R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2026-27

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – V

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Durationof SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC08N	PCC	Deep Learning	3	-	-	3	40	60	3
2	22CAC09N	PCC	Full Stack Web Development	2	1	-	3	40	60	3
3	22CSC15N	PCC	Operating Systems	3	-	-	3	40	60	3
4	22*****	PEC	Professional Elective – I	3	-	-	3	40	60	3
5	22*****	OE	Open Elective-I	3	-	-	3	40	60	3
6	22MBC01	HS	Engineering Economics and Accountancy	3	-	-	3	40	60	3
PRACTICAL										
7	22CAC10N	PCC	Deep Learning Lab	-	-	3	3	50	50	1.5
8	22CAC11N	PCC	Full Stack Web Development Lab	-	-	3	3	50	50	1.5
9	22CSC18N	PCC	Operating Systems Lab	-	-	3	3	50	50	1.5
10	22CAI02N		Industrial / Rural Internship-2	3-4 weeks / 90 Hours			-	50	-	2
TOTAL				**17**	**1**	**9**	**-**	**440**	**510**	**24.5**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

PE1 (T) Semester-V		Open Elective-I Semester-V	
22CAE01N	Soft Computing	22CEO01	Infrastructure for Smart Cities
22CAE02N	Knowledge Representation and Reasoning	22ECO02	Remote Sensing & GIS
22CAE03N	Image Processing	22MEO01	Principles of Design Thinking
22CSE08	User Interface and User Experience Design	22MB**	Engineering Leadership
22CSE19	Big Data Analytics		

22CAC08N

DEEP LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Calculus, Probability and Statistics, Python Programming, Machine Learning.

Course Objectives: The objectives of this course are

1. Provide students with a strong foundation in the history, concepts, and mathematical principles of deep learning.
2. Develop students' skills in gradient descent methods and regularization techniques for effective model training.
3. Equip students to design and implement convolutional and recurrent neural network architectures.
4. Enhance students' understanding in recurrent neural networks
5. Expose students to the latest deep learning models to solve complex problems.

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

1. Understand the fundamental concepts, architectures, training methods, and evaluation techniques of deep learning models.
2. Apply optimization algorithms and regularization techniques to train deep neural networks effectively and improve model performance..
3. Design and develop convolutional neural network models using standard and pre-trained architectures for image analysis tasks.
4. Analyse and apply sequence learning models using recurrent neural networks, LSTM, GRU, and encoder-decoder architectures with attention mechanisms
5. Apply and evaluate the transformer and generative adversarial network (GAN) models to solve complex real-world problems.

CO-PO & PSO Articulation Matrix

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	1	3	1	-
CO2	3	3	2	2	3	-	-	-	1	1	1	3	2	-
CO3	3	3	3	3	3	-	-	-	2	2	1	3	3	1
CO4	3	3	3	3	3	-	-	-	2	2	1	3	3	2
CO5	3	3	3	3	3	1	1	1	2	2	2	2	3	3

UNIT-I

Biological to Artificial Neurons: Biological Neurons, Logical Computations with Neurons, McCulloch–Pitts (MCP) Neuron, Hebb Network, Threshold Logic, Perceptron Learning, and Multilayer Perceptron (MLP).

Activation Functions: Sigmoid, Linear, Tanh, ReLU, Leaky ReLU, and Softmax. **Loss Functions:** Loss Function Notation, Loss Functions for Classification and Regression, and Fine-Tuning of Neural Network Hyperparameters

UNIT-II

Optimizers: Gradient Descent (GD), Momentum-Based Gradient Descent, AdaGrad, RMSProp, and Adam.
The Vanishing and Exploding Gradient Problems: Batch Normalization and Gradient Clipping, Avoiding Overfitting through Regularization: L1 and L2 Regularization, Dropout, Dataset Augmentation, and Early Stopping.

UNIT-III

Convolutional Neural Networks: Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, Fine-Tuning of Pre-trained Models, and Performance Evaluation.

Pre-trained Models: Introduction, LeNet, AlexNet, VGG16, GoogLeNet, and ResNet50.

UNIT-IV

Recurrent Neural Networks (RNNs): Introduction, Recurrent Neural Networks with Hidden States, Converting Raw Text into Sequence Data, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), and Bidirectional LSTM.

Encoder–Decoder Models: Encoder–Decoder Architecture, Autoencoders, and Attention Mechanism.

UNIT-V

Transformer Models: Transformer Architecture, Vision Transformer (ViT), and Bidirectional Encoder Representations from Transformers (BERT).

