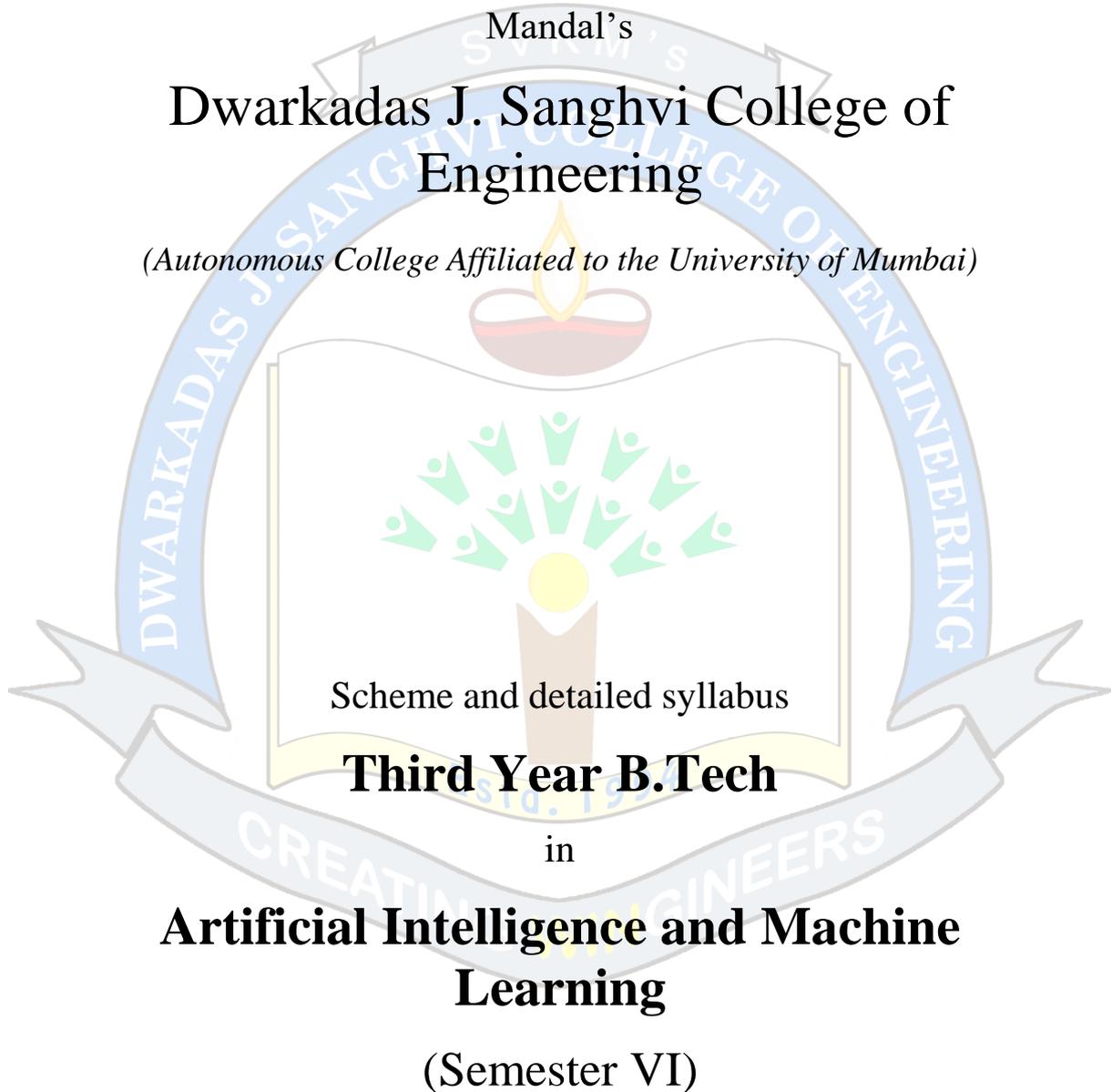Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus

Third Year B.Tech

in

Artificial Intelligence and Machine Learning

(Semester VI)

Academic Year 2023-24

Proposed Scheme for Third Year Undergraduate Program in Artificial Intelligence and Machine Learning : Semester VI (Autonomous)
Academic Year(2023-24)

Sr No	Course Code	Course	Teaching Scheme(hrs)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					Aggregate (A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th	O	P	O&P	Total SEA (B)		
1	DJ19AMC601	Computer Vision	3	--	--	3	25	--	25	75	--	--	--	75	100	4
	DJ19AML601	Computer Vision Laboratory	--	2	-	1	--	25	25	--	--	--	25	25	50	
2	DJ19AMC602	Natural Language Processing	3	--	--	3	25	--	25	75	--	--	--	75	100	4
	DJ19AML602	Natural Language Processing Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
3	DJ19AMC603	Machine Learning Operations (ML Ops)	3	--	--	3	25	--	25	75	--	--	--	75	100	4
	DJ19AML603	Machine Learning Operations (ML Ops) Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
4	DJ19AML604	Design Thinking Laboratory	--	4	--	2	--	25	25	--	25	_	_	25	50	2
5@	DJ19AMEC6011	Elective 1: IoT Foundations	3	--	--	3	25	--	25	75	--	--	--	75	100	4
	DJ19AMEL6011	IoT Foundations Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
	DJ19AMEC6012	Elective 2: Time Series Analysis	3	-	--	3	25	--	25	75	--	--	--	75	100	
	DJ19AMEL6012	Time Series Analysis Laboratory	_	2	-	1	--	25	25	--	25	--	--	25	50	
	DJ19AMEC6013	Elective 3: Human Machine Interaction	3	--	--	3	25	--	25	75	--	--	--	75	100	
	DJ19AMEL6013	Human Machine Interaction Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	
6#	DJ19IHL2	Professional and Business Communication Laboratory	--	4	--	2	--	50	50	--	--	--	--	--	50	2
7	DJ19ILL2	Innovative Product Development IV	--	2	--	1	--	25	25	--	--	--	25	25	50	1
		Total	18	22	--	21	150	250	400	450	175	--	25	650	1050	21

@Any 1 Elective Course

#2 hrs. of theory (class wise) and 2 hrs of activity based laboratory(batch wise)

Th	Theory	T/W	Termwork
P	Practical	O	Oral
T	Tutorial		

Prepared by   Checked by   Head of the Department   Vice Principal   Principal

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	One Term test (based on 40 % syllabus)	25 each (Avg.25)	1
	Second Term test (next 40 % syllabus) / presentation / assignment / course project / group discussion / any other.		
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	as applicable
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	25	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	75	3
	* Computer based assessment in the college premises.		
Oral	Questions based on the entire syllabus.	25	as applicable
Practical	Performance of the practical assigned during the examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	as per the scheme	2

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Computer Vision(DJ19AMC601)		
Course: Computer Vision Laboratory (DJ19AML601)		

Pre-requisite: Linear Algebra, Digital Signal Processing, Digital Image Processing

Course Objectives:

1. To develop a comprehensive understanding of computer vision and its real-world applications.

2. To apply image feature detection and noise reduction methods to improve image quality, to extract features and perform model fitting methods to analyze and process images.

