	50	-	-	50
5	23DSEU7E05	PEC-IV	Business Intelligence	3	3	-	-	20	30	50	-	-	100
6	23DSEU7E06		Big Data Analytics										
7	23DSEU7E07		Social Network Analysis										
8	23DSEU7E08	PEC-V	Image Processing	3	3	-	-	20	30	50	-	-	100
9	23DSEU7E09		Natural Language Processing										
10	23DSEU7E10		Soft Computing										
11	23DSEU7R11	RM$	Research Methodology	**4**	4	-	-	20	30	50	-	-	100
12	23DSEU7J12	PR	Project	**4**	-	8	-	-	-	-	75	75	150
13	23DSEU7D13	AC	Liberal Learning	-	2*	-	-	-	-	-	50*	-	
			Total	**22**	**14**	**12**							**700**

Note:
$ - Open & Distance Learning
* - Values are not included in total marks
Min. Marks for Passing: 40% of total marks of individual course

HONORS

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme				Theory			Practical		Total Marks
				Credits	L	P	T	ISE	MSE	ESE	INT	OE/	
1	23DSEU7Z01	Honors	Cyber-crime and Laws	3	3	-	-	20	30	50	-	-	100
2	23DSEU7Z02	Honors	Cyber-crime and Laws Lab	1	-	2	-	-	-	-	25	-	25



Course Code:	23DSEU7P01
Course Name:	Deep Learning

L	T	P	Credit
3			3

Course Prerequsites:

Python Programming and Scripting

Course Description:

This course introduces the fundamentals and advanced concepts of Deep Learning, covering machine learning basics, neural network architectures, and optimization techniques. It explores feed-forward networks, backpropagation, CNNs, RNNs, LSTMs, and GRUs for vision and sequence tasks. The course also covers generative models, autoencoders, GANs, and modern deep architectures such as ResNet and GCN, with applications in computer vision, language processing, image captioning, and video analysis.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	illustrate the basic concepts of linear algebra for Mathematical models and Deep neural network model	4,9
CO2	construct the feed forward network using gradient descent and regularization technique	9
CO3	model the Convolutional neural network and articulate the sequence modelling using Recurrent models for processing high dimensional	3,9,11,13
CO4	design the deep neural network to model computer vision related applications such as object detection, image captioning	3,9,11,13

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2									1	2		
CO2	2	2			2					1	2			
CO3	1	1	2	1	3							1		2
CO4	2	2		1	1								1	2

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents

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Course Contents:			SDGs
Unit 1	**Introduction**	**7 Hours**	4,9
Introduction to Artificial Intelligence, Machine Learning and Deep Learning. Machine Learning Basics, Learning Algorithms, Supervised Learning and Unsupervised Learning, Linear Algebra for Machine Learning, Historical Trends in Deep Learning, Deep Learning Software Libraries, Introduction to a Simple Deep Neural Network (DNN).			
Unit 2	**Data Preparation and Model Evaluation**	**8 Hours**	9
Dimensionality Reduction, Overfitting and Underfitting, Cross-Validation, Hyperparameters, Training Set, Validation Set and Test Set, Estimators, Bias and Variance, Regularization Techniques.			
Unit 3	**Feed Forward Networks and Backpropagation**	**8 Hours**	
Introduction to Deep Feed Forward Networks, Shallow Neural Networks, Deep Neural Networks, Learning XOR Problem, Gradient-Based Learning, Backpropagation Algorithm, Activation Functions, Error/Loss Functions, Architecture Design, Differentiation Algorithms, Hyperparameter Tuning, Batch Normalization.			
Unit 4	**Regularization and Convolutional Neural Networks**	**7 Hours**	3,9,11,13
Regularization for Deep Learning, Early Stopping, Dropout, Convolutional Neural Networks (CNNs), Convolution Operations, Pooling, Normalization, Applications of CNNs in Computer Vision.			
Unit 5	**Sequence Modeling and Autoencoders**	**8 Hours**	3,9,10
Sequence Modeling, Recurrent Neural Networks (RNNs), Difficulties in Training RNNs, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Encoder–Decoder Architectures, Applications in Spam Classification and Sentiment Analysis. Autoencoders – Architecture, Undercomplete Autoencoders, Regularized Autoencoders, Stochastic Autoencoders, Denoising Autoencoders, Contractive Autoencoders, Variational Autoencoders (VAE), Applications.			
Unit 6	**Optimization, GANs and Deep Architectures**	**7 Hours**	3,9,11,13
Optimization for Deep Learning, RMSProp for RNNs, SGD for CNNs, Adversarial Generative Networks (GANs), GAN Applications, Deep Architectures in Computer Vision, ImageNet and ImageNet Large Scale Visual Recognition Challenge (ILSVRC), ResNet, Graph Convolutional Networks (GCN), Applications in Image Captioning, Applications in Video Tasks			

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press,
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
3. Michael Nielsen, “Neural Networks and Deep Learning”, Online book, 2016
4. Jason Brownlee, “Deep Learning with Python”, 2016.
5. Aaron Courville, Ian Goodfellow, and Yoshua Bengio, “Deep Learning”, MIT Press, 2015.

Reference Books:

1. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”
2. by SethWeidman, “Deep Learning from Scratch: Building with Python from First Principles”O’Reily
3. Francois Duval, “Deep Learning for Beginners, Practical Guide with Python and Tensorflow”

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Course Code:	23DSEU7P02
Course Name:	Deep Learning Labs

L	T	P	Credit
		2	1

Course Prerequsites:

Python Programming and Scripting

Course Description:

This Deep Learning Laboratory provides hands-on experience with modern neural network techniques using open-source tools and datasets. Students implement classifiers, feed-forward networks, CNNs, RNNs, LSTMs, autoencoders, GANs, and transfer learning models. The course emphasizes activation functions, optimization, backpropagation, generative modeling, and real-world applications such as image classification, compression, and object detection.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Apply deep learning tools, frameworks, and programming techniques to develop and evaluate neural network models for classification and prediction tasks.	4,9
CO2	Design and implement deep learning architectures including Feed Forward Neural Networks, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and LSTMs for solving real-world problems.	9
CO3	Develop and analyze advanced deep learning models such as Autoencoders, Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and Transfer Learning models for applications in image processing, feature extraction, and object detection.	9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			3							2	3	
CO2	1	2	2		2				2				3	3
CO3		3	2	3	2							2	2	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation (ISE)	50%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	End Semester Examination (ESE)	50%	Practical Oral Exam



List of Experiments:		SDGs
1	Exploring the Deep learning platforms	4,9
2	Implement a classifier using open-source dataset	9
3	Study of the classifiers with respect to statistical parameters	9
4	Build a simple feed forward neural network to recognize handwritten character. (MNIST Dataset)	4,9
5	Study of activation functions and its role	9
6	Implement gradient descent and backpropagation in deep neural network	9
7	Build a CNN model to classify Cat and dog image	9
8	Experiment using LSTM	9
9	Build a Recurrent Neural Network	9
10	Perform compression on mnist dataset using auto encoder	9
11	Experiments using Variational Autoencoder	9
12	Implement a Deep Convolutional GAN to generate complex color images	9
13	Understanding the architecture of Pre-trained Model.	9
14	Implement a Pre-trained CNN model as a Feature Extractor using Transfer Learning models	9
15	Implement a YOLO model to detect objects	9



Course Code:	23DSEU7P03
Course Name:	Data Visualization

L	T	P	Credit
1		2	2

Course Prerequsites:

Data Analytics Tools, Statistics and Probability, Programming Fundamentals (Python/JavaScript)

Course Description:

This course focuses on the principles, theories, and advanced techniques of effective data visualization. Students will learn the cognitive and perceptual foundations of visual communication, design principles for creating impactful visualizations, and advanced interactive visualization techniques. The course emphasizes storytelling with data, dashboard design, and modern web-based visualization frameworks beyond basic plotting libraries.