Generative Adversarial Networks (GANs): Introduction, Generator, Discriminator, and GAN Training.

Foundation Models and Applications: Foundation Models and Applications of Deep Learning.

Text Books:

1. Goodfellow. I., Bengio. Y. and Courville. A., "Deep Learning ", MIT Press, 2016.
2. Rothman, Denis, "Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more", Packt Publishing Ltd, 2021.
3. Ganguly Kuntal, "Learning generative adversarial networks: next-generation deep learning simplified", Packt Publishing, 2017

Suggested Reading:

1. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006. ISBN 978-0-387-31073-2
3. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
4. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
5. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004. David Marr, Vision, 1982.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85/

22CAC09N

FULL STACK WEB DEVELOPMENT

Instruction	2L+1T Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basics of Programming.

Course Objectives: This course aims to

1. Create responsive web pages using HTML, CSS, Bootstrap, and JavaScript.
2. Develop dynamic front-end applications using React and understand agile development basics.
3. Build full-stack applications using Node.js, Express, and MongoDB for data handling.

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

1. Design responsive web pages using HTML, CSS, and Bootstrap.
2. Develop interactive client-side features using JavaScript and AJAX.
3. Build single-page applications with React and its core features.
4. Create backend services using Node.js and Express.js.
5. Perform CRUD operations and schema design using MongoDB.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	1	-	2	2	-	2	-	1	-
CO2	3	2	3	1	3	-	-	2	2	-	3	-	2	1
CO3	3	3	3	2	3	-	-	2	2	1	3	-	2	2
CO4	3	2	3	2	3	-	-	2	1	2	3	1	2	3
CO5	3	3	3	2	3	-	-	1	1	1	3	2	3	2

UNIT-I

Introduction to Full Stack Development: HTML 5.0: Introduction to basic HTML tags, HTML DOM, Working with Images, Tables, Lists, Forms, Layout elements, Usage of span and div tags for layout structuring.
Introduction to Cascading Style Sheets (CSS): Types of CSS (Inline, Internal, External), CSS Selectors, CSS BOX Model.
Bootstrap 5: Introduction to Bootstrap framework, usage of container and container-fluid classes, grid system, UI components such as carousel, buttons, tables, forms, alerts, images, tabs/pills, navbar, and modals.

UNIT-II

JavaScript: Data types and type conversion, handling events. Object-Oriented Programming in JavaScript, use of regular expressions.
AJAX: Introduction to AJAX, working with XMLHttpRequest and the Fetch API, JSON data,sending and receiving JSON data asynchronously, and handling server responses in the browser.

UNIT-III

ReactJS: Introduction to React JS, using JSX syntax, comparison of actual DOM vs React's Virtual DOM (VDOM). Creating and managing functional components, understanding state and props, handling events, useState and useEffect hooks,React Router, Handling user inputs with controlled forms and form validation.
Angular: Introduction to Angular and Angular CLI, creating and managing Angular components and templates. Data binding: property binding and event binding.

UNIT-IV

Node.js: Introduction to Node.js and the Node Package Manager (npm). Working with Node.js modules, creating a basic web server, and understanding the request-response cycle. Working with the file system to read and write files asynchronously.

Introduction to event-driven architecture: EventEmitter class, creating custom events, and extending the EventEmitter class. Handling common I/O operations and implementing basic middleware.

UNIT-V

Express.js: Introduction to the Express.js framework for server-side application development. Routing and handling GET and POST requests, middleware functions, creating and using custom middleware, and serving static files. Using templating engines like EJS or Pug for dynamic content rendering.

MongoDB: Introduction to NoSQL databases, comparison of JSON and BSON data formats, working with MongoDB data types. CRUD operations (Create, Read, Update, Delete), schema design.

Textbooks:

1. Jon Duckett, "HTML and CSS: Design and Build Websites", Wiley India, 1st Edition, 2011.
2. Eric Freeman, "Head First HTML and CSS", O'Reilly Media, 2nd Edition, 2012.
3. Ethan Brown, "Web Development with Node and Express", O'Reilly Media, 1st Edition, 2014.
4. Brad Traversy, "Modern JavaScript From The Beginning", Traversy Media, Online Course/Edition, 2020.

Online Resources:

1. MDN Web Docs: https://developer.mozilla.org/
2. W3Schools: https://www.w3schools.com/
3. React Official Docs: https://reactjs.org/
4. Angular Official Docs: https://angular.io/
5. Node.js Official Site: https://nodejs.org/
6. Express.js Docs: https://expressjs.com/
7. MongoDB Manual: https://docs.mongodb.com/

22CSC15N

OPERATING SYSTEMS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture and Programming Fundamentals.