3. To implement segmentation and object detection algorithms to identify and locate objects in images.

4. To implement pattern recognition methods to classify and analyze data and motion analysis and action detection methods to track and recognize dynamic objects in videos.

Course Outcomes: Upon completion of this course, students will be able to:

1. Analyze and explain the core concepts of computer vision, principles of imaging geometry, radiometry, and digitization.
2. Recognize key image features, implement techniques for modeling noise and feature extraction effectively.
3. Apply clustering, classification, and dimensionality reduction methods in pattern recognition and understand the significance of classifiers and their practical applications in pattern recognition.
4. Utilize motion analysis techniques to track moving objects in videos. Implement spatio-temporal analysis and dynamic stereo methods in motion analysis and action detection.

Computer Vision (DJ19AMC601)		
Unit	Description	Duration
1	**Overview of Computer Vision and its Applications:** Image Formation and Representation: Imaging geometry, radiometry, digitization, cameras and Projections, rigid and affine transformation.	4
2	**Image Features and Noise:** Points, corners, edges, Scale and orientation, Modeling image noise, Convolution, image smoothing, pyramid.	4

3	**Feature Extraction and Model Fitting:** Edges - Canny, LOG, DOG, Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Deformation, RANSAC, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	8
4	**Object Segmentation and Detection:** Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation, Semantic segmentation, Scene Parsing, Clustering method for segmentation, Distance metrics, Linkage.	9
5	**Pattern Recognition:** Use of Supervised, unsupervised and semi supervised learning in Computer Vision; Deep Learning Models for Computer Vision: CNNs, RNNs, R-CNNs; Transfer Learning; YOLO; Attention Mechanism in Computer Vision.	7
6	**3-D Computer Vision:** 3-D Visualization: Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images. Multiple Image: Stereo, Epipolar Geometry, Stereo Essential and Fundamental Matrices, Multiview stereo, Triangulation, Correspondence, Rectification, 3D Reconstruction. Shape from X: Reflectance map, Shape from shading, Photometric stereo, Shape from optical flow (moving camera, moving objects), Rotating camera, Silhouettes, Space carving.	7
	TOTAL	39

Books Recommended:

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition ,Springer-Verlag London Limited 2022.
2. Rajeev Ratan, Hands-On Computer Vision with OpenCV, Keras, and TensorFlow, 1st edition, Packt Publishing, 2021
3. E. R. Davies, Computer Vision: Principles, Algorithms, Applications, Learning, 5th Edition, Academic Press Publisher, 2018.

Reference Books:

1. Hafsa Asad, Vishwesh Shrimali, Nikhil Singh, The Computer Vision Workshop, 1st edition, Packt Publishing, 2022
2. Katsushi Ikeuchi, Computer Vision: A Reference Guide, 2nd edition, Springer Publishing, 2021
3. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2nd Edition, 2015.

4. Scott Krig, Computer Vision Metrics: Survey, Taxonomy, and Analysis, 1st edition, Apress, Publisher, 2014.

Useful Links:
1. Advances in Computer Vision : 6.869 Course Materials (mit.edu)
2. Machine Vision | Electrical Engineering and Computer Science | MIT OpenCourseWare
3. vision.stanford.edu
4. Computer Vision Notes (Faisal Z. Qureshi at Ontario Tech University) (uoit.ca)
5. Deep Learning for Computer Vision - Course (nptel.ac.in)
6. Computer Vision Basics | Coursera
7. Introduction to Computer Vision and Image Processing | Coursera

Suggested List of Experiments (Any 8):

Computer Vision Laboratory (DJ19AML601)	
Sr. No.	**Title of the Experiment**
1	Image assessment with NumPy and OpenCV
2	Image Transformation in OpenCV
3	Feature Detection using OpenCV- Corner, Edge, Pyramid
4	Image Denoising and enhancement techniques
5	Object Detection
6	Basic Video Processing in OpenCV
7	Object Tracking
8	Pattern Recognition
9	Face Recognition
10	Optical Flow computation algorithm
11	3D Image Reconstruction
12	Project Based Learning
13	Research Article Review

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Natural Language Processing (DJ19AMC602)		
Course: Natural Language Processing Laboratory (DJ19AML602)		

Pre-requisite: Python Programming

Course Objectives:

1. To introduce the fundamental concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.

2. To examine the NLP models and interpret algorithms for classification of NLP sentences by using both the traditional, symbolic and the more recent statistical approach.

3. To get acquainted with the algorithmic description of the main language levels that includes morphology, syntax, semantics, and pragmatics for information retrieval and machine translation applications.

Course Outcomes: Students will be able to

1. Understand the Principles and Process of Natural Languages and real-world applications.
2. Demonstrate understanding of state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology.
3. Perform POS tagging for a given natural language and select a suitable language modelling technique based on the structure of the language.
4. Check the syntactic and semantic correctness of sentences using grammars and labelling.