Course Outcomes:	After the completion of the course the student will be able to -	SDG
CO1	Apply visual perception principles and design theory to create effective data visualizations	4,10
CO2	Design and develop interactive web-based visualizations and dashboards to enable exploratory data analysis	9
CO3	Construct data stories and narrative visualizations that communicate complex insights effectively and evaluate visualization quality using established metrics and heuristics.	4,17

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	2	2	2				1		2	3
CO2	3	3	3	2	3	2	2						3	3
CO3	1	3	3	3	3	3	3						2	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation (ISE)	50%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	End Semester Examination (POE)	50%	100% course contents

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Course Contents:			SDG
Unit 1	**Foundations of Data Visualization**	**4 Hours**	
Human visual perception: Pre-attentive attributes, Gestalt principles, color theory, Data types and their visual encoding: Nominal, ordinal, quantitative, temporal, spatial Visual encoding channels: Position, length, angle, area, volume, color, texture Marks and channels framework for visualization design, Expressiveness and effectiveness criteria Visual design principles: Contrast, hierarchy, balance, emphasis, unity Accessibility in visualization: Color blindness, universal design principles Cognitive load and information processing theory Tufte's principles: Data-ink ratio, chartjunk, and visual integrity			4,10
Unit 2	**Interactive Visualization and Web Technologies**	**6 Hours**	
Introduction to web-based visualization: HTML5, CSS3, SVG, Canvas D3.js architecture: Selections, data binding, scales, axes, transitions Interactive techniques: Brushing and linking, zooming and panning, filtering, details-on-demand Animation principles for data visualization Responsive and adaptive visualization design Alternative frameworks: Vega-Lite, Observable, Bokeh Real-time data visualization techniques Geospatial visualization: Map projections, choropleth maps, cartograms			9
Unit 3	**Data Storytelling and Advanced Visualization**	**6 Hours**	
Narrative visualization: Author-driven, reader-driven, and hybrid approaches Story structure for data: Setup, conflict, resolution Dashboard design principles and patterns Information architecture for visual analytics Visual analytics frameworks and systems Uncertainty visualization techniques High-dimensional data visualization: Parallel coordinates, scatterplot matrices, dimensionality reduction Temporal visualization: Time series patterns, event sequences, calendars Comparative visualization techniques			4,16

Text Books:

1. "Visualization Analysis and Design" - Tamara Munzner (CRC Press) - 1st Edition (Units 1, 2)
2. "Interactive Data Visualization for the Web" - Scott Murray (O'Reilly Media) - 2nd Edition (Unit 2)
3. "Storytelling with Data" - Cole Nussbaumer Knaflic (Wiley) (Unit 3)

Reference Books:

1. "The Visual Display of Quantitative Information" - Edward Tufte (Graphics Press)
2. "Information Visualization: Perception for Design" - Colin Ware (Morgan Kaufmann) - 3rd Edition
3. "Design for Information" - Isabel Meirelles (Rockport Publishers)
4. "Data Visualization: A Practical Introduction" - Kieran Healy (Princeton University Press)
5. "Fundamentals of Data Visualization" - Claus O. Wilke (O'Reilly Media)
6. "The Truthful Art" - Alberto Cairo (New Riders)

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List of Experiments		SDGs
1	Designing encodings for different data types	4,10
2	Building basic SVG-based visualizations	9
3	Creating interactive charts with D3.js (bar, line, scatter, hierarchical)	4,9
4	Implementing brushing and linking across multiple views	4,16
5	Developing animated transitions for data updates	7,12
6	Creating interactive maps with projections	11,13
7	High-dimensional data visualization: Parallel coordinates, scatterplot matrices, dimensionality reduction	17
8	Creating narrative visualizations with Scrollytelling techniques	4,16
9	Designing comprehensive analytical dashboards	9,16,17



Course Code:	23DSEU7M04		L	T	P	Credit
Course Name:	Big Data Analytics		2			2

Course Prerequsites:

Object-Oriented Programming (Java/Python)
Database Management Systems (DBMS) & SQL
Data Structures and Algorithms
Basic Linear Algebra and Statistics

Course Description:

This course introduces the fundamentals of Big Data Analytics, focusing on big data concepts, Hadoop architecture, MapReduce programming, NoSQL databases, Apache Hive, and Apache Spark. Students gain an understanding of distributed data processing frameworks and basic analytical techniques used for handling large-scale datasets.

Course Outcome	After the completion of the course the student will be able to -	SDGs
CO1	Explain the concepts of Big Data and the Hadoop ecosystem.	4,9
CO2	Implement basic MapReduce applications and manage data using HDFS.	4,9
CO3	Perform data storage and querying using MongoDB and Hive.	4,9
CO4	Apply Apache Spark for basic big data processing and analytics.	4,9

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2							2	3	
CO2	3	3	2	2	3							1	3	2
CO3	3	2	3		3								3	3
CO4	3	3	3	2	3							2	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents

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Course Contents			SDGs
Unit 1	**Introduction to Big Data**	**8 Hours**	4,9
Classification and characteristics of data, Evolution and definition of Big Data, Traditional Business Intelligence vs Big Data, Data warehouse and Hadoop environment, Big Data Analytics, Types of analytics, Technologies used in Big Data, Introduction to NoSQL and Hadoop ecosystem			
Unit 2	**Hadoop and MapReduce**	**8 Hours**	4,9
Introduction to Hadoop, Need for Hadoop, RDBMS vs Hadoop, Hadoop architecture, HDFS, YARN, MapReduce programming model, Mapper and Reducer, Combiner and Partitioner, Searching, Sorting and Compression			
Unit 3	**NoSQL and Hive**	**4 Hours**	4,9
Introduction to MongoDB, MongoDB data model, Data types, MongoDB Query Language, Introduction to Hive, Hive Architecture, Hive Data Types, Hive Query Language (HQL)			
Unit 4	**Apache Spark and Big Data Applications**	**8 Hours**	4,9
Introduction to Apache Spark, Spark Architecture , Data Processing using Spark, Basic Data Analysis with Spark, Overview of Text Mining, Overview of Web Mining and PageRank (Concept only)			

Text Books:

1. Seema Acharya and Subhashini Chellappan “Big data and Analytics” Wiley India Publishers, 2nd Edition,
2019.
2. Rajkamal and Preeti Saxena, “Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning”
McGraw Hill Publication, 2019.

Reference Books

1. Adam Shook and Donald Mine, “MapReduce Design Patterns: Building Effective Algorithms and Analytics
for Hadoop and Other Systems” - O'Reilly 2012
2. Tom White, “Hadoop: The Definitive Guide” 4th Edition, O’reilly Media, 2015.
3. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques,
Pearson India Education Service Pvt. Ltd., 1st
Edition, 2016
4. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning for Predictive Data
Analytics: Algorithms, Worked Examples, MIT Press 2020, 2nd Edition

Web links and Video Lectures (e-Resources):

- https://www.kaggle.com/datasets/grouplens/movielens-20m-dataset
- https://www.youtube.com/watch?v=bAyrObl7TYE&list=PLEiEAq2VkUUJqp1k-g5W1mo37urJQOdCZ
- https://www.youtube.com/watch?v=VmO0QgPCbZY
- https://www.youtube.com/watch?v=GG-VRm6XnNk

https://www.youtube.com/watch?v=JglO2Nv_92A

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Course Code:	23DSEU7E05
Course Name:	Business Intelligence

L	T	P	Credit
3			3

Course Prerequsites:

Basic knowledge of programming, database management systems, data structures, and introductory statistics is required. Familiarity with data analysis concepts and SQL will be beneficial.

