Semester: 7th			
Paper code: AIDS401/AIML401/IOT401	**L**	**T/P**	**Credits**
Subject: Principles of Management for Engineers	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:	
1.	To introduce students to the principles and functions of management in engineering environments.
2.	To develop the skills and knowledge required for effective decision-making in engineering contexts.
3.	To understand the dynamics of organizational behavior and its impact on engineering teams and projects.
4.	To equip students with project management skills for successful execution of engineering projects.
Course Outcomes:	
CO1	Understand the fundamental principles of management, its evolution, and the roles of managers in engineering contexts.
CO2	Apply various decision-making models and techniques to solve engineering problems and make effective decisions.
CO3	Analyze individual and group behavior, motivation, leadership, and communication in engineering organizations.
CO4	Acquire project management skills and techniques to plan, execute, monitor, and control engineering projects effectively.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:
Principles of Management for Engineers is an essential course providing a comprehensive understanding of management principles, leadership, decision-making, and organizational behavior in engineering contexts.

Unit I **[8]**
Definition of management: Science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Unit II **[8]**
Nature and purpose of Planning: types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Unit III **[8]**
Organizational Behavior: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Unit IV **[8]**
Controlling, system and process of controlling : Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Textbooks:
1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999

Semester: 7th			
Paper code: AIDS409T	**L**	**T/P**	**Credits**
Subject: Business Intelligence & Analytics	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Gain a comprehensive understanding of Business Intelligence and Analytics concepts, techniques, and tools.
2.	Develop skills to analyze and interpret data, perform statistical analysis, and visualize data effectively.
3.	Acquire knowledge of machine learning algorithms and their applications in business analytics.
4.	Stay updated with emerging trends and technologies in the field of Business Intelligence and Analytics.

Course Outcomes:

CO1	Understand the fundamental concepts of Business Intelligence and Analytics and their application in AI and Data Science.
CO2	Analyze and interpret data using various statistical techniques and develop actionable insights for business decision-making.
CO3	Apply machine learning algorithms for business analytics, including regression, classification, clustering, and recommendation systems.
CO4	Explore emerging trends in Business Intelligence and Analytics, such as Big Data Analytics, real-time analytics, and streaming data.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	3	-	-	-	-	-	1	2
CO4	3	3	3	3	3	-	-	-	-	-	2	3

Course Overview:
This course provides an in-depth understanding of Business Intelligence (BI) and Analytics concepts, techniques, and tools, with a focus on their application in the field of Artificial Intelligence (AI) and Data Science. Students will learn to analyze and interpret data, develop BI solutions, and apply analytics to make informed business decisions.

Unit I **[8]**
Introduction to Business Intelligence and Analytics: Introduction to Business Intelligence and Analytics, Data Warehousing and Data Mining, Data Extraction, Transformation, and Loading (ETL), Introduction to Analytics: Descriptive, Predictive, and Prescriptive Analytics.

Unit II **[8]**
Data Analysis and Visualization: Exploratory Data Analysis (EDA), Statistical Analysis for Business Intelligence, Data Visualization Techniques and Tools, Interactive Dashboards and Reports

Unit III **[8]**
Machine Learning for Business Analytics: Supervised and Unsupervised Learning Algorithms, Regression and Classification Models, Clustering Techniques for Customer Segmentation, Recommendation Systems

Unit IV **[8]**
Big Data Analytics and Emerging Trends: Introduction to Big Data Analytics, Hadoop and Map Reduce, Real-time Analytics and Streaming Data, Emerging Trends in Business Intelligence and Analytics

Textbooks:
1. "Business Intelligence: A Managerial Perspective on Analytics" by Ramesh Sharda, Dursun Delen, Efraim Turban
2. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" by Foster Provost, Tom Fawcett
3. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney

Reference Books:
1. "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball, Margy Ross
2. "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel
3. "Big Data Analytics: Methods and Applications" by Chang Liu, Quan Z. Sheng, Jian Yu, Yongrui Qin

Semester: 7th			
Paper code: AIDS409P	**L**	**T/P**	**Credits**
Subject: Business Intelligence and Analytics Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Understand the fundamental concepts and techniques of business intelligence and analytics.
2.	Gain hands-on experience in applying business intelligence and analytics methods to real-world datasets and interpret the results.