Unit	Description	Duration
1	**Introduction to Natural Language Processing** Origin & History of NLP, Stages in NLP, Ambiguities and its types in English and Indian Regional Languages; Applications of NLP- Machine Translation, Information Retrieval, Question Answering System, Sentiment Analysis, Text Categorization , Text Summarization, Named Entity Recognition.	4
2	**Computational tools for text analysis** Basic Terms: Tokenization, Stemming, Lemmatization, Natural Language Toolkit (NLTK): Corpora and other data resources, Uses of corpora: Lexicography, Grammar and syntax, Stylistics, Training and evaluation. Basic corpus analysis: Frequency distribution building and analyzing a corpus. Tokenization in the NLTK, Tokenizing text	6
3	**Word Level Analysis (statistical language model)** Inflectional Morphology, Derivational Morphology, Regular expression with types, Morphological Models: finite state morphology,	9

	Morphological parsing with FST (Finite State Transducer), Lexicon free FST Porter Stemmer algorithm, Grams and its variation: Bigram, Trigram, Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus, Evaluating N-grams: Perplexity, smoothing: Laplace Smoothing, Good-Turing Discounting		
4	**Syntax analysis** Part-Of-Speech tagging (POS), Tag set for English (Upenn Treebank), Difficulties /Challenges in POS tagging , Rule-based, Stochastic and Transformation-based tagging, Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging, Discriminative Model: Maximum Entropy model, Conditional random Field (CRF), CYK.	7
5	**Semantic Analysis** Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet. Attachment for fragment of English, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Semantic Ambiguity, Word Sense Disambiguation (WSD), Knowledge based approach (Lesk's Algorithm), Supervised (Naïve Bayes, Decision List).	8
6	**Pragmatic & Discourse Processing** Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence, Anaphora Resolution using Hobbs and Cantering Algorithm, Discourse segmentation, Conference resolution	5
	TOTAL		39

Books Recommended:

Text Books:

1. Raymond S. T. Lee, "Natural Language Processing: A Textbook with Python Implementation", First Edition, 2023.
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly , 2022.
3. Thushan Ganegedara, Andrei Lopatenko, "Natural Language Processing with TensorFlow: The definitive NLP book to implement the most sought-after machine learning models and tasks", 2nd Edition, 2022.
4. Daniel Jurafsky, James H. and Martin, Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson, 2014.

Reference Books:

1. Masato Hagiwara, "Real-World Natural Language Processing: Practical applications with deep learning", Mnaning,2021.
2. Ashish Bansal, "Advanced Natural Language Processing with TensorFlow 2: Build effective real-world NLP applications using NER, RNNs, seq2seq models, Transformers, and more", Packt Publishing, 2021.

Web Resources Blogs and Websites:
1. POS Tagging Hidden Markov Models (HMM) Viterbi algorithm in NLP maths | Data Science in your pocket (medium.com)
2. Text Generation Using N-Gram Model | by Oleg Borisov | Towards Data Science
3. How to Create Beautiful Word Clouds in Python | by Tia Plagata | Towards Data Science
4. Best NLP Algorithms to get Document Similarity | by Jair Neto | Analytics Vidhya | Medium
5. How to Chunk Text Data — A Comparative Analysis | by Solano Todeschini | Towards Data Science
6. Natural Language Processing. Title :- Morphological Analysis | by Raghvendra Zarkar | Medium

Online Courses and Tutorials:
1. NPTEL Course : Natural Language Processing - Course (nptel.ac.in)
2. Cousera: Natural Language Processing Specialization [4 courses] (DeepLearning.AI) | Coursera
3. Udemy: NLP - Natural Language Processing with Python | Udemy

Suggested List of Experiments:

Natural Language Processing Laboratory (DJ19AML602)	
Sr. No.	**Title of the Experiment**
1	Preprocessing steps in NLP: Tokenization, stop word Removal, Lemmatization, stemming using NLTK and SPACY
2	Implement Named Entity Recognition for any given text
3	Perform morphological analysis and word generation for any given text
4	Implement Chunking for the given input text.
5	Build a POS tagger using HMM
6	Similarity Detection in NLP
7	Implement N-Gram model for the given text input
8	Generate word cloud using Python
9	Any application of NLP: Spell Check, Autocorrect, plagiarism detection, sentiment analysis, sarcasm detection or text analytics in any domain

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Machine Learning Operations (ML Ops) (DJ19AMC603)		
Course: Machine Learning Operations Laboratory (ML Ops Laboratory) (DJ19AML603)		

Pre-requisite:

1. Knowledge of Linux Operating system, installation and configuration of services and command line basics,
2. Basics of Machine Learning
3. Knowledge Development Life cycle, development frameworks and DevOps

Course Objectives:

1. The objective of this course is to understand the fundamentals of MLOps and its significance in the ML lifecycle.
2. Students will Learn various tools and technologies used in MLOps to design and build scalable ML pipelines.
3. Students will get exposure to deploy ML models.
4. Students will learn techniques for monitoring, debugging, and optimizing ML systems.
5. Finally, students will explore methods for reproducibility, version control, and model governance.

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

1. Automate the deployment of ML models into the core software system or as a service component
2. Deploy machine learning models in a production environment.
3. Implement model monitoring and performance evaluation.
4. Manage and scale machine learning infrastructure.

Machine Learning Operations (DJ19AMC603)		
Unit	Description	Duration
1	**Introduction to Machine Learning Operations** Overview of MLOps and its importance, Understanding the challenges in deploying and managing ML models, ML development lifecycle, Role of MLOps in the ML development lifecycle, Introduction to DevOps and its application to ML, MLOps in Practice.	**06**

2	**Data Management, Model Development and Training for MLOps** Model Development and Training for MLOps, Data versioning and reproducibility, Data preprocessing and feature engineering pipelines, Data validation and monitoring, Data quality assurance and governance, Model versioning and tracking, Model training pipelines and automation, Hyperparameter tuning and model selection, Model evaluation and validation techniques	**06**
3	**Model Deployment and Serving, Continuous Integration and Delivery (CI/CD) for ML** Model packaging and containerization (e.g., Docker), Infrastructure provisioning and orchestration (e.g., Kubernetes), Deploying models as scalable services, managing model endpoints and versioning, Version control and collaboration (e.g., Git), Building reproducible ML pipelines, Automated testing and code quality checks, Continuous integration and deployment strategies.	**08**
4	**Monitoring and Performance Optimization** Monitoring model performance and behavior, Real-time and batch monitoring techniques, Logging and error tracking in ML systems, Performance optimization and scalability considerations.	**06**
5	**Cloud Platforms and Infrastructure for MLOps** Introduction to cloud platforms (e.g., AWS, Azure, GCP), Deploying ML models on cloud infrastructure, Managing resources and scaling ML workloads, Cost optimization strategies for ML systems.	**08**
6	**Governance and Compliance in MLOps** Data privacy and protection in ML systems, Access control and authentication mechanisms, Security considerations for model deployment, Compliance with industry regulations (e.g., GDPR, HIPAA).	**05**
	Total	**39**

Books Recommended

Textbooks

1. Noah Gift , "Practical MLOps: A Guide to Building Real-World Machine Learning Systems", O'Reilly, First Edition, September 2021.
2. Mark Treveil, Nicolas Omont, "Introducing MLOps: How to Scale Machine Learning in the Enterprise", O'Reilly Media, First Edition, January 5, 2021
3. Emmanuel Raj, "Engineering MLOps: Rapidly build, test, and manage production-ready machine learning life cycles at scale", Packt Publishing Limited, 1st edition, 19 April 2021

Reference Books:

1. Hannes Hapke and Catherine Nelson, "Building Machine Learning Pipelines: Automating Model Life Cycles with TensorFlow", O'Reilly, First Edition, 19 July 2020.