Course Description:

This course provides an overview of Business Intelligence concepts and analytical techniques used for data-driven decision making. It covers data warehousing, data mining, visualization, performance management, text analytics, web analytics, and social analytics.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Define basic concepts ,Architecture and data warehousing related concepts of Business Intelligence	4, 9
CO2	Demonstrate the impact of business reporting, information visualization, and dashboards.	4, 9
CO3	Apply text analytics and web analytics business intelligence methods to various situations.	4, 9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	2				2	3	3	3	3	3
CO2	2	3	2	3	2	3		3	3	3	3	3	3	3
CO3	1	3	2	3	2	3		3	3	3	3	3	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:			SDGs
Unit 1	**Introduction to Business Intelligence**	**8 Hours**	
Introduction to Business Intelligence (BI), Need for Business Intelligence in Organizations, Framework for Business Intelligence (BI), Architecture of Business Intelligence Systems (Data sources, Data integration layer, Data warehouse, Analytics and reporting layer) Benefits and Business Value of BI, Role of BI in Decision Making (Strategic, Tactical, Operational), Comparison of Business Intelligence with Competitive Intelligence and Knowledge Management, Applications of BI in different domains (Finance, Marketing, Healthcare, Retail overview)			9, 8, 3.
Unit 2	**Data warehousing**	**7 Hours**	
Introduction to Data Warehousing, Characteristics of Data Warehousing, Data Marts and their Types, Data Warehousing Process, Data Warehousing Architectures(Single-tier, Two-tier, and Three-tier architectures), Data Integration, Extraction Transformation and Load (ETL) Process, OLAP versus OLTP, Data Warehousing Implementation Issues, Real-Time Data Warehousing			9
Unit 3	**Business Reporting, Visual Analytics and Business Performance Management**	**6 Hours**	
Introduction to Business Reporting, Data and Information Visualization, Types of Charts and Graphs, Emergence of Data Visualization and Visual Analytics, Performance Dashboards, Balanced Scorecard, Dashboards versus Scorecards, Six Sigma as a Performance Measurement System			8, 9
Unit 4	**Data mining – Supervised and unsupervised learning**	**8 Hours**	
Introduction to Data Mining, Data Mining Concepts and Applications, Data Mining Process, Data Mining Methods, Supervised Learning Techniques, Unsupervised Learning Techniques, Association Rule Mining, Data Mining Software Tools, Case Studies, OLAP and ETL Tools: Case Studies			9, 4
Unit 5	**Text Analytics, Text Mining and Sentiment Analysis**	**7 Hours**	
Introduction to Text Analytics and Text Mining, Text Analytics and Text Mining: Concepts and Definitions,Text Mining Process, Text Mining Tools, Sentiment Analysis Overview, Sentiment Analysis Applications, Sentiment Analysis Process			9, 12
Unit 6	**Web Analytics, Web Mining, and Social Analytics**	**6 Hours**	
Introduction to Web Mining, Web Mining Overview, Web Content Mining and Web Structure Mining, Search Engines, Search Engine Optimization (SEO), Web Usage Mining, Web Analytics Maturity Model, Web Analytics Tools, Social Analytics, Social Network Analysis			8, 9

Text Books:

Ramesh Sharda, Dursun Delen, Efraim Turban, Business Intelligence and Analytics, Pearson 10th edition, 2018 .

Reference Books:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, Business Intelligence, Analytics, and Data Science: A Managerial
Perspective, 4th Edition, Pearson, 2017
2. "Business Intelligence For Dummies" by Swain Scheps.



Course Code:	23DSEU7E06
Course Name:	Big Data Analytics

L	T	P	Credit
3			3

Course Prerequsites:

Object-Oriented Programming (Java/Python)
Database Management Systems (DBMS) & SQL
Data Structures and Algorithms
Basic Linear Algebra and Statistics

Course Description:

This course provides a comprehensive introduction to Big Data Analytics, covering the architectures, tools, and algorithms required to process massive datasets. Students will explore the transition from traditional business intelligence to distributed frameworks, mastering the core components of Apache Hadoop (HDFS and YARN) and the MapReduce programming model. The curriculum details key ecosystem components, including MongoDB for document-based NoSQL storage, Apache Hive and Pig for data warehousing and procedural workflows, and Apache Spark for high-performance, in-memory processing. Finally, students will analyze unstructured data through text mining, web graph analysis, and ranking algorithms.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	To implement MapReduce programs for processing big data.	4,9
CO2	To realize storage and processing of big data using MongoDB, Pig, & Hive	4,9
CO3	To manage big data using Spark	4,9
CO4	To analyze big data using machine learning techniques.	4,9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	1	-	-	1	1	1	2	3	2
CO2	3	2	2	1	3	-	-	-	1	1	1	2	3	2
CO3	3	2	2	2	3	-	-	-	1	1	1	2	3	2
CO4	3	3	3	3	3	1	-	-	1	1	1	2	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:			SDGs
Unit 1	**INTRODUCTION**	**8 Hours**	
Classification of data, Characteristics, Evolution and definition of Big data, What is Big data, Why Big data, Traditional Business Intelligence Vs Big Data,Typical data warehouse and Hadoop environment. Big Data Analytics: What is Big data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments, Few Top Analytical Tools , NoSQL, Hadoop.			4,9
Unit 2	**Introduction to Hadoop**	**8 Hours**	
Introduction to Hadoop: Introducing hadoop, Why hadoop, Why not RDBMS, RDBMS Vs Hadoop, History of Hadoop, Hadoop overview, Use case of Hadoop, HDFS (Hadoop Distributed File System),Processing data with Hadoop, Managing resources and applications with Hadoop YARN(Yet Another Resource Negotiator). Introduction to Map Reduce Programming: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.			4,9
Unit 3	**Introduction to MongoDB:**	**6 Hours**	
What is MongoDB, Why MongoDB, Terms used in RDBMS and MongoDB, Data Types in MongoDB, MongoDB Query Language.			4,9
Unit 4	**Introduction to Hive:**	**8 Hours**	
What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF). Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig, Pig Latin Overview, Data types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Eval Function, Complex Data Types, Piggy Bank, User Defined Function, Pig Vs Hive.			4,9
Unit 5	**Spark and Big Data Analytics:**	**6 Hours**	
Spark, Introduction to Data Analysis with Spark.			4,9
Unit 6	**Text, Web Content and Link Analytics:**	**6 Hours**	
Introduction, Text Mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and Analyzing a Web Graph.			4,9

Text Books:

1. Seema Acharya and Subhashini Chellappan “Big data and Analytics” Wiley India Publishers, 2nd Edition,
2019.
2. Rajkamal and Preeti Saxena, “Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning”
McGraw Hill Publication, 2019.