Course Outcomes:

CO1	Apply business intelligence and analytics techniques to solve real-world problems in various domains.
CO2	Develop skills in using tools and technologies for data cleaning, analysis, modeling, and visualization in the context of business intelligence and analytics.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	-	1	1	1
CO2	2	2	2	1	1	-	-	-	-	1	1	1

List of Experiments:

1. To provide students with hands-on experience in applying data cleaning and preprocessing techniques for business analytics.
2. To develop skills in exploring and analyzing data using exploratory data analysis methods for market research.
3. To understand and apply predictive modeling techniques, such as regression analysis, for business analytics.
4. To segment customers and perform cluster analysis to gain insights for targeted marketing strategies.
5. To forecast future sales using time series analysis and evaluate the accuracy of the predictions.

6. To mine association rules from transactional data for market basket analysis and cross-selling opportunities.
7. To analyze customer sentiment from text data and derive insights for improving products and services.
8. To build decision tree and random forest models for predicting customer churn and identify factors influencing it.
9. To implement recommender systems for personalized product recommendations based on user preferences.
10. To create interactive dashboards and reports using Power BI for effective communication and decision-making in business intelligence.

Semester: 7th			
Paper code: AIDS411T	**L**	**T/P**	**Credits**
Subject: Advances in Data Science	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Gain a comprehensive understanding of deep learning architectures, training techniques, and advanced topics.
2.	Develop skills in NLP for text analysis, classification, and language modeling.
3.	Learn the principles and techniques of big data analytics, including distributed computing and scalable machine learning.
4.	Understand the ethical implications of data science and implement techniques for model interpretability, fairness, and privacy.

Course Outcomes:

CO1	Apply advanced techniques in deep learning and neural networks for solving complex data analysis problems.
CO2	Develop expertise in natural language processing (NLP) and apply it to text-based data for tasks such as sentiment analysis, named entity recognition, and language generation.
CO3	Analyze and process big data using distributed computing frameworks like Hadoop and Spark, and apply machine learning algorithms to large-scale datasets.
CO4	Understand the importance of explainable AI and ethical considerations in data science, and apply techniques to address model interpretability, bias, fairness, privacy, and security.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	3	-	-	1	-	-	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	-
CO3	2	-		2	3	-	1	-	-	1	-	-
CO4	2	2		3	3	-	-	-	-		1	2

Course Overview:
This course explores advanced topics in data science, including deep learning, natural language processing, big data analytics, and ethical considerations. Students will gain practical skills in applying these techniques to solve complex problems, analyze large-scale datasets, and address interpretability, fairness, privacy, and security in AI applications.

Unit I **[8]**
Deep Learning and Neural Networks: Introduction to deep learning, Neural network architectures: CNNs, RNNs, and Transformers, Training deep learning models, Transfer learning and fine-tuning, Advanced topics in deep learning: Generative models, GANs, and reinforcement learning.

Unit II **[8]**
Natural Language Processing (NLP): Basics of NLP: Tokenization, POS tagging, and parsing Text classification and sentiment analysis, Named Entity Recognition (NER) and entity linking, Word embedding's and language modeling, Neural machine translation and language generation.