Course Objectives:
This course aims to:
1. Understand the basic concepts and design of an operating system.
2. Interpret the structure and organization of the file system.
3. Learn Inter Process Communication mechanisms and memory management approaches.
4. Explore cloud infrastructures and technologies.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand the basics of Operating systems and its major components.
2. Illustrate the concepts related to process management.
3. Distinguish various memory management techniques.
4. Apply concepts of process synchronization and deadlocks to a given situation.
5. Evaluate various file allocation methods and security as well as recovery features in the designing Operating system.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	-	3	1	-	-	-	-	-	-	2	2	1
CO3	3	3	2	1	1	-	-	-	-	-	-	1	2	-
CO4	3	3	1	3	-	-	-	-	-	-	-	1	2	1
CO5	3	3	2	3	1	-	-	-	-	-	-	1	2	3

UNIT-I
Introduction to Operating Systems: Computer System overview, Components of a computer system, functions of OS, Examples and different types of OS (RTOS vs. desktop vs. mobile etc.), OS distributions and versions.
OS architectures: Micro-kernel, Layered, Kernel Approaches and examples, Linux/Unix OS Design and architecture overview.

UNIT-II
Process management: Program vs. process, process states, Process Control Block (PCB), OS services and system calls (fork, wait, exec, getpid, getppid etc.), system calls vs. System programs, Process scheduling- Process context switching, scheduling algorithms, scheduling criteria.
Process management in Unix/Linux. Inter Process Communication: Linux IPC Mechanisms, RPC, RPC exception handling and Security issues.

UNIT-III
Memory Management: Memory view of a process, Process memory usage requirements, virtual and physical memory related system calls (mmap, munmap, sbrk, mprotect). Address translation mechanisms static mapping, segmentation, paging, page faults, page replacement algorithms, page sharing, read/write permissions, swapping.
Memory management in Linux/Unix. Secondary Memory Management: Disk structure, disk scheduling, disk management, buffering, swap space management.

UNIT-IV

Concurrency and Synchronization: Introduction to threads, benefits, types and thread APIs, Synchronization, issues, hardware and software solutions for synchronization, Classical problems of synchronization.

Deadlocks: Introduction, necessary conditions for deadlock occurrence, RAG, deadlock handling mechanisms - prevention, avoidance and recovery.

UNIT-V

File Systems: File concepts, file types, allocation and organization methods, file handling system calls, File system metadata, directory structure, caching optimizations, File Systems case study.

OS Security and Defence: Types of threats in OS, basic security mechanisms, malware taxonomy, viruses, worms, and rootkits, logging, auditing, and recovery.

Text Books:

1. Galvin, Silberschatz, "Operating system Concepts", 10th Edition, John Wiley & Sons, 2018.
2. William Stallings, "Operating Systems Internals and Design Principles" Pearson Edition, 2012.

Suggested Reading:

1. Ekta Walia Khanna, "Operating System Concepts", 2nd Edition, Publishing House, 2019.
2. W. Richard Stevens, Stephen A. Rago, "Advanced Programming in the UNIX® Environment", 3rd Edition, Pearson Education India; 2013.
3. Maurice J. Bach, "Design of the UNIX Operating System", 1st Edition, Pearson Education India, 2015.

Online Resources:

1. Remzi H. Arpaci-Dusseau and Andrea C. , "Three Easy Pieces", Arpaci-Dusseau Arpaci-Dusseau Books, LLC https://pages.cs.wisc.edu/~remzi/OSTEP/ (online version).
2. Frans Kaashoek, Robert Morris, and Russ Cox, Xv6, a simple Unix-like teaching operating system [T4-R] https://github.com/mit-pdos/xv6-riscv (RISC-V version) [T4-X] https://github.com/mit- pdos/xv6-public (x86 version).

22CAE01N

SOFT COMPUTING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Artificial Intelligence & Machine Learning

Course Objectives:

1. Acquire the fundamental knowledge in soft computing.
2. Understand the basics of fuzzy sets and fuzzy logic rules.
3. Discuss the basics of genetic algorithms
4. Analyze the fundamentals of artificial neural network models.