2. Chris Fregly, Antje Barth, "Data Science on AWS: Implementing End-to-End Continuous Machine Learning Pipelines", O'Reilly, First Edition, 9 May 2021.
3. Sridhar Alla, Suman Kalyan Adari, "Beginning MLOps with MLFlow: Deploy Models in AWS SageMaker, Google Cloud, and Microsoft Azure", Apress publication, 1st edition, 8 December 2020.

Web Resources Blogs and Websites:
1. MLflow Blog: MLflow is an open-source platform for managing the ML lifecycle. The blog covers topics related to MLOps, model deployment, and reproducibility.
2. Towards Data Science: A popular online publication with a dedicated section on MLOps, featuring articles and tutorials on topics like model deployment, monitoring, and CI/CD pipelines.

Online Courses and Tutorials:
1. Coursera: "Machine Learning Engineering for Production (MLOps)" by deeplearning.ai. This course provides a comprehensive introduction to MLOps, covering topics like data and model versioning, deployment, monitoring, and more.
2. Udacity: "Machine Learning Deployment" by Google Cloud. This course focuses on deploying and scaling machine learning models using Google Cloud technologies and covers MLOps principles.
3. YouTube: You can find numerous tutorials and talks on MLOps from conferences and industry experts. Look for channels like TensorFlow, PyTorch, and DevOps-related channels.

Suggested List of Experiments:

Machine Learning Operations Laboratory (DJ19AML603)	
Sr. No	Title of the Experiment
1	Case Studies and Best Practices a) Real-world MLOps case studies b) Best practices and lessons learned c) Industry trends and emerging technologies in MLOps d) Future directions and challenges in the field
2	Setting up a Version Control System (VCS) for ML Projects: a) Experiment with popular VCS tools like Git and create a repository for ML projects. b) Learn to track code changes, collaborate with team members, and manage different branches.
3	Creating a Continuous Integration (CI) Pipeline: a) Build a CI pipeline using tools like Jenkins, Travis CI, or GitLab CI. b) Automate the process of building, testing, and validating ML models with each code commit.
4	Containerization with Docker: a) Containerize ML models and their dependencies using Docker. b) Experiment with Docker images, containers, and Dockerfile configurations.
5	Orchestrating ML Workflows with Kubernetes: a) Deploy ML models as scalable and resilient services using Kubernetes. b) Experiment with deploying, managing, and scaling ML workloads in Kubernetes clusters.

6	Experiment Tracking and Management: a) Use tools like MLflow or Neptune.ai to track experiments, log metrics, and manage model versions. b) Explore features like hyperparameter tuning, model registry, and experiment reproducibility.
7	Continuous Deployment (CD) for ML Models: a) Implement a CD pipeline to automate the deployment of ML models to production. b) Experiment with different deployment strategies, such as blue-green deployment or canary releases.
8	Monitoring and Alerting: a) Set up monitoring and alerting systems to track model performance, data drift, and anomalies. b) Experiment with tools like Prometheus, Grafana, or DataDog to visualize and monitor ML system metrics
9	Model Performance Optimization: a) Explore techniques for optimizing model performance, such as model quantization, pruning, or distillation. b) Experiment with different optimization approaches and measure their impact on model efficiency.
10	A/B Testing and Experimentation: a) Design and conduct A/B tests to compare the performance of different ML models or algorithms. b) Experiment with statistical analysis and hypothesis testing to evaluate model improvem Understand the importance of model governance and compliance in regulated industries. c) Experiment with model explainability, bias detection, and fairness assessment techniques.
11	Infrastructure as Code (IaC) for ML: a) Use tools like Terraform or AWS CloudFormation to manage ML infrastructure. b) Experiment with provisioning and automating the setup of ML environments.

Any 10 experiments from the below given topics or any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Design Thinking Laboratory (DJ19AML604)		

Course Objectives:

1. To familiarize students with fundamentals of design thinking and principles.
2. To ensure students can practice the methods, processes and tools of design thinking.
3. To emphasize the role of design thinking in creating innovative and socially impactful solutions using design thinking tools.

Outcomes: Students will be able to

1. Develop an application using fundamentals of Design Thinking.
2. Acquire hands-on proficiency in applying design thinking methodologies, processes
3. Develop a proactive attitude towards addressing societal challenges using design thinking
4. Work efficiently as a team member.

Unit	Description	Duration
1	**Foundation of Design Thinking:** Introduction to Design Thinking, Introduction to Design Thinking, Significance of Design Thinking, Key Tenets of Design Thinking, Design Thinking Process- 4 Critical Questions, Design Thinking Process, Human-Centered Design (HCD) process - Empathize, Define, Ideate, Prototype and Test and Iterate or Empathize, Analyse, Solve and Test.	10
2	**Stage 1 Empathy:** Foundation and Tools of Empathy Foundation of Empathy, Purpose of empathy, Observation as a tool of empathy, Methods of Observation Empathetic Interview, Stakeholder maps, Jobs to be done, Empathy Maps	09
3	**Define- Foundation and tools:** Rules of Defining, Importance of Defining, Models of Framing Problem, Customer Journey Map, Customer experience, Persona, big picture thinking through function modelling.	09
4	**Ideate:** Introduction to Ideation, Double Diamond, Silent brainstorming, Rules for Brainstorming, Mind Mapping, metaphors for ideation, CREATE and What-If tool for ideation, introduction to TRIZ, Inventive principles and their applications	09
5	**Prototype & Test -Foundation:** Concept of Prototyping**,** Paper prototype, Story Board prototype, Scenario prototype, Low fidelity and high fidelity, Test Assumptions during the design thinking **Testing phase**: Necessity to test, user feedback, conducting a user test, guidelines for planning a test, how to test, desirable, feasible and viable solutions, iterate phase.	10

6	**Design Innovation:** Benefits of iteration in the design thinking process, taking the idea to the market, introduction to innovation management in a company.	05
	Total	**52**

Books Recommended

Text Books

1. "Design Your Thinking The Mindsets, Toolsets and Skill Sets for Creative Problem- solving" by Pavan Soni , 2020

2. Design Thinking Playbk: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems by Michael Lewrick, Patrick Link, Larry Leifer, 2018

3. Design Thinking For Strategic Innovation: What They Can't Teach You at Business or Design School by Idris Mootee, 2014.