Unit III **[8]**
Big Data Analytics: Introduction to big data analytics, Distributed computing and storage: Hadoop and Spark, Processing big data: MapReduce and Spark programming, Machine learning on big data: Scalable algorithms and frameworks, Stream processing and real-time analytics

Unit IV **[8]**
Explainable AI and Ethical Considerations: Interpretable machine learning models, Model explainability and feature importance, Bias, fairness, and accountability in AI, Privacy and security in data science, Ethical guidelines and responsible AI practices

Textbooks:
1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
2. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper
3. "Big Data: A Revolution That Will Transform How We Live, Work, and Think" by Viktor Mayer-Schönberger and Kenneth Cukier

Reference Books:
1. "Interpretable Machine Learning: A Guide for Making Black Box Models Explainable" by Christoph Molnar
2. "Fairness and Machine Learning: Limitations and Opportunities" edited by Solon Barocas, Moritz Hardt, and Arvind Narayanan
3. "Privacy and Big Data: The Players, Regulators, and Stakeholders" by Terence Craig and Mary Ludloff

Semester: 7th			
Paper code: AIDS411P	**L**	**T/P**	**Credits**
Subject: Advances in Data Science Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Gain hands-on experience in building and training deep learning models and applying them to various domains.
2.	Understand the challenges and considerations in natural language processing tasks and analyze the performance of NLP algorithms.

Course Outcomes:

CO1	Develop practical skills in advanced data science techniques such as deep learning, NLP, and distributed computing for real-world applications.
CO2	Analyze and interpret the behavior of complex machine learning models, address issues of fairness and bias, and apply privacy-preserving methods to ensure ethical data science practices

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. To implement and train deep learning models (e.g., CNN, RNN) on real-world datasets for various applications.
2. To perform text classification tasks using NLP techniques and compare different algorithms for accuracy and efficiency.
3. To process large-scale datasets using Spark's distributed computing capabilities and run machine learning algorithms on them.
4. To build and train GAN models for generating realistic images and evaluate the quality of the generated samples.
5. To implement and train sequence-to-sequence models for language translation tasks using attention mechanisms.

6. To apply various anomaly detection techniques on time series data and evaluate their effectiveness.
7. To assess and mitigate bias in machine learning models using fairness indicators and AIF360.
8. To interpret and explain the predictions of complex machine learning models using LIME and SHAP techniques.
9. To design and train reinforcement learning agents to play games and achieve high scores.
10. To apply differential privacy techniques to protect sensitive information while performing data analysis.

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Semester: 7th			
Paper code: OAE403T	**L**	**T/P**	**Credits**
Subject: Computer Vision	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students the major ideas, methods and techniques of computer vision and pattern recognition.
2.	Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.
3.	Perform shape analysis and extract features form Images and do analysis of Images
4.	Get an exposure to advanced concepts, including state of the art deep learning architectures, in all aspects of computer vision.

Course Outcomes:

CO1	Describe different image representation, their mathematical representation and different data structures used.
CO2	Classify different segmentation algorithm for given input.
CO3	Detect a moving object in video using the concept of motion analysis.
CO4	Recognize the object using the concept of computer vision

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

Computer Vision introduces B.Tech students to the fascinating world of visual perception through machines. This course explores algorithms and techniques that enable computers to understand and interpret images and videos. Students will delve into image processing, feature

extraction, object recognition, and deep learning models for computer vision tasks. Practical applications such as facial recognition, autonomous vehicles, and medical imaging will be discussed, preparing students for exciting opportunities in AI-driven visual systems.

UNIT I **[8]**

Digital Image Formation and low, level processing: Overview and State of the art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Depth estimation and Multi camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry, Homography, Rectification, DLT, RANSAC, 3D reconstruction framework, Auto calibration.

UNIT II **[8]**

Feature Extraction: Edges , Canny, LOG, DOG, Line detectors (Hough Transform), Corners , Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale, Space Analysis, Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph, Cut, Mean, Shift, MRFs, Texture Segmentation, Object detection.

UNIT III **[8]**

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio, Temporal Analysis, Dynamic Stereo, Motion parameter estimation. Shape from X: Light at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, and Shape from Texture, color, motion and edges.

UNIT IV **[8]**

Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing, Modern trends, super-resolution, GPU, Augmented Reality, cognitive models, fusion and SR&CS.