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Reference Books:

1. Adam Shook and Donald Mine, “MapReduce Design Patterns: Building Effective Algorithms and Analytics
for Hadoop and Other Systems” - O'Reilly 2012
2. Tom White, “Hadoop: The Definitive Guide” 4th Edition, O’reilly Media, 2015.
3. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques,
Pearson India Education Service Pvt. Ltd., 1st
Edition, 2016
4. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning for Predictive Data
Analytics: Algorithms, Worked Examples, MIT Press 2020, 2nd Edition

Web links and Video Lectures (e-Resources):

- https://www.kaggle.com/datasets/grouplens/movielens-20m-dataset
- https://www.youtube.com/watch?v=bAyrObl7TYE&list=PLEiEAq2VkUUJqp1k-g5W1mo37urJQOdCZ
- https://www.youtube.com/watch?v=VmO0QgPCbZY
- https://www.youtube.com/watch?v=GG-VRm6XnNk

https://www.youtube.com/watch?v=JglO2Nv_92A



Course Code:	23DSEU7E07		L	T	P	Credit
Course Name:	Social Network Analysis		3			3

Course Prerequsites:
Networks fundamentals

Course Description:
This course mainly describes about social network and semantic web which are used to learn knowledge representation using ontology and also understand human behavior in social web and related communities.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Ability to design and develop semantic web related applications	9, 17
CO2	Ability to represent knowledge using ontology	9, 16, 17
CO3	Ability to predict human behavior in social web and related communities	10, 11, 16
CO4	Ability to visualize social networks	9, 11, 16

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	2	1		3	1	2	3	1	3	1
CO2	2	2	1	1	2	1		3	1	2	3	2	3	1
CO3	2	2	2	2	2	1		3	1	2	3	1	3	1
CO4	2	1	1	2	3	1		3	1	2	3	1	3	1
CO5														

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents

Course Contents:			SDGs
Unit 1	**INTRODUCTION**	**8 Hours**	
Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Web-based networks – Applications of Social Network Analysis			9, 17
Unit 2	**MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION**	**8 Hours**	
Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.			9, 16, 17
Unit 3	**EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS**	**6 Hours**	

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Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – Multi-Relational characterization of dynamic social network communities.			10, 11, 16, 17
Unit 4	**PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES**	**6 Hours**	
Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.			10, 16
Unit 5	**VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS**	**6 Hours**	
Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrix-based representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – Co-Citation networks.			9, 11, 17

Text Books:

1. Peter Mika, —Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, —Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

Reference Books:

1. Guandong Xu ,Yanchun Zhang and Lin Li,-Web Mining and Social Networking – Techniques and applications, First Edition, Springer, 2011.
2. Dion Goh and Schubert Foo,-Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant and Stefan Decker, -The Social Semantic Web, Springer, 2009.

D.Y. PATIL EDUCATION SOCIETY KOLHAPUR Kasba Bawada, Kolhapur

Course Code:	23DSEU7E08
Course Name:	Image Processing

L	T	P	Credit
3	0	0	3

Course Prerequsites:

Basic knowledge of signals and systems, linear algebra, probability, and programming in Python

Course Description:

This course introduces the principles and techniques of digital image processing, covering image acquisition, enhancement, restoration, segmentation, compression, and color processing, with practical applications using tools like Python

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Understand the basics of digital images and image acquisition.	4,9
CO2	Apply spatial and frequency domain techniques for image enhancement.	9,3
CO3	Perform image restoration and color image transformations.	9,3
CO4	Implement image segmentation, morphological operations, and compression methods.	3,9,11

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2				1	2	1	1	3	3
CO2	3	3	2	3	2				1	2	2	1	3	3
CO3	3	2	2	2	2				1	2	1	1	3	3
CO4	3	2	2	2	2				1	2	2	1	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation1 [10 Marks]	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination [30 Marks]	30%	50% Course Contents
3	In Semester Evaluation2 [10 Marks]	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination [50 Marks]	50%	100% Course Contents

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Course Contents:			SDGs
Unit 1	**Introduction to Digital Image Processing**	**6 Hours**	4,9
Fundamentals of image processing and computer vision, image sensing, acquisition and representation, sampling and quantization, basic relationships between pixels, imaging modalities: grayscale, color, binary			
Unit 2	**Image Enhancement in Spatial Domain**	**7 Hours**	3,9
Intensity transformations: contrast stretching, thresholding, histogram processing: equalization, matching, smoothing and sharpening filters (linear and non-linear), Laplacian and gradient-based enhancement			
Unit 3	**Image Enhancement in Frequency Domain**	**8 Hours**	9,3
Fourier Transform and DFT for images, frequency domain filtering: low pass, high pass, band pass, homomorphic filtering, Fast Fourier Transform (FFT)			
Unit 4	**Image Restoration and Color Processing**	**7 Hours**	3,9
Degradation model, noise models, restoration filters: inverse, Wiener, median, color image processing: RGB, HSV, HSI models, pseudocolor and full-color processing			
Unit 5	**Image Segmentation and Morphological Processing**	**8 Hours**	3,9,11
Edge detection: Sobel, Prewitt, Canny, thresholding, region growing, watershed segmentation, morphological operations: erosion, dilation, opening, closing, boundary detection and object representation			
Unit 6	**Image Compression and Applications**	**6 Hours**	3,9,11,13
Fundamentals of image compression, lossless vs lossy compression, Huffman coding, Run-Length encoding, JPEG compression, applications: medical imaging, satellite image processing, OCR			

Text Books:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education, 4th Edition
2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, Digital Image Processing, McGraw Hill Education

Reference Books:

1. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall
2. William K. Pratt, Digital Image Processing, Wiley
3. Bhabatosh Chanda & Dwijesh Dutta Majumder, Digital Image Processing and Analysis, PHI
4. Kenneth R. Castleman, Digital Image Processing, Pearson

D.Y. PATIL EDUCATION SOCIETY KOLHAPUR
Kasba Bawada, Kolhapur

Course Code:	23DSEU7E09
Course Name:	Natural Language Processing

L	T	P	Credit
3			3

Course Prerequsites:

Basic Python programming skills, Fundamentals of probability and statistics, Introductory machine learning concepts

Course Description:

This course introduces the fundamentals and modern techniques of Natural Language Processing (NLP). It covers text preprocessing, language modeling, text classification, sentiment analysis, vector semantics, embeddings, sequence labeling, and lexical resources. Students will gain hands-on experience with popular NLP tools and explore recent trends such as transformer-based models and real-world applications like question answering and chatbots.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Explain the core concepts and challenges in natural language processing.	4
CO2	Apply language modeling, text preprocessing, and classification techniques to text data.	4,9
CO3	Implement NLP applications using standard tools and resources.	9
CO4	Analyze recent trends and resources in NLP for real-world applications.	9,10