Reference Books.

1. Dr. Bala Ramadurai, Karmic Design Thinking - A Buddhism-Inspired Method to Help Create Human- Centered Products & Services, Self-Published (1 January 2020).

2. Michael G. Luchs, Scott Swan, Abbie Griffin, Design Thinking: New Product Development Essentials from the PDMA, Wiley-Blackwell; 1st edition (25 September 2015).

3. Creative Confidence: Unleashing the Creative Potential Within Us All by Tom Kelley and David Kelley

4. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation by Tim Brown

5. Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days by Jake Knapp, John Zeratsky, and Braden Kowitz

Online Reference:

1. https://onlinecourses.nptel.ac.in/noc22_mg32/preview
2. https://archive.nptel.ac.in/courses/110/106/110106124/
1. **Design and Innovation:**
a. https://openstax.org/books/entrepreneurship/pages/4-suggested-resources
1. **Overview of Design Thinking:**
b. https://www.interaction-design.org/literature/topics/design-thinking
c. https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular
d. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process
e. https://www.karelvredenburg.com/home/2016/8/29/design-vs-design-thinking-explained
f. 10 Models for Design Thinking. In 2004, business consultants Hasso… | by Libby Hoffman | Medium
g. https://www.tcgen.com/design-thinking/#What_is_Design_Thinking_and_How_Does_it_Relate_to_Product_Development
h. https://www.interaction-design.org/literature/topics/wicked-problems
2. **Understand, Observe and Define the Problem:**
a. https://uxdesign.cc/the-purpose-of-a-journey-map-and-how-can-it-galvanize-action-9a628b7ae6e
b. https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them
c. https://userpilot.com/blog/empathy-map-vs-persona/
3. **Ideation and Prototyping**:
a. https://www.interaction-design.org/literature/topics/prototyping
b. https://www.uxmatters.com/mt/archives/2019/01/prototyping-user-experience.php
c. https://qpsoftware.net/blog/pros-and-cons-prototyping-complex-projects

4. **Testing and Implementation:**
a. https://www.interaction-design.org/literature/article/test-your-prototypes-how-to-gather-feedback-and-maximise-learning
b. https://www.futurelearn.com/info/courses/ux-design-fundamentals-management-business-model/0/steps/245286
5. **Design Thinking in Various Sectors:**
a. https://online.hbs.edu/blog/post/design-thinking-examples

Design Thinking	
Sr. No	**List of Laboratory Experiments**
1	Use online survey tools like Typeform or virtual collaboration tools like Zoom to assess students' understanding of the design thinking process.
2	Design relevant products/services using Smaply, Userforge, or MakeMyPersona to understand user needs
3	Thirty circle Exercise ---ideation
4	Implement Human-Centered Design (HCD) methodology for developing AI-ML products or services
5	Apply Ideation Techniques with SessionLab/Stormboard/IdeaFlip
6	Exercise: Rewarding Creativity and Risk Taking
7	Construct empathy maps for a given case study-1
8	Perform the steps for practical prototyping in AI-ML projects using digital tools **like Boords/Mockingbird/POP**
9	Test and validate AI-ML solutions using user testing and feedback with HotJar/PingPong
10	Design thinking using sprint base software

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: IoT Foundations (DJ19AMEC6011)		
Course: IoT Foundations Laboratory (DJ19AMEL6011)		

Course Objectives:

1. To introduce basic architecture and organization of processor and controller.
2. To introduce optimizing techniques for machine learning.
3. To introduce different architectures used for connected smart devices.
4. To study integration of AI with IoT and various protocols used in the IoT environment.

Outcomes: Students will be able to

1. Understand the basic architecture and organization of processor and controller.
2. Discover embedded systems design principles and concepts.
3. Appraise the role of IoT protocols for efficient network communication.
4. Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.

Unit	Description	Duration
1	**Introduction to Microprocessor and Microcontroller** Architecture of Microprocessor 8086-Internal registers, CPU, ALU, Types of System Bus, Bus Structure- address and data bus, Instruction Register, Timing and Control, Interrupts and Serial I/O. Microcontroller: CPU architecture, memory organization, and I/O ports, Embedded peripherals (timers, counters, ADC, DAC), Interrupt handling and real-time programming.	8
2	**Embedded systems design principles and concepts** Design Principles for Embedded Systems, Techniques for optimizing ML algorithms for low-power devices, Quantization, pruning, and model compression, Model selection and trade-offs in resource-constrained environments.	4
3	**Introduction to IoT** Definition, Characteristics, Physical and 8 Logical Designs, IoT Protocols, IoT Communications Models and API, IoT Enabling Technologies, IoT Levels and Deployment Templates, IoT Examples, M2M, Industrial IoT (IIoT) and architecture. RFID Technology – Working of RFID, Components of an RFID system, RFID Transponder (tag) classes, System architecture, Localization and Handover Management, Technology considerations, Performance Evaluation, Applications.	8
4	**IoT Data Collection and Preprocessing** Sensor networks and data acquisition techniques - Data Preprocessing for AI and machine learning, Edge Computing for Machine Learning - Deploying machine learning models on edge devices - Edge analytic and decision-making algorithms.	6

5	**IoT and AI Integration** AI –Graphic Processing Unit, Tensor Processing Unit, FPGA-based acceleration for machine learning, case study on Google's TPU and the Edge TPU. TensorFlow Lite, ONNX Runtime, and Edge TPU for deployment of AI models.	8
6	**IoT applications** IoT for Entertainment and wearables, IoT for Manufacturing, IoT for Employee safety, IoT for healthcare, IoT for Logistics & Supply chain, Retail Supply chain control, NFC Payment, Intelligent shopping application, Smart product management. Case studies on Smart cities, Smart Home, Smart Environment, Smart Agriculture.	5
	Total	39

Books Recommended:

Textbooks:

1. Design Principles for Embedded Systems, KCS Murti, Springer Singapore ISBN-978-981-16-3295-2, 22 September 2022.
2. Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", First Edition, Packt Publishing, 2018.
3. Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017.
4. Hakima Chaouchi, "Internet of Things: Connecting Objects to the Web", 1st Edition, Wiley, 2013.