Text Books:

1. Szeliski, R., Computer Vision: Algorithms and Applications, Springer, Verlag London .
2. Forsyth, A., D. and Ponce, J., Computer Vision: A Modern Approach, Pearson Education.

Reference Books:

1. Hartley, R. and Zisserman, A., Multiple View Geometry in Computer Vision Cambridge University Press.
2. Fukunaga, K., Introduction to Statistical Pattern Recognition, Academic Press, Morgan Kaufmann.

Semester: 7th			
Paper code: OAE403P	**L**	**T/P**	**Credits**
Subject: Computer Vision Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Understand the fundamentals of computer vision algorithms and their use cases.
2.	Develop practical skills in using popular computer vision tools and frameworks to solve real-world problems.

Course Outcomes:

CO1	Gain expertise in computer vision techniques and applications, including object detection, segmentation, and facial recognition.
CO2	Acquire hands-on experience in building computer vision models and deploying them on edge devices for real-world applications.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	1	-	1	-	1	1	-
CO2	2	2	2	2	3	2	1	1	1	1	1	1

List of Experiments:

1. Learn to preprocess images by applying techniques such as resizing, filtering, and histogram equalization.
2. To implement object detection algorithms to identify and localize objects in images and video streams.
3. To use semantic segmentation models to segment objects in an image and understand pixel-level classification.
4. To build a facial recognition system to detect and recognize faces in images and video.
5. To implement OCR techniques to recognize text from images and scanned documents
6. To apply neural style transfer to blend the style of one image onto the content of another image.
7. To use pose estimation models to detect and track human body keypoints in images and videos.
8. To implement super-resolution algorithms to upscale low-resolution images.

9. To fine-tune pre-trained models like VGG, ResNet, or MobileNet for image classification tasks.
10. To develop an image captioning system to generate textual descriptions of images.
11. To combine computer vision and natural language processing to create a model that answers questions about images.
12. To optimize object detection models for deployment on edge devices with real-time performance.

Semester: 7th			
Paper code: OAE407T	**L**	**T/P**	**Credits**
Subject: Metaverse and its Applications	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To Understand the social and cultural implications of the metaverse, including issues related to identity, representation, and community-building.
2.	To analyze and evaluate the opportunities and limitations of the metaverse in various domains, such as gaming, social interaction, business, and education.
3.	To Stay updated with the latest developments and emerging trends in the field of the metaverse and its applications.
4.	To Apply critical thinking and problem-solving skills to address real-world scenarios and challenges in the context of the metaverse.

Course Outcomes:

CO1	To Understand the social and cultural implications of the metaverse, including issues related to identity, representation, and community-building.
CO2	Identify and analyze the technologies enabling the metaverse, such as virtual reality, augmented reality, and blockchain.
CO3	Examine the economic aspects of the metaverse, including virtual economies, digital assets, and monetization strategies.
CO4	Apply critical thinking and problem-solving skills to address real-world scenarios and challenges in the context of the metaverse.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	-	-	-	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	-	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
This course provides an in-depth exploration of the concept, technologies, and applications of the metaverse. The metaverse refers to a virtual universe where individuals can interact with digital environments and each other in real or simulated time.

UNIT I **[10]**

Introduction: definition of Metaverse applications, design dimensions, Metaverse application ecology and economy, design and development process

Immersive Techniques and Functionality: SDKs, tools, and services for augmented reality, virtual reality, extended reality (XR), human computer interactions, devices and internet of things, and digital twins.

UNIT II **[10]**

UIUX: SDKs, tools, and services for avatar systems, spatial user interface, multimodal user interface, locomotion, UI prototyping, and accessible and inclusive UX design

UNIT III **[10]**

Metaverse Privacy Security and Ethics: SDKs, tools, and services for cyberspace encryption, blockchain, and federated learning.

Metaverse Intelligence: SDKs, tools, and services for nature language processing, machine learning, data mining, and recommendation systems.