Course Outcomes:

After completion of the course, students will be able to

1. Identify artificial intelligence and soft computing techniques in building intelligent machines.
2. Apply fuzzy logic and reasoning to handle uncertainty.
3. Understand different operators and basic terminologies of genetic algorithms
4. Understand the concept of artificial neural networks.
5. Evaluate different soft computing techniques for suitable applications.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	2	-	-	-	1	-	1	2	1	2	1
CO2	2	3	2	2	-	-	-	1	-	2	-	1	3	1
CO3	2	1	1	2	-	-	-	1	-	1	-	2	2	1
CO4	2	1	1	2	-	-	-	1	-	2	-	1	1	-
CO5	2	1	2	2	-	1	-	1	1	2	2	-	2	3

UNIT-I:

Introduction to Soft Computing: Introduction, Hard Computing vs Soft Computing, Soft Computing Constituents, Machine Learning Basics: Supervised, Unsupervised and Reinforcement Learning.

Introduction to Fuzzy Logic: Classical Sets (Crisp Sets) Theory: Basic Definitions and Terminology, Operations, Properties, Crisp Relations and Operations, Fuzzy Sets Theory: Operations, Fuzzy Relations and compositions, Types of Membership Functions, Features.

UNIT-II:

Fuzzy Logic and Inference rules: Introduction, Classical Logic, Multi-valued Logic, Fuzzy Logic, Fuzzy Propositions, Inference Rules for Fuzzy Propositions.

Fuzzy Inference Systems: Introduction, Fuzzy Inference System (Fuzzification, Defuzzification), Types of Fuzzy Inference Engines and its Implementation, Neuro Fuzzy System.

UNIT-II:

Introduction to Evolutionary Computing: Biological Evolutionary Process, Paradigms, Strategies, Evolutionary Programming, Advantages and applications**.**

Genetic Algorithm Process: GA Introduction, Selection, Encoding of Genetic Operators, Classification of GA, Applications, Advantages and Disadvantages of GA.

UNIT-IV:

Single Layer Feed Forward Neural Networks: Introduction, Biological Neurons, Artificial Neural Networks, ANN Model, Single Layer Feed forward Neural Network, Applications of NN.

Multi-Layer Feed Forward Neural Networks: Architecture, Learning Methods, Backpropagation Method, Design Issues of ANN, and Applications.

UNIT-V:

Radial Basis Function Neural Networks (RBNF): RBNF Introduction, Architecture, Learning, Comparison of RBNF and FFNN(Feed Forward Neural Networks), and Applications.

Recurrent Neural Networks: RNN Architecture and Training, Hopfield Networks, Self-Organizing Neural Networks.

Text Books:

1. Saroj Kaushik, Sunita Tiwari, Soft Computing Fundamentals, Techniques and Applications, McGraw Hill, 2018.

Reference Books:

1.Elaine Rich, Kevin Knight and Shivashankar B.Nair, Artificial Intelligence, 3rd Edition TMH, 2009, rp2017.

2.Jyh:Shing Roger Jang, Chuen:Tsai Sun and Eiji Mizutani, Neuro Fuzzy and Soft Computing, Prentice Hall of India/PHI, 2003.

3.Amit Konar, Artificial Intelligence and Soft Computing- Behavioural and Cognitive Modelling of the Human Brain, CRC press, 1st Edition, Taylor and Francis Group, 1999.

4.Hung T Nguyen and Elbert A Walker, A first course in Fuzzy Logic, CRC Press, 3rd Edition, Taylor and Francis Group, 2006.

5.Fakhreddine Karray and Clarence D Silva, Soft Computing and Intelligent System Design, Pearson Edition, 2004.

Online Resources:

1. http://www.myreaders.info/html/soft_computing.html.
2. https://onlinecourses.nptel.ac.in/noc22_cs54/preview

22CAE02N

KNOWLEDGE REPRESENTATIONS AND REASONING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MFDS

Objectives:
1. To understand the key concepts of knowledge representation and reasoning.
2. To explore the role of logic in knowledge representation.
3. To study ontology and its categories, including philosophical background and top-level categories.
4. To learn about knowledge representations, including knowledge engineering and representing structure in frames.
5. To examine processes, including times, events, situations, and computation, in knowledge representation.