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	2	1			2								2	1
CO3	1	2	2	2	3								3	3
CO4		3	2	3	3								3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:			SDGs
Unit 1	**Introduction**	**7 Hours**	4,9
Origins and challenges of NLP, Levels of NLP (morphology, syntax, semantics, pragmatics), Ambiguity and language complexities, Text normalization, Regular expressions, Corpora, Applications of NLP in real-world systems			
Unit 2	**Language Modelling & Text Preprocessing**	**9 Hours**	4,9
N-gram models (unigram, bigram, trigram), Evaluating language models (perplexity, entropy), Smoothing techniques (Laplace, Kneser-Ney), Minimum Edit Distance (MED), Spelling correction, Stop-word removal, Stemming, Lemmatization, Introduction to NLP tools (NLTK, spaCy)			
Unit 3	**Text Classification & Sentiment Analysis**	**7 Hours**	9,10
Naive Bayes classifier for text classification, Sentiment analysis approaches (rule-based VADER, statistical), Feature representation (Bag-of-Words, TF-IDF), Evaluation metrics (Precision, Recall, F1-score), Ethical considerations in classification			
Unit 4	**Vector Semantics & Embeddings**	**7 Hours**	9,10
Lexical semantics and word similarity, Vector space models (TF-IDF, PMI), Word embeddings (Word2Vec basics), Applications of embeddings in NLP tasks, Bias in embeddings and mitigation strategies			
Unit 5	**Sequence Labeling & Named Entity Recognition**	**7 Hours**	4,9
English word classes, Part-of-Speech tagging (rule-based, HMM), Named Entity Recognition (NER) basics, Conditional Random Fields (CRFs) for sequence labeling, Evaluation of tagging and NER systems, Hands-on with spaCy for POS and NER			
Unit 6	**Lexical Resources & Recent Trends**	**8 Hours**	4,9
WordNet (synsets, synonyms, antonyms, word senses), Word Sense Disambiguation (WSD) techniques, Lexical resources (Treebank, PropBank, Indian WordNet), Recent trends in NLP (transformers overview: BERT, GPT), Applications (Question answering, chatbots)			

Text Books:

1. “Natural language processing and Information Retrieval” Tanveer Siddiqui, U.S. Tiwary, Oxford
2. “Speech and Language Processing” Daniel Jurafsky and James H Martin 2E, Pearson Education

Reference Books:

1. “Natural language Understanding”, James Allen 2e, Pearson Education
2. “Natural language processing”: a Paninian perspective, Bharati A., Sangat R., Chaitanya V.. PHI



Course Code:	23DSEU7E10
Course Name:	Soft Computing

L	T	P	Credit
3			3

Course Prerequsites:

Basic knowledge of mathematics (linear algebra, probability, and calculus).
Fundamentals of programming (C, Python, or equivalent).
Basic understanding of data structures and algorithms.
Familiarity with artificial intelligence and machine learning concepts is desirable.

Course Description:

This course introduces soft computing techniques including neural networks, fuzzy logic, and evolutionary algorithms, focusing on their application to real-time problem solving, decision-making, optimization, expert systems, and hybrid intelligent models for complex engineering applications.

Course Outcomes: After the completion of the course the student will be able to -

CO1	Describe various soft computing concepts for practical applications and Apply suitable neural network for real time problems.
CO2	Apply the various hybrid soft computing techniques in real time problems
CO3	Apply fuzzy rules and reasoning to develop decision making and expert system.
CO4	Explain the importance of optimization techniques and genetic programming

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	SDGs
CO1	3	3	2	2	2	-	-	-	-	-	-	2	3	2	4,9,11
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	3	4,9,16
CO3	3	3	3	2	1	1	-	-	-	-	-	2	2	3	4,9,16
CO4	3	3	2	2	1	-	1	-	-	-	-	2	2	2	4,8,9,12

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:			SDGs
Unit 1	**Introduction**	**7 Hours**	
Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models - important technologies - applications. Fuzzy logic: Introduction - crisp sets- fuzzy sets crisp relations and fuzzy relations: cartesian product of relation - classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Genetic algorithm- Introduction - biological background, traditional optimization and search techniques - Genetic basic concepts.			4,9
Unit 2	**Neural networks**	**7 Hours**	
McCulloch-Pitts neuron - linear separability - hebb network - supervised learning network: perceptron networks - adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: autoassociative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonen self organizing feature maps, LVQ – CP networks, ART network.			4,9
Unit 3	**Fuzzy Logic**	**7 Hours**	
Membership functions: features, fuzzification, methods of membership value assignments- Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules - decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning- fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.			4,9,16
Unit 4	**Genetic Algorithms**	**7 Hours**	
Genetic algorithm and search space - general genetic algorithm – operators - Generational cycle stopping condition – constraints - classification - genetic programming – multilevel optimization – real life problemadvances in GA.			4,8,9,12
Unit 5	**Hybrid Soft Computing Techniques**	**7 Hours**	
Neuro-fuzzy hybrid systems - genetic neuro hybrid systems - genetic fuzzy hybrid and fuzzy genetic hybrid systems - simplified fuzzy			4,9,11
Unit 6	**ARTMAP - Applications**	**7 Hours**	
A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.			4,9,11,12

Text Books:

1. S.N.Sivanandam and S.N.Deepa,,Principles of Soft Computing,,3rd Edition Wiley India Pvt Ltd, 2018.
2. J.S.R.Jang, C.T. Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, 2nd Edition PHI / Pearson Education 2014.

Reference Books:

1. S.Rajasekaran and G.A.Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications, 4th edition,Prentice-Hall of India Pvt. Ltd., 2016.
2. David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning, 2nd Edition, Pearson Education India, 2013.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_cs17/preview

D.Y. PATIL EDUCATION SOCIETY Deemed to be University Kasba Bawada, Kolhapur KOLHAPUR

Course Code:	23CSEU7R11
Course Name:	Research Methodology

L	T	P	Credit
4			4

Course Prerequsites:

Fundamental knowledge of statistics and mathematics.
Basic English communication and academic writing skills.
Analytical thinking and problem-solving ability.

Course Description:

This course introduces the fundamentals of research methodology, including research design, data collection, sampling, statistical analysis, hypothesis testing, report writing, and research ethics. It also covers citation methods, reference management tools, and the use of software such as SPSS, R, and Python for research. The course prepares students to conduct and communicate ethical, systematic, and high-quality research in engineering and technology.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Understand the meaning, objectives, types of research, research process, and formulate research problems	4, 9
CO2	Apply various sampling techniques, data collection methods, and analyze research data using appropriate statistical techniques and tests of significance.	4, 9
CO3	Prepare research reports, thesis writing, research proposals, and communicate research findings effectively through presentations.	4, 9, 17
CO4	Apply research ethics, understand plagiarism issues, and follow proper citation and referencing methods in academic writing.	4, 16

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	1					1	1	1		
CO2	1	2		3	3						2	2	3	
CO3	1				1	3			2	3	3	1		
CO4	1		2		1			3		2		2	1	2