Reference Books:

1. Intelligent Connectivity: AI, IoT, and 5G (IEEE Press), Abdulrahman Yarali Wiley-IEEE Press, 2021.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems–Real Time Interfacing", Publisher Cengage Learning, 3rd Edition, 2012.
3. Vijay Madisetti, Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 2015.

Web Links

1. NPTEL :: Computer Science and Engineering - Microprocessors and Microcontrollers
2. Embedded Systems Academy- https://www.embedded-sys.com/plus/
3. Embedded Systems Basics by Tutorials point-
   https://www.tutorialspoint.com/embedded_systems/index.htm

Suggested List of Experiments

IoT Foundation (DJ19AMEL6011)	
Sr. No.	**Title of the Experiment**
1	Setting Up and Programming the Arduino.
2	Implement basic operations for the MQTT protocol: publish and subscribe
3	Use the NodeMCU to subscribe to messages that published by MQTT client, then display these messages on a 1602 I2C LCD display.
4	To study and implement interfacing of different IoT sensors with Raspberry Pi pico/Arduino/ModeMCU.

5	To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper motor)
6	To study and implement IoT Data processing using Pandas
7	3D Pong Game With Arduino and vPython
8	Understanding and Creating a Simple Client Server Configuration

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Time Series Analysis(DJ19AMC6012)		
Course: Time Series Analysis Laboratory (DJ19AML6012)		

Objectives:

1. Learn basic analysis of time series data.
2. Auto regressive and model averaging models.
3. Learn basic concepts of forecasting.
4. To understand the detection of outliers in time series data.

Outcomes: On completion of the course, learner will be able

1. To understand the basics of Time series Analysis.
2. To apply statistical smoothening methods for the time series data
3. To forecast the time series data using traditional methods
4. To analyze and explore the deep learning techniques for forecasting the time series data

Time Series Analysis(DJ19AMC6012)		
Unit	Description	Duration
1	**Introduction to Time series:** Taxonomy of time series forecasting methods, Time series Decomposition. Real-life examples of time series, types of variation in time series, tests of randomness, tests for trend, seasonality.	5
2	**Exploratory Data Analysis & Visualizations for Time Series Analysis:** Handling time series data: working with Date and Time, Handling Missing values: Understanding missing data, performing data quality checks, handling missing data with univariate imputation using pandas and scikit-learn, Plotting Time series data with interactive Visualizations using hvPlot, Decomposing Time series data.	8
3	**Smoothening Methods:** Naïve method, Seasonal Naïve method, Average method, Moving Average Smoothing, Time series analysis using Linear Regression, Autocorrelation, Auto Regression, stationary data, differentiation, Seasonal differentiation, moving average of error, ARIMA Model, SARIMA, Machine Learning methods- windowing, Neural Network Auto Regressive	8
4	**Forecasting:** Forecasting in time series models, forecasting for autoregressive processes, One-step ahead predictors based on the finite past: Durbin-Levinson algorithm.	6

5	**Deep Learning for Time Series Forecasting:** Understanding Artificial Neural Networks, forecasting with an RNN using keras, forecasting with LSTM with keras, forecasting with a GRU using keras , forecasting with an RNN using PyTorch, Forecasting with an LSTM using PyTorch, Forecasting with GRU using PyTorch	6
6	**Outlier Detection in Time series Data:** Detecting Outliers using Statistical methods: Visualizations, Tukey method, z-score and modified z- score. Detecting Outliers using Unsupervised Machine Learning Techniques: KNN, LOF, iForest, One-class Support Vector Machine (OCSVM), Detecting outliers using COPOD and PyCaret.	6
	Total	39

Books Recommended:

Text Books:

1. Tarek A. Atwan, "Time Series Analysis with Python Cookbook: Practical recipes for exploratory data analysis, data preparation, forecasting, and model evaluation", Packt Publishing Limited, 2022.
2. James D. Hamilton, "TIME SERIES ANALYSIS" ,Levant Books, 2012.
3. B. V. Vishwas and Ashish Patel, "Hands-on Time Series Analysis with Python," First Edition, Apress, 2020.
4. Ted Dunning and Ellen Friedman," Time Series Databases: New Ways to Store and Access Data", First Edition, O'Reilly, 2019.

Reference Books:

1. Vijay Kotu , Bala Deshpande , "Data Science: Concepts and Practice", Second Edition, Morgan Kaufmann, 2018.
2. Robert H. Shumway and David S. Stoffer, "Time Series Analysis and Its Applications : With R Examples," Springer, 4th Edition, 2017.

Web Links:

1. Energy consumption time series forecasting with python and LSTM deep learning model | by Eligijus Bujokas | Towards Data Science
2. Autoregression Models for Time Series Forecasting With Python - MachineLearningMastery.com
3. Python | ARIMA Model for Time Series Forecasting - GeeksforGeeks
4. Weekly Rainfall and Temperature Forecasting | Kaggle
5. Air Passenger Forecast : ARIMA - SARIMA | Kaggle
6. Stock Price prediction by simple RNN and LSTM | Kaggle
7. LSTM for Time Series Prediction in PyTorch - MachineLearningMastery.com

8. Gated Recurrent Unit (GRU) With PyTorch (floydhub.com)

Suggested List of Experiments:

	Time Series Analysis Laboratory(DJ19AMEL6012)
S No	Name of Experiment
1	Data Preprocessing: Clean and preprocess a given time series dataset, handling missing values.
2	Data Exploration: Use Pandas to explore and visualize various time series datasets.
3	Autoregression Models for Time Series Forecasting with Python
4	Apply ARIMA - SARIMA models to predict / forecast the number of passengers travelling using aeroplanes based on time series data.
5	Implementing Basic RNN: Develop an RNN model for stock price prediction using historical data.
6	Time Series Prediction with LSTM Recurrent Neural Networks in Python with Keras
7	Gated Recurrent Unit (GRU) With PyTorch
8	Outlier Detection using statistical methods.
9	Outlier Detection using Unsupervised Machine Learning Techniques
10	Compare and contrast on Statistical methods and Deep Learning methods by forecasting the Weekly Rainfall and Temperature.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept
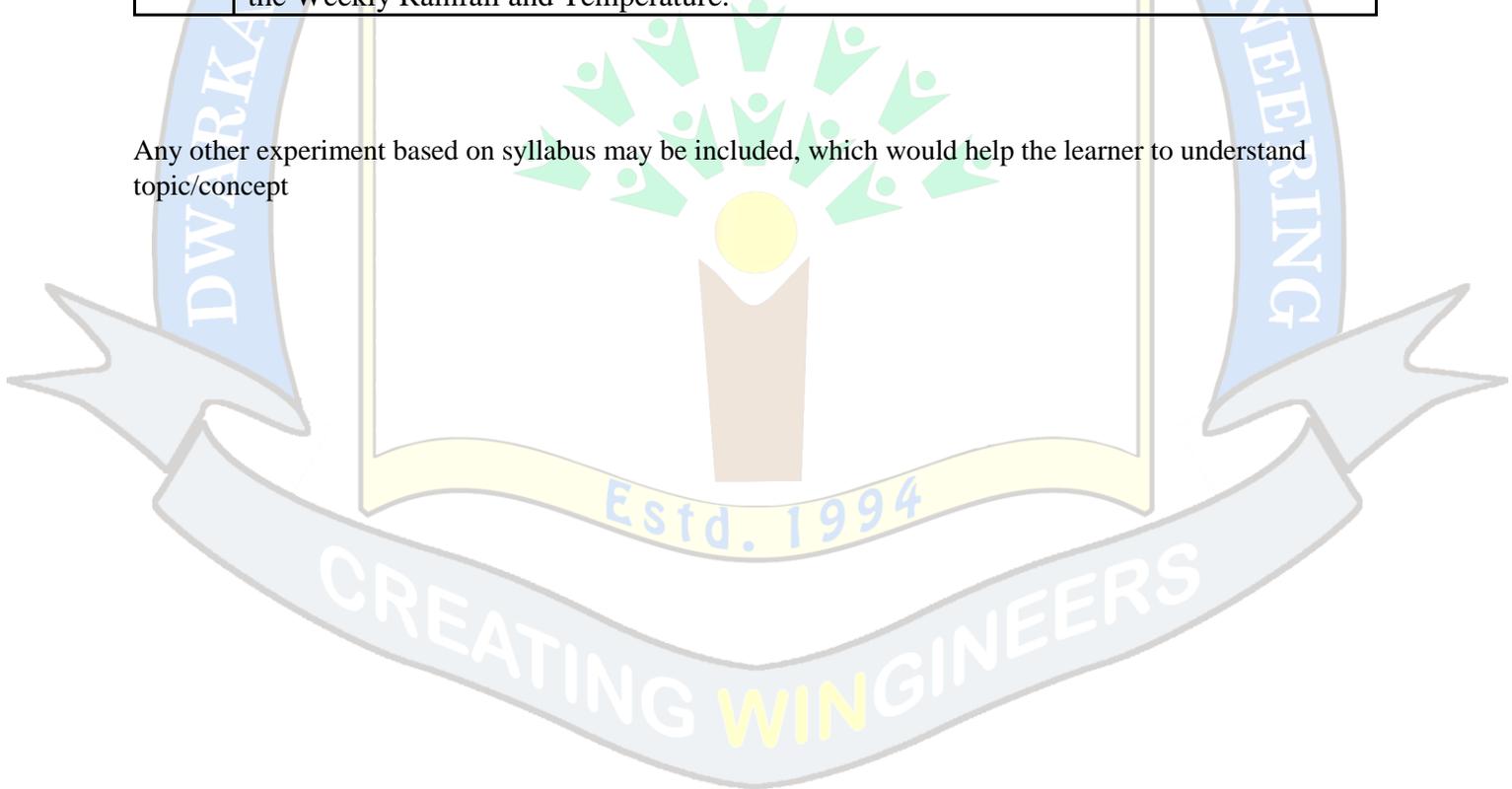
Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI

Course: Human Machine Interaction (DJ19AMEC6013)

Course: Human Machine Interaction Laboratory (DJ19AMEL6013)

Objectives:

1. This course provides an opportunity to learn and apply the design principles of Human Machine Interaction.
2. Learners will learn the basic human psychology of everyday actions and will be able to design an UI prototype of an application.
3. This course covers the discussion on various interaction design concepts.
4. The laboratory experiments are designed to practice the concepts and to adopt the systematic approach for interface design using various UX tools.

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

1. Identify the various design principles used for interacting between human and machine.
2. Apply human psychology of everyday actions and UI design processes for real world applications.
3. Implement mobile, windows, and web-based application
4. Evaluate and justify UI design and Create an application for a social and technical task.

Course: Human Machine Interaction (DJ19AMEC6013)		
Unit	Description	Duration
1	**Introduction:** Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields. The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error.	07
2	**Graphical User Interface and Web Interface:** The Graphical User Interface: Popularity of graphics, the concept of direct manipulation, characteristics of GUI, Web user Interface: Interface popularity, characteristics. Principles of user interface design.	06
3	**Understanding Goal-Directed Design:** Goal-directed design; Implementation models and mental models; Beginners, experts, and intermediates – designing for different	07

	experience levels. Understanding users; Modeling users – personas and goals.	
4	**Design Guidelines:** perception, Gestalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, and time.	07
5	**Interaction Styles and Communication:** **Interaction Styles:** Menus, Windows, Device-based and Screen-based Controls. **Communication:** Text messages, Feedback, and Guidance, Icons, Multimedia, and colors.	07
6	**UX tools**: Figma, Just In Mind, and any open-source tool for prototype designing. Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.	05
	Total	39

Books Recommended:

Text Books:

1. Kalbande,Kanade,Iyer, "Galitz's Human Machine Interaction", 1st Edition, Wiley Publications, 2015.
2. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale, "Human Computer Interaction", Peason,Prentice Hall, 3rd Edition, 2003
3. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication, 3rd Edition, 2007.
4. Donald A. Normann," Design of everyday things", Basic Books; 2nd Edition, 2013

Reference Books:

1. Rogers Sharp Preece, "Interaction Design: Beyond Human Computer Interaction", 5th Edition, Wiley publications.
2. Brian Fling, "Mobile Design and Development", 1st Edition, O'Reilly Media Inc.,2009.

Web links

1. Nielsen's Heuristics: 10 Usability Principles To Improve UI Design - Aela School
2. 12 UX Designer Tools You Should Be Using (From Beginner to Pro) | Columbia Engineering Boot Camps

Human Machine Interaction Laboratory (DJ19AMEL6013)	
Sr. No.	**Title of the Experiment**
1	To Study of open-source UX tools (Justinmind Prototype, Pidoco, Marvel ,Figma Prototype) and create a simple design for a given problem definition.