Course Outcomes:
1. Ability to explain the key concepts of knowledge representation and reasoning.
2. Proficiency in representing knowledge in logic and understanding different varieties of logic.
3. Understanding of ontology, including ontological categories and how to describe physical entities and define abstractions.
4. Competence in representing knowledge structures in frames, rules, and data.
5. Ability to apply knowledge representation techniques to address real-world problems involving vagueness, uncertainty, and randomness

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	1	1	1			
CO2	3	3	2	2	3	1	1	1	1	1	1			
CO3	3	2	2	3	2	1	2	1	1	1	2			
CO4	3	3	3	3	3	2	2	1	1	1	2			
CO5	3	3	3	3	3	2	2	1	1	1	2			

UNIT I:
The Key Concepts: Knowledge, Representation, Reasoning, why knowledge representation and reasoning, Role of logic
Logic: Historical background, representing knowledge in logic, Varieties of logic, Name, Type, Measures, Unity Amidst diversity

UNIT II:
Ontology: Ontological categories, Philosophical background, Top-level categories, Describing physical entities, Defining abstractions, Sets, Collections, Types and Categories, Space and Time

UNIT III:
Knowledge Representations: Knowledge Engineering, Representing structure in frames, Rules and data, Object-oriented systems, Natural language Semantics, Levels of representation

UNIT IV:
Processes: Times, Events and Situations, Classification of processes, Procedures, Processes and Histories, Concurrent processes, Computation, Constraint satisfaction
Change Contexts: Syntax of contexts, Semantics of contexts, First-order reasoning in contexts, Modal reasoning in contexts, Encapsulating objects in contexts.

UNIT V:

Knowledge Soup: Vagueness, Uncertainty, Randomness and Ignorance, Limitations of logic, Fuzzy logic, Nonmonotonic Logic, Theories, Models and the world

Semiotics Knowledge Acquisition and Sharing: Sharing Ontologies, Conceptual schema, Accommodating multiple paradigms, Relating different knowledge representations, Language patterns, Tools for knowledge acquisition

Text Books:

1. Knowledge Representation logical, Philosophical, and Computational Foundations by John F. Sowa, Thomson Learning.
2. Knowledge Representation and Reasoning by Ronald J. Brachman, Hector J. Levesque, Elsevier.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106140/

22CAE03N

IMAGE PROCESSING
(Professional Elective – I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Signal Processing.

Course Objectives: The objectives of this course are
1. To introduce basics of visual perception, sampling, quantization and representation of Digital images.
2. To introduce spatial domain and frequency domain filtering techniques necessary for Image processing operations.
3. To learn advanced image analysis techniques such as image restoration, image Compression, image segmentation.
4. To learn techniques of multi resolution methods, wavelets and morphological Processing.
5. To understand the applications of image processing

Course Outcomes: After completion of course, students would be able to:
1. Understand the basic image enhancement techniques in spatial & frequency domains.
2. Understand the basics of multi-resolution techniques.
3. Understand the basics of segmentation methods.
4. Apply this concept for image handling in various fields.
5. Knowledge about Morphological operations.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	1	1	1	1	1	2	-
CO2	3	2	2	2	3	1	1	1	1	1	1	1	2	1
CO3	3	2	2	2	3	1	1	1	1	1	1	2	1	-
CO4	3	2	3	3	3	2	1	1	2	2	2	2	3	1
CO5	3	2	2	2	3	1	1	1	1	1	1	2	2	-

UNIT-I
Fundamentals of Image Processing: Introduction, , fundamental steps, components, , , image sensing and acquisition, image sampling and quantization, basic relationships between pixels. Intensity Transformations and Spatial Filtering: Background, some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods.

UNIT-II
Filtering in the Frequency Domain: Background, preliminary concepts, sampling and Fourier transform of sampled functions, discrete Fourier transform (DFT) of one variable, extension to functions of two variables, some properties of the 2-D discrete Fourier transform, basics of filtering in the frequency domain, image smoothing, image sharpening, homo- morphic filtering.

UNIT-III
Image Restoration: Noise models, restoration in the presence of noise only-spatial filtering, periodic noise reduction by frequency domain filtering, linear degradation, position-invariant degradation, estimating the degradation function, inverse filtering, minimum mean square error filtering, constrained least squares filtering, geometric mean filter.

UNIT-IV

Wavelets and Multi Resolution Processing: Background, multi-resolution expansions, wavelet transforms in one dimension, the fast wavelet transform, wavelet transforms in two dimensions, wavelet packets. Image Compression: Fundamentals, image compression models, , lossy compression,.

UNIT-V

Image Segmentation: Fundamentals, point, line and edge detection, thresholding, region-based segmentation, segmentation using morphological watersheds, the use of motion in segmentation. Morphological Image Processing: Preliminaries, erosion and dilation, opening and closing, the Hit-or-Miss transformation, some basic morphological algorithms, some basic gray-scale morphological algorithms.