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:			SDGs
Unit 1	**Introduction to Research and Research Problem**	**8 Hours**	
Meaning of Research, Objectives of Research, Motivation in Research, Types of Research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Methods vs. Methodology. Research Process - Steps involved in research process. Criteria of Good Research. Problems Encountered by Researchers in India. Defining the Research Problem - Selecting the problem, Necessity of defining the problem, Technique involved in defining a problem.			4, 9
Unit 2	**Research Design**	**8 Hours**	
Meaning of Research Design, Need for Research Design, Features of a Good Design. Important Concepts Relating to Research Design - Dependent and Independent Variables, Extraneous Variable, Control, Confounded Relationship, Research Hypothesis, Experimental and Non-Experimental Hypothesis-testing Research. Different Research Designs - Research design in case of exploratory research studies, Descriptive and Diagnostic research studies, Hypothesis-testing research studies. Basic Principles of Experimental Designs - Principle of Replication, Principle of Randomization, Principle of Local Control. Important Experimental Designs - Informal Experimental Designs, Formal Experimental Designs (Completely Randomized Design, Randomized Block Design, Latin Square Design, Factorial Designs)			4, 9
Unit 3	**Sampling and Data Collection**	**6 Hours**	
Census and Sample Survey. Implications of a Sample Design. Steps in Sampling Design. Criteria of Selecting a Sampling Procedure. Characteristics of a Good Sample Design. Different Types of Sample Designs - Probability Sampling (Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling, Area Sampling, Multi-stage Sampling) and Non-probability Sampling (Deliberate Sampling, Convenience Sampling, Quota Sampling). Methods of Data Collection - Primary Data - Observation Method, Interview Method, Collection through Questionnaires, Collection through Schedules. Secondary Data - Sources of secondary data, Precautions in using secondary data. Selection of Appropriate Method for Data Collection.			4, 16
Unit 4	**Processing and Analysis of Data**	**8 Hours**	
Processing Operations - Editing, Coding, Classification, Tabulation. Statistics in Research - Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Range, Quartile Deviation, Mean Deviation, Standard Deviation). Measures of Asymmetry (Skewness). Measures of Relationship (Correlation - Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation). Regression Analysis - Simple Linear Regression, Multiple Regression. Testing of Hypotheses - Basic Concepts concerning Testing of Hypotheses (Null Hypothesis and Alternative Hypothesis, Level of Significance, Decision Rule, Type I and Type II Errors). Flow Chart for Hypothesis Testing Procedure. Important Parametric Tests - z-test, t-test, F-test (ANOVA). Chi-square Test as a Non-parametric Test. Computer Software Packages for Data Analysis - SPSS, R, Python basics.			4, 9
Unit 5	**Interpretation and Report Writing**	**8 Hours**	
Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation. Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report - Preliminary Pages, Main Text, End Matter. Types of Reports - Technical Report, Popular Report, Thesis/Dissertation format. Writing Research Proposal - Purpose and format of research proposal, Components (Introduction, Review of Literature, Research Methodology, Expected Results, Budget and Time Schedule). Presentation of Research Work - Oral Presentation, Poster Presentation. Mechanics of Writing a Research Report - Layout, Structure and Language of Report, Footnotes, Appendix, Bibliography and References. Precautions for Writing Research Reports.			4, 9, 17
Unit 6	**Research Ethics and Citation Methods**	**6 Hours**	
Ethics in Research - Research involving human subjects, Animal rights and research, Ethical issues in data collection and analysis, Informed consent, Privacy and confidentiality. Academic Integrity - Plagiarism (Types, Detection, Prevention), Fabrication and Falsification of data, Authorship issues. Citation and Referencing - Importance of citations, Different Citation Styles (APA Style, IEEE Style, ACM Style, Harvard Style, Chicago Style). In-text Citations and Reference List preparation. Using Reference Management Software - Mendeley, Zotero, EndNote basics. Intellectual Property Rights in Research - Copyright, Patents in Computer Science context. Publication Ethics - Duplicate publication, Predatory journals, Peer review process.			4, 16



Text Books:

1. C.R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publishers, 4th Edition (2004).
2. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications, 5th Edition (2019).

Reference Books:

1. John W. Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", SAGE Publications, 5th Edition.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta and Company Ltd, 2nd Edition.
3. Anol Bhattacherjee, "Social Science Research: Principles, Methods, and Practices", University of South Florida, 2nd Edition.
4. Donald H. McBurney and Theresa L. White, "Research Methods", Cengage Learning, 8th Edition.



Course Code:	23DSEU7J12
Course Name:	Project

L	T	P	Credit
		8	4

Course Prerequsites:

Completion of the prescribed courses in the Major Engineering Programme and the Multidisciplinary Minor Programme.
Basic knowledge of engineering design, programming/software tools, research methodology, and project development.

Course Description:

The Capstone Project is the culminating component of the Multidisciplinary Minor Programme. It enables students to integrate knowledge acquired from their major discipline and multidisciplinary minor to solve real-world engineering, industrial, societal, or research problems.

Course Outcomes:	After the completion of the course the student will be able to -	**SDGs**
CO1	Identify and analyze a real-world engineering problem related to society, industry, and individuals.	4, 11, 17
CO2	Design and develop an innovative engineering solution as per the requirements	9, 8, 12
CO3	Implement, test, and evaluate the proposed solution considering technical, ethical, environmental, and societal aspects.	9, 12, 13, 16
CO4	Demonstrate effective teamwork, project management, technical documentation, and professional communication through successful project execution and presentation.	4, 8, 17

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	1	2	1					1	1	2
CO2	2	2	3	2	3	1	1		1		2	2	2	2
CO3	2	2	3	3	3	2	2	2	1	1	1	2	2	3
CO4			1		1			2	3	3	3	2	2	

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	Internal POE	50%	
2	External POE	50%	

D.Y. PATIL EDUCATION SOCIETY Kasba Bawada, Kolhapur KOLHAPUR

Guidelines

Students have to form teams that consist of four to five members. Every group will have to submit their area of interest and the corresponding student details through the provided form. Next, in accordance with the selected area of interest and in consideration of the expertise of the faculty, every group will get a guide.

Topic selection and finalization process will take place at the hands of the project evaluation team. After topic selection and finalization, there will be a need for the group to move forward with the preparation and presentation of the project's synopsis inline with the standard document format provided by the Programme Evaluation Committee. The group will need to prepare an SRS document. Evaluation of SRS will be done considering many aspects such as requirement gathering, requirement analysis, teamwork and presentation.

The project selected will be implemented and tested as per the guidelines provided by the group guide. The Project Documentation/Report would be submitted at the end of the semester. The guidelines for all Documentations will be duly provided by the department at relevant time frames.



D. Y. PATIL DEEMED TO BE UNIVERSITY
SCHOOL OF ENGINEERING AND MANAGEMENT
Teaching and Evaluation Scheme from Year 2023-24 (as per NEP-2020)
B. Tech. Data Science Engineering (SEMESTER- VIII)

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme				Theory			Practical		Total Marks
				Credits	Contact Hrs			ISE	MSE	ESE	INT	OE/ PoE	
					L	P	T						
1	23DSEU8P01	PCC $	Agentic AI	**3**	3	-	-	20	30	50	-	-	100
2	23DSEU8P02	PCC $	Agentic AI Lab	**1**	-	2	-	-	-	-	25	-	25
3	23DSEU8M03	MDM-VI $	Capstone Project	**2**	-	4	-	-	-	-	25	25	50
4	23DSEU8E04	PEC-VI $	Computer Vision	2	2	-	-	-	-	50	-	-	50
5	23DSEU8E05		Human Computer Interaction										
6	23DSEU8E06		Augmented and Virtual Reality										
7	23DSEU8I07	INT	Internship	**12**	-	24	-	-	-	-	200	200	400
			Total	**20**	**5**	**30**	**-**						**625**

Note:
$ - Open & Distance Learning
* - Values are not included in total marks
Min. Marks for Passing: 40% of total marks of individual course

HONORS

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme				Theory			Practical		Total Marks
				Credits	L	P	T	ISE	MSE	ESE	INT	OE/	
1	23DSEU8Z01	Honors	Capstone Project Cyber Security$	2	-	4	-	-	-	-	50	-	50



Course Code:	23DSEU8P01
Course Name:	AgenticAI

L	T	P	Credit
3			3

Course Prerequsites:

Data Structures, Intermediate Python Object-Oriented Programming (OOP), and Foundational Natural Language Processing (NLP).