2	**Know your client.** ● Design an app that can teach mathematics to children of 4-5 years age in schools in Rural Sector. ● Design an app that can teach mathematics to children of 4-5 years age in schools in Urban Sector. ● Design a site that can help people to sell their handmade products in metro cities. ● Design a site that can connect housewives and keep them engaged. Note **: Students should be able to do the following for any given problem statement** ● Analysis of user's/client's behavior eg their preferences, interests etc ● What kind of interfaces will they like and why? ● Existing apps - analyze and rate them. ● What will be your choice of screen elements? ● How will your app/web design be better than the existing one?
3	**Goal-oriented design** - Design an experience for passengers whose flight /train is delayed.
4	**Design Principles** - Understand principles of good UI design by heuristic evaluation. Design UI for a given problem statement.
5	**Menus & Navigation** – Redesign of a user interface (Suggest and implement changes in Existing User Interface) for a given problem statement.
6	a. **Windows & Screen controls** – Design UI for a given problem statement.Design a navigator for a student new in your Institute. b. Design a navigator for a person new in tourist city/ village. c. Motor paralysis for differently able people. d. Vaccination App design with localization
7	**Icons** - Design appropriate icons pertaining to a given domain. (Eg. Greeting cards, Travelling, restaurants, Education, Medical, security at Airport, Malls etc)
8	**Colors** – Design a personal website for any socio-technical problem. Use color guidelines with statistical graphics for better visualization.
9	Design a Map-based UI(Web User) for the given problem statement. Example: Mumbai Dabbawallas with localization feature. Pet Care New Visitors to Hospital
	To calculate the screen complexity of the existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Prepared by   Checked by   Department Coordinator   Principal

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Professional and Business Communication Laboratory (DJ19IHL2)		

Pre-requisite:

Basic course in Effective Communication Skills

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance communication and interpersonal skills
3. To develop effective presentation skills
4. To hone written skills for technical documentation

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

1. Prepare technical documents using appropriate style, format, and language
2. Use employability skills to optimize career opportunities
3. Employ storytelling techniques in corporate situations
4. Conduct effective meetings and document the process
5. Demonstrate interpersonal skills in professional and personal situations
6. Describe cultural differences, etiquettes, and the concept of professional ethics

Professional and Business Communication Laboratory (DJ19IHL2)		
Unit	**Description**	**Duration**
1	**Unit 1:Technical Writing:** **Report Writing:** Types of reports, Basic structure of a report, collection of data through questionnaires, survey analysis, language and style in reports **Business Proposal Writing:** Types of business proposals, format of proposal,language and style, presentation of proposal **Plagiarism:** Types of plagiarism, consequences of plagiarism	06
2	**Unit 2: Employment Skills** **Group Discussion:** Purpose of a GD, types of GD, criteria for evaluating GD,Dos and Don'ts of GD **Resume Writing:** Types of resumes, structure, content and formatting of resume **Interview Skills:** Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview **Presentation Skills:** Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation.	08
3	**Unit 3 : Corporate Story Telling:** **Basics of storytelling:** Setting, characters, plot, crisis, climax, resolution,	

	Benefits of storytelling **Types of stories:** Elevator pitch, product stories, event stories, stories in presentations, storytelling in SOP's and interviews, storytelling to manage conflict or to motivate **Storytelling techniques:** Narration using verbal and non-verbal communication, Analysis of storytelling strategies of corporate master storytellers	03
4	**Unit 4: Meetings and Documentation:** **Planning and preparation for meetings:** Planning layout of meetings, arranginglogistics, defining roles and responsibilities **Strategies for conducting effective meetings:** Follow the agenda, record discussion, observe meeting decorum **Documentation:** Draft notice, agenda and minutes of meeting **Business meeting etiquettes**: Verbal and non-verbal aspects of etiquettes	02
5	**Unit 5: Introduction to Interpersonal Skills** **Emotional Intelligence:** Definition, difference between IQ and EQ, how todevelop EQ **Leadership:** Types of leadership, leadership styles, case studies **Team Building:** Difference between group and team, importance of teamwork,strategies to be a good team player **Time Management:** Importance of time management, cultural views of time,80/20 rule, time wasters, setting priorities and goals, **Conflict Management:** Types of conflicts, strategies to manage conflict, case studies	05
6	**Unit 6: Cross-cultural communication and Professional ethics** **Communication across cultures**: Understanding cultures and developingsensitivity towards cultural differences **Corporate etiquettes**: Telephone, dining, cubicle etiquette, etc. **Professional ethics**: Effective work habits, accountability, integrity and excellence	02
	Total	39

Books Recommended:

Text Books:

1. Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition

Reference Books:
1. Heta Murphy*, "Effective Business Communication",* Mc Graw Hill, edition
2. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
3. Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill. Lehman,
4. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.

5. Dr. Alex, K., "Soft Skills", S Chand and Company
6. Subramaniam, R., "Professional Ethics" Oxford University Press.
7. Sandeep Das, "How Business Story Telling Works: Increase Your Influence and Impact" Penguin Random House India Pvt. Ltd.

Program: Artificial Intelligence & Machine Learning	T.Y. B.Tech.	Semester: VI
Course: Innovative Product Development IV		

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualise and create a successful product.

Outcome:

Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualising a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyse the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of theteam or as theleader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

- Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
- Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
- Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.

- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
- The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, i.e. during the semesters V and VI.

Guidelines for Assessment of the work:

- The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
- In the continuous assessment, focus shall also be on each individual student's contribution tothe team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
- Distribution of term work marks during the subsequent semester shall be as given below:
    - Marks awarded by the supervisor based on log-book   10
    - Marks awarded by review committee   10
    - Quality of the write-up   05

In the last review of the semester VI, the term work marks will be awarded as follows.
- Marks awarded by the supervisor (Considering technical paper writing)   15
- Marks awarded by the review committee10

Review/progress monitoring committee may consider the following points during the assessment.
- In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.
- First shall be for finalisation of the product selected.
- Second shall be on finalisation of the proposed design of the product.
- In the semester VI, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester III.
- First review is based on readiness of building the working prototype.
- Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester IV. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

- The semester reviews (V and VI) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:
- The write-up should be prepared as per the guidelines given by the department.
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organisations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester IV.Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Prepared by   Checked by   Department Coordinator   Principal