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, PHI Learning Pvt. Limited, 3rd Edition, 2008.
2. Rafael C.Gonzalez, Richard E.Woods and Steven L.Eddins, Digital Image Processing Using MATLAB,2nd Edition, McGraw Hill, 2010.

Suggested Reading:

1. AL. Bovik, The Essential Guide to Image processing, 2 nd Edition, Elsevier, 2009.
2. Anil K.Jain, "Fundamentals of Digital Image Processing", PHI, 2006.
3. William K. Pratt, Digital Image Processing, John Wiley & Sons, Inc., 3rd Edition, 2001

Online Resources:

1. https://www.youtube.com/watch?v=DSGHkvQBMbs&list=PLuv3GM6-gsE08DuaC6pFUvFaDZ7EnWGX8
2. https://archive.nptel.ac.in/courses/117/105/117105135/

22CSE08

USER INTERFACE AND USER EXPERIENCE DESIGN
(Professional Elective – I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Fundamental Computer Skills, Knowledge of Web Technologies.

Course Objectives:
This course aims to:
1. Familiarize students with the fundamental principles and concepts of user interface (UI) and user experience (UX) design.
2. Equip students with the practical skills and knowledge necessary to design effective UI/UX interfaces.
3. Understand the importance of applying user-centered design methods throughout the design process.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Apply user-centered design principles to create interfaces that meet the needs and preferences of target users.
2. Demonstrate proficiency in designing intuitive user interfaces that are easy to navigate and understand.
3. Develop the skills to create wireframes, prototypes, and mockups using industry-standard design tools.
4. Gain an understanding of accessibility guidelines and principles, designing interfaces that are accessible to users with disabilities.
5. Identify emerging trends and technologies in UI/UX design.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	-	2
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	-	1
CO 3	2	3	3	3	3	2	-	3	3	3	3	3	-	1
CO 4	3	3	3	3	3	3	-	3	3	3	3	3	-	2
CO 5	3	3	1	2	2	1	-	3	3	1	-	3	2	2

UNIT - I
Introduction to UI/UX Design: Understanding UI/UX Design: Definition and importance of UI/UX design, Difference between UI and UX, Roles and responsibilities of UI/UX designers, Overview of the design process.
User-Centered Design Principles: Principles of user-centered design, User research methods (interviews, surveys and observations), Creating user personas and scenarios, Conducting user journey mapping exercises.

UNIT – II
Design Fundamentals: Basic principles of visual design (layout, typography, color),Gestalt principles and their application in UI design, Applying visual hierarchy to improve user experience.
Introduction to design tools (Sketch, Figma, Adobe XD) Interaction Design: Principles of interaction design, Designing effective navigation systems, Feedback mechanisms and user affordances Prototyping techniques for interaction design

UNIT - III
Usability and User Testing: Understanding usability principles, Nielsen's heuristics for user interface design, conducting heuristic evaluations of UI designs, Usability testing methods (moderated vs. unmoderated, remote testing)

User Testing and Feedback: Planning and conducting usability tests, Analyzing usability test results incorporating user feedback into UI design iterations, Best practices for iterative design and testing cycles

UNIT - IV

Accessibility in UI/UX Design: Understanding accessibility guidelines (WCAG), Designing accessible interfaces for users with disabilities, Assistive technologies and their impact on UI/UX design.

Emotional Design and Engagement: Principles of emotional design, creating emotionally engaging user experiences, Strategies for enhancing user engagement and retention, Case studies of emotionally successful UI/UX designs.

UNIT - V

Responsive and Mobile Design: Principles of responsive web design, Mobile-first design approach, Adapting layouts and content for different screen sizes, Testing and debugging responsive designs.

Designing for Mobile Platforms: Mobile UI design patterns and conventions, Navigation and interaction patterns for mobile apps, Challenges and best practices for designing mobile interfaces, Introduction to mobile prototyping tools (InVision, Marvel)

Text Books:

1. Krug, S. Don't Make Me Think, Rider publication,2006
2. Don Norman , "The Design of Everyday Things", Published by Basic Books,2013

Suggested Reading:

1. Jim K. Design Basics Index, How books,2010.
2. Lidwell, W., Holden, K. and Butler, J. Universal Principles of Design, Rockport Publishers,2010.