UNIT IV **[10]**

Meat Entertainment: Metaverse prototypes for entertainment, including multiplayer VR gaming, social VR, live performance in Metaverse.

Metaverse in Web Learning: Metaverse prototypes for education, including avatar-mediated teaching and learning, immersive learning, experiential learning, collaborative learning, etc.

Metaverse in Healthcare: Metaverse prototypes for healthcare and mental well-being, including teletherapy, teleoperation, rehabilitation.

Text Books:

1. LaViola Jr, J. J., Kruijff, E., McMahan, R. P., Bowman, D., & Poupyrev, I. P. (2017). 3D user interfaces: theory and practice. Addison-Wesley Professional.
2. LaValle, M. (2019). Virtual reality. Cambridge University Press.

Reference Books:

1. Metaverse Roadmap (2007) https://www.metaverseroadmap.org/overview/

Semester: 7th			
Paper code: OAE413T	**L**	**T/P**	**Credits**
Subject: Audio and Speech Processing	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the basics of audio and speech signals and their pre-processing.
2.	To provide insights into speech recognition and the techniques involved in automatic speech recognition systems.
3.	To familiarize students with speech synthesis methods and the process of converting text to speech.
4.	To enable students to apply audio feature extraction techniques for various audio processing tasks.

Course Outcomes:

CO1	Understand the fundamentals of audio and speech signals, their characteristics, and the challenges in processing and analyzing them.
CO2	Learn the techniques for building automatic speech recognition systems and comprehend their real-world applications and limitations.
CO3	Gain the knowledge of developing text-to-speech synthesis systems using different approaches and evaluate their quality.
CO4	Apply various audio feature extraction techniques for classification, music information retrieval, and audio event detection in AI-based systems.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
Audio and Speech Processing is an advanced course for B.Tech AI, ML, IIoT, and Data Science students to explore the principles and techniques for analyzing and processing audio and speech data. The syllabus covers speech recognition, synthesis, audio feature extraction, and applications in AI-based systems.

UNIT I **[8]**

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT II **[8]**

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT III **[8]**

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV **[8]**

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.
Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody.

Text Books:

1. Lawrence Rabinerand Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
2. Ben gold and Nelson Morgan, “Speech and audio signal processing”, processing and perception of speech and music, Wiley- India Edition, 2006 Edition.
3. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education.

Reference Books:

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education.
3. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons.

Semester: 7th			
Paper code: OAE413P	**L**	**T/P**	**Credits**
Subject: Audio and Speech Processing Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To provide hands-on experience in audio data handling, preprocessing, and feature extraction.
2.	To enable students to apply machine learning and signal processing techniques to real-world speech-related problems and evaluate their performance.

Course Outcomes:

CO1	Gain practical experience in processing and analyzing audio signals for various applications, including speech recognition and emotion analysis.
CO2	Develop skills in implementing machine learning models for audio and speech-related tasks, and understanding their limitations and challenges.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. To visualize audio signals in the time and frequency domains, understanding the characteristics of audio data.
2. To preprocess audio data, remove noise, and apply techniques like normalization and filtering.
3. To extract relevant features (e.g., MFCC, Mel spectrogram) from audio data for speech recognition tasks.
4. To implement a basic speech recognition system using HMM and observe its performance.
5. To identify speakers from a dataset using methods like Gaussian Mixture Models (GMM) or Support Vector Machines (SVM).
6. To classify the emotional state of speakers from audio data using machine learning techniques.

7. To compress audio files using MPEG audio compression standards and analyze the trade-offs between size and quality.
8. To convert text into speech using TTS systems and evaluate the synthesized speech quality.
9. To automatically segment an audio recording and identify distinct speakers present in it.
10. To develop a deep learning model for detecting specific keywords or commands in an audio stream.
11. To optimize a speech emotion recognition model for running on edge devices like Raspberry Pi or Arduino.
12. To apply deep learning techniques to enhance the quality of noisy speech signals.