Course Description:

A comprehensive deep-dive into the architecture of Agentic AI. Students will move from theoretical reasoning frameworks to building, fine-tuning, and evaluating autonomous agents that can use tools and interact with external environments.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Explain the fundamental architecture of AI agents, specifically the "Think → Act → Observe" loop and the role of LLMs as reasoning engines.	4
CO2	Design and implement custom "Tools" for agents to interact with web APIs, databases, and local code environments.	4, 9
CO3	Develop multi-agent systems and agentic RAG workflows using frameworks like smolagents, LangGraph, or LlamaIndex.	9
CO4	Fine-tune models for function-calling and evaluate agent performance using modern observability and testing protocols.	9, 10

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	2	2	2
CO2	2	2	3	2	3	-	-	1	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	2	1	-	3	3	3
CO4	3	3	2	3	3	-	-	2	-	-	-	2	3	2

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents



Course Contents:

Unit 1	**Foundations of Agentic Intelligence & The ReAct Framework**	**6 Hours**	**SDGs**
Focus: Transitioning from static LLM prompting to dynamic, loop-based reasoning.Core Concepts:The anatomy of an Agent: Core LLM, System Prompts, Chat Templates, and Special Tokens.The Thought --Action --Observation loop.Deep dive into the ReAct (Reason + Act) paradigm.Building custom programmatic "Tools" via Python function parsing and docstring extraction.			4, 9
Unit 2	**Code-Executing Agents & smolagents**	**8 Hours**	
JSON/Text Tool-calling versus Code Execution modalities. The smolagents architecture (CodeAgent vs. ToolCallingAgent). Secure runtime sandboxing and state management for dynamic code execution. Multi-step autonomous tool creation.			9
Unit 3	Agentic RAG & Knowledge Retrieval	**8 Hours**	
Schedulability problem, Classification of real-time tasks, Schedulability tests , Worst Case Execution Time (WCET), Static scheduling, Dynamic scheduling, Dependent and independent tasks			9, 11
Unit 4	Data Driven Agents and Agentic RAGs	**8 Hours**	
Static RAG versus Agentic RAG. Semantic routing, document indexing, and vector database integration. Advanced query pipelines: Sub-question decomposition and query rewriting. Data Agents: Direct SQL database querying and structured API interaction.			5, 10
Unit 5	Multimodal Agents, Web Automation, & SLM Optimization	**8 Hours**	
Vision-Language Models (VLMs) as agent drivers. Web Browser Automation: DOM tree parsing and element bounding boxes. Fine-tuning Small Language Models (SLMs) for strict syntax and function calling. Local agent deployment using Ollama backends.			9
Unit 6	**Benchmarking, Safety, & Observability**	**6 Hours**	
Evaluation frameworks: GAIA and SWE-bench benchmarks. LLM-as-a-Judge validation methodologies. Execution tracing, debugging, and cost-tracking (LangSmith, Phoenix). Agent security: Prompt injection defenses and infinite loop mitigation.			9, 10, 11

Text Books:

https://huggingface.co/agents-course

Reference Books:

Supplementary Technical References



Course Code:	23DSEU8P02
Course Name:	Agentic AI Lab

L	T	P	Credit
		2	1

Course Prerequsites:

Proficiency in Python Programming (functions, object-oriented concepts, and basic error handling). Foundational understanding of Generative AI & LLMs (tokenization, prompting, API-based model consumption). Basic acquaintance with data libraries (Pandas) and databases (SQL) is helpful but not strictly required.

Course Description:

This hands-on laboratory course introduces students to the architecture, design patterns, and implementation of Agentic AI and multi-agent systems. Moving beyond static Large Language Model (LLM) prompts, students will learn to build autonomous systems capable of reasoning, planning, tool execution, and collaborative problem-solving. Utilizing industry-standard frameworks such as CrewAI, LangGraph, AG2 (AutoGen), and PydanticAI, students will design, debug, and deploy state-driven AI agents tailored for real-world domains like automated software workflows, data exploration, healthcare, and customer support.

Course Outcomes:	After the completion of the course the student will be able to -	**SDGs**
CO1	CO1 (Analyze & Design): Evaluate business and technical workflows to break them down into state-driven, multi-agent architectures using appropriate design patterns (sequential, routing, parallel).	4
CO2	CO2 (Implement & Orchestrate): Build and configure autonomous AI agents that successfully call external APIs, execute custom Python/SQL tools, and manage structured schema inputs safely.	4, 9
CO3	CO3 (Evaluate & Optimize): Implement self-reflection and multi-agent collaboration mechanisms to debug, critique, and optimize the quality of autonomous AI outputs.	9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2	3								2	1
CO2	2	3	2	3	3								3	3
CO3	2	3	2	3	3								3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	Internal Evaluation	100%	Assignment, Test, Quiz, Seminar, Presentation, etc.

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List of Experiments:		SDGs
1	Lab 1: Fundamentals of Autonomous Reasoning & ReAct — Implement the foundational thought-action-observation loop from scratch using raw Python.	4
2	Lab 2: Precision Tool-Calling & Input Validation — Bind functional math and logic tools to an LLM with strict error-handling defenses.	4, 9
3	API Integration & Web Content Extraction — Build an agent that securely pulls, parses, and summarizes live data from external web services.	9
4	Conversational SQL & Data Exploration — Create an AI data assistant that translates natural language queries into executable SQL commands.	9
5	State Management & Routing with LangGraph — Design a graph-based agent architecture with structured state transitions and conditional routing logic.	9
6	Multi-Agent Choreography with CrewAI — Orchestrate a team of role-specific agents wrapped in a front-end UI to handle complex, multimodal tasks.	9
7	Schema-Driven Design with PydanticAI — Enforce enterprise-grade data guardrails on agent inputs and outputs using strict Pydantic data schemas.	9
8	Self-Reflective Loops & Collaborative Research — Deploy a multi-agent system featuring automated self-critique nodes to iteratively optimize output quality.	9



Course Code:	23DSEU8E04
Course Name:	Computer Vision

L	T	P	Credit
2	0	0	2

Course Prerequsites:

Image Processing, Computer graphics ,Data structures

Course Description:

This course on Computer Vision introduces students to the fundamental principles, techniques, and applications of computer vision. Through hands-on experience, students will learn how to process, analyze, and interpret visual data from the world around us. The course covers topics such as image preprocessing, feature extraction, object detection, deep learning for computer vision, and advanced topics like generative models and autonomous systems. Students will also work with popular computer vision frameworks and libraries such as OpenCV, TensorFlow, and Keras

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Define computer vision and image processing and explain the basics of image representation	4,9
CO2	Apply edge detection techniques and image segmentation methods	9,3
CO3	Examine the principles of neural networks and deep learning and apply CNNs for image classification	9,4
CO4	Develop image analysis using the Google Cloud Vision API	9,8

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2				1	2	2	1	3	3
CO2	3	3	2	3	3				2	2	2	2	3	3
CO3	3	3	3	2	3	2	1	1	2	2	2	2	3	3
CO4	3	2	2	3	2	2	1		2	2	3	2	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation1 [10 Marks]	NA	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination [30 Marks]	NA	50% Course Contents
3	In Semester Evaluation2 [10 Marks]	NA	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination [50 Marks]	100%	100% Course Contents