Online Resources:

1. User Interface Design - Course (nptel.ac.in)
2. Introduction to User Experience Design Course (Georgia Tech) | Coursera

22CSE19

BIG DATA ANALYTICS
(Professional Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Proficiency in python programming, Database fundamentals

Course Objectives:

This course aims to:

1. Introduce the importance of Big Data and the role of the Hadoop framework in analyzing large datasets.
2. Gain practical knowledge in working with Hadoop ecosystem tools such as MapReduce,pig,hive,Spark.
3. Provide hands-on experience in using Spark for real-time stream processing.

Course Outcomes:

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

1. Define and describe the types, characteristics, and challenges of Big Data and the need for its analysis.
2. Analyze the differences between traditional systems and Hadoop, and explain the functions of core components like HDFS and YARN.
3. Develop MapReduce programs and analyze different join strategies and pipeline models for big data processing.
4. Design and execute queries using Hive and Pig to extract, transform, and analyze large datasets.
5. Implement scalable data processing applications using Apache Spark and evaluate its performance over traditional frameworks

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	3	1	3	3	3	-	3	3	2	3	3	3	2
CO 2	3	3	3	3	3	2	-	3	3	2	3	3	3	2
CO 3	3	3	3	3	3	2	-	3	3	2	3	3	1	2
CO 4	3	3	3	3	3	2	-	3	3	2	3	3	2	2
CO 5	3	3	3	3	3	3	-	3	3	2	3	3	2	2

UNIT-I

Introduction to Big Data: Data and its types: Unstructured, Semi-structured, Structured – Sources of data – Evolution and Definition of Big Data – Characteristics(3Vs/5Vs) and Challenges – Need for Big Data, , Big data integration process, Applications.Overview of Business Intelligence, Data Science, Analytics – Typical analytical architecture – Types of Analytics (Descriptive, Predictive, Prescriptive)

UNIT-II

Hadoop Ecosystem: Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system (SQL, RDBMS) - Core ccomponents of Hadoop – Architecture -Hadoop 1 vs Hadoop 2 – HDFS operations, Data ingestion layer, ETL and ELT, Ingestion tools in Hadoop ecosystem, Data ingestion types.

UNIT-III

Big Data Frame Works: Hadoop Frame Work: Introduction to MapReduce, Processing data with Hadoop using MapReduce, Map Reduce Programming: I/O formats, Map side join-Reduce Side Join, Secondary Sorting-Pipelining MapReduce jobs.Introduction to YARN, Architecture, Managing Resources and Applications with Hadoop YARN.

UNIT-IV

Hive and Pig: Introduction to Hive: What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF).

Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Data types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Eval Function, Complex Data Types, Piggy Bank, User Defined Function, Pig Vs Hive.

UNIT-V

Apache Spark Frame Work: Introduction to Apache spark-Design principles, Advantages and Disadvantages, Layered architecture, Programming with RDDs: Create RDD- Spark operations - transformations, actions-DAG in Apache spark. Case Study: Analyze student academic data to find trends, subject difficulty levels, and top performers using big data tools.

Text Books:

1. S. Chandramouli, 'Big Data Analytics', University press,2024 edition.
2. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley India Pvt. Ltd., 2016.

Suggested reading:

1. Tom White, 'Hadoop: The Definitive Guide', 4th Edition, O'Reilly Media Inc, 2015.
2. Thilinagunarathne, 'Hadoop MapReduce v2 Cookbook', 2nd Edition, Packet Publishing, 2015.
3. Chuck Lam, Mark Davis, Ajit Gaddam, 'Hadoop in Action', Manning Publications, 2016.
4. Alan Gates, 'Programming Pig', O'Reilly Media Inc, 2011.

Online resources:

1. http://www.planetcassandra.org/what-is-nosql
2. http://www.iitr.ac.in/media/facspace/patelfec/16Bit/index.html
3. https://class.coursera.org/datasci-001/lecture
4. http://bigdatauniversity.com

22CEO01

INFRASTRUCTURE FOR SMART CITIES
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: To enable the students to

1. Comprehend the Necessity of Infrastructural Development for Smart Cities.
2. Illustrate the Components and Planning Aspects of a Smart City.
3. Outline Smart Transportation Systems for Smart Cities.
4. Summarize the Significance of Disaster Resilient Infrastructure in Smart Cities.
5. Review Policies and Implementation of Smart Cities at National and Global Perspectives.