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Course Contents:			SDGs
Unit 1	**Introduction to Computer Vision and Image Processing**	**6 Hours**	
Overview of Computer Vision, Image representation and formats, Basic image transformations (scaling, rotation, flipping), Image enhancement and filtering techniques, Color space conversions and histogram equalization, Introduction to OpenCV			9,3
Unit 2	**Detection, Extraction & Object Detection and Recognition**	**8 Hours**	
Key point detection and matching(SIFT, SURF, ORB), Edge detection techniques (Sobel, Canny, Laplacian), Image segmentation(Thresholding, Region Growing), Histogram of Oriented Gradients (HOG), Feature extraction using deep learning. Object detection vs. image classification, Haar Cascades and Viola-Jones Algorithm for face detection, Convolutional Neural Networks (CNN) for image classification, R-CNN, Fast R-CNN, Faster R-CNN for object detection, YOLO(You Only Look Once) for real-time object detection, SSD(Single Shot Multibox Detector)			9,3,11
Unit 3	**Deep Learning for Computer Vision**	**6Hours**	
Introduction to neural networks and deep learning, Training CNNs for image classification, Transfer learning and pre-trained models (VGG, ResNet, Inception), Data augmentation techniques, Generative Adversarial Networks (GANs) for image generation			9,4
Unit 4	**Visual Intelligence and Cloud-based Computer Vision Solutions**	**8 Hours**	
Image captioning using CNN and RNN, Semantic segmentation using models like U-Net and FCN, 3D computer vision: Stereo vision, depth sensors, Face recognition using deep learning (FaceNet, OpenFace), Object tracking techniques: Optical flow, Kalman filters and Deep SORT , Computer vision in autonomous systems (Self-driving cars), Google Cloud Vision API for image analysis, Training custom models using Google Cloud AutoML Vision, Cloud-based deployment and scaling using Google Cloud AI Platform, Real-time inference and monitoring using Google Cloud			9,17

Text Books:

1.“Programming Computer Vision with Python: Tools and algorithms for analyzing images”- Jan Erik Solem
2.“Learning OpenCV 4: Computer Vision with Python” by Adrian Kaehler and Gary Bradski
3.“Computer Vision: Algorithms and Applications” (2nd Edition)- Richard Szeliski

Reference Books:

1. “Hands-On Computer Vision with TensorFlow 2" by Benjamin Planche and Eliot Andres
2.“Cloud AI Services with Google Cloud: Building Smart Applications with Vision,
Language, and Conversation AI”- Gunjan Aggarwal

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Course Code:	23DSEU8E05
Course Name:	Human Computer Interaction

L	T	P	Credit
2			2

Course Prerequsites:

Basic knowledge of computers and introductory programming concepts.

Course Description:

This course introduces the principles and practices of Human–Computer Interaction, focusing on user-centered design, interface development, and usability evaluation to create effective and user-friendly interactive systems.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Understand the fundamental concepts, principles, and importance of Human–Computer Interaction.	4,9
CO2	Apply user-centered design principles to develop effective and usable user interfaces.	4,9,10
CO3	Evaluate and improve interactive systems using usability testing and evaluation techniques.	4,9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2			1				1	2		2	1	
CO2	2	3	2	2	2				2	3		1	2	2
CO3	1	3	2	3	3				1	2		2	3	3

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	End Semester Examination (ESE) [50 marks]	100% (50 Marks)	100% course contents



Course Contents:

Unit 1	**Introduction**	**6 Hours**	**SDGs**
Introduction to Human–Computer Interaction, Importance and Scope of HCI, Evolution and History of HCI, Interdisciplinary nature of HCI, Types of Human–Computer Interaction, Domains and applications of HCI, Interaction styles: command line, menu-based, form-based, direct manipulation			4,9
Unit 2	**Human Factors in Interaction**	**8 Hours**	
Human information processing, Cognitive models, Memory, perception, attention, Mental models, Human errors and error handling, Individual differences			4,9,10
Unit 3	**Interaction and Interface Design**	**8 Hours**	
Interaction styles: Command line, Menu-driven, Form fill-in, Direct manipulation User-centered design process, Principles of user interface design, Screen layout, color, icons, typography, Accessibility and universal design			4,9,10
Unit 4	**Usability Engineering and Applications**	**6 Hours**	
Usability goals and measures, Usability engineering lifecycle, Prototyping techniques, Usability testing and evaluation methods, Heuristic evaluation, Modern applications: mobile interfaces, VR/AR, Human–AI interaction			4,9

Text Books:

1. Human–Computer Interaction by Alan Dix et. al.
2. Usability for Beginners by Joel Sklar and Aaron Marcus
3. Interaction Design Foundation by Interaction Design Foundation

Reference Books:

1. Human-computer interaction by Preece, Jenny, Yvonne Rogers, Helen Sharp, David Benyon, Simon Holland, and Tom Carey. "Human-computer interaction". Addison-Wesley Longman Ltd., 1994.
Human–Computer Interaction by Alan Dix, Janet Finlay, Gregory D. Abowd and Russell Beale
2. Designing the User Interface by Ben Shneiderman, Catherine Plaisant, Maxine Cohen and Steven Jacobs
3. The Design of Everyday Things by Donald A. Norman

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Course Code:	23DSEU8E06
Course Name:	Augmented Reality and Virtual Reality

L	T	P	Credit
3			3

Course Prerequsites:

Basics of Computer Graphics

Course Description:

This course provides a comprehensive introduction to Augmented Reality (AR) and Virtual Reality (VR) technologies, focusing on their concepts, tools, and real-world applications. Students will learn how AR overlays digital content onto the real world, while VR creates fully immersive virtual environments. The course covers the theoretical foundations, hardware and software components, development platforms, and interaction techniques used in AR/VR systems.

Course Outcomes:	After the completion of the course the student will be able to -	SDGs
CO1	Describe the concept of virtual reality and Communication Media	4,9
CO2	Understand current virtual reality hardware and software	9
CO3	Understand various modeling approaches.	9
CO4	Illustrate the concepts of Human Factors and Applications of VR	3,9

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1										1			
CO2	1	2			2					1	2		1	
CO3	1	1	2	1	3			2				2	2	2
CO4	1	2		1	1							1	2	

Assessment Scheme:

SN	Assessment	Weightage	Remark
1	In Semester Evaluation 1 (ISE1)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
2	Mid Semester Examination (MSE)	30%	50% of course contents
3	In Semester Evaluation 2 (ISE2)	10%	Assignment, Test, Quiz, Seminar, Presentation, etc.
4	End Semester Examination (ESE)	50%	100% course contents

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Course Contents:			SDGs
Unit 1	**INTRODUCTION TO VIRTUAL REALITY (VR)**	**6 Hours**	4,9
Defining Virtual Reality, Key elements of virtual reality experience, Virtual Reality, Telepresence, Augmented Reality and Cyberspace. Bird's-Eye View: Hardware, Software, Human Physiology and Perception.			
Unit 2	**Input Devices: (Trackers, Navigation, and Gesture Interfaces)**	**7 Hours**	9
Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces. Output Devices: Graphics displays, sound displays & haptic feedback.			
Unit 3	**Modeling**	**6 Hours**	9
Geometric modeling, Kinematics modeling, Physical modeling, Behaviour modeling, Model management			
Unit 4	**Augmented Reality (AR**	**7 Hours**	9
Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems AR software development : AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit.			
Unit 5	**Interaction & Audio**	**7 Hours**	3,9
Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering			

Text Books:

1.Virtual Reality Technology, Second Edition, Gregory C. Burdea & Philippe Coiffet, John Wiley & Sons, Inc, 2017
2. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

Reference Books:

1. Rajesh K. Maurya, Computer Graphics with Virtual Reality System, 3rd Edition, Wiley Publication, 2018.
2. William R. Sherman and Alan B. Craig, Understanding Virtual Reality Interface, Application, and Design, 2 nd Edition, Morgan Kaufmann Publishers, Elsevier, 2019.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, 2 nd Edition, Wiley,2017.
4. K.S. Hale and K. M. Stanney, Handbook on Virtual Environments, 2 nd Edition, CRC Press, 2015

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