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

1. Understand the necessity of infrastructural development for smart cities.
2. Illustrate the components and planning aspects of a smart city.
3. Outline smart transportation systems for smart cities.
4. Summarize the significance of disaster resilient infrastructure in smart cities.
5. Review policies and implementation of smart cities at national and global perspective.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	-	-	-	-	1	-	-	-	-	-			
CO 2	2	-	-	-	-	1	-	-	-	-	-			
CO 3	2	-	-	-	3	1	-	-	-	-	-			
CO 4	2	3	-	-	3	1	-	-	-	-	-			
CO 5	2	-	-	-	-	1	-	-	-	-	3			

UNIT I

Fundamental of smart city & Infrastructure: Introduction of Smart City, Concept of smart city, Objective for smart cities. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems, Infrastructures need assessment

UNIT II

Planning and development of Smart city Infrastructure: Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security.

UNIT III

Intelligent transport systems: Connected vehicles, autonomous vehicles, GPS, Navigation system, traffic safety management, mobility services, E-ticketing.

UNIT IV

Disaster resilient Infrastructure: Electricity, sanitation and water supply systems, fire hazard management, earthquake resilient structures, ICT tools.

UNIT V

Infrastructure Management: System and Policy for Smart city, integrated infrastructure management systems, worldwide policies for smart city, Government of India - policy for smart city, Smart cities in India, Case studies of smart cities.

Text Books:

1. John S. Pipkin, Mark E. La Gory, Judith R. Balu (Editors); “Remaking the city: Social science perspective on urban design”; State University of New York Press, Albany (ISBN: 0-87395-678-8)
2. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science

References:

1. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science.
2. Mission statement &guidelines on Smart City Scheme". Government of India - Ministry of Urban Development http://smartcities.gov.in/upload/uploadfiles/files/Smart City Guidelines (1).pdf
3. Grig N.S., Infrastructure engineering and management, Wiley-Interseience, 1988 5. Hudson W.R., Haas R., Uddin W., Infrastructure Management, McGraw-Hill, 1997.

E Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ar12/preview
2. http://acl.digimat.in/nptel/courses/video/105105160/L01.html

22ECO02

REMOTE SENSING AND GIS
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Prerequisite: Basic knowledge of Geography is required

Course Objectives: This course is aims to:

1. Explain the fundamental concepts of remote sensing and digital imaging techniques.
2. Make the students to understand the principles of thermal and microwave remote sensing.
3. Make the students understand the significance of GIS and the process of GIS.

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

1. Demonstrate the understanding of basic concepts of remote sensing and interpreting energy interactions.
2. Choose an appropriate technique for a given scenario by appreciating the types of remote sensing.
3. Distinguish the principle behind the working of microwave and LiDAR sensing.
4. Apply Microwave remote sensing techniques
5. Explain the procedure for encoding data and geospatial data analysis.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 2	3	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 3	2	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 4	2	1	1	1	-	1	1	-	1	-	2	1	1	1
CO 5	3	1	1	1	-	1	1	-	1	-	2	1	1	1

UNIT-I

Concept of Remote Sensing: Remote sensing definition, data, process, EM bands used in remote sensing, Interactions and recording of energy: interaction with atmosphere, interaction with earth surface features (soil, water, vegetation), recording of energy by sensors, Transmission, reception and processing, Image interpretation and analysis, Applications, Advantages, and limitations of Remote sensing.

UNIT-II

Digital Imaging: Types of Remote sensing, Sensor resolutions, Digital Image, Sensor components, Principle of a long-track and across-track scanning, Hyperspectral Imaging, Thermal Remote Sensing.

UNIT-III

Microwave Remote Sensing: Active and Passive Microwave Remote Sensing, Radar Imaging: Key components of imaging radar, viewing geometry, spatial resolution, principle of RAR, SAR and their range resolution, Satellite Radar Imaging, LIDAR.

UNIT-IV

Concept of Geographic Information Systems: Key components of GIS, joining spatial and attribute data, functions, advantages and applications of GIS, Spatial data model, Raster data model, Vector data model.

UNIT-V

Process of GIS and Geospatial analysis: Data sources, encoding raster data, encoding vector data, encoding attribute data, linking spatial and attribute data, Geospatial data analysis methods database query, geospatial measurement, overlay operations, network analysis and surface analysis. Integration of GIS and remote sensing.

Text Books:

1. Basudeb Bhatta, "Remote Sensing and GIS", 2/e, Oxford University Press, 2012.
2. Lillesand T.M., and Kiefer R.W. "Remote Sensing and Image Interpretation", 6/e, John Wiley &Sons, 2000.

Suggested Reading:

1. James B. Campbell and Randolph H. Wynne, "Introduction to Remote Sensing", the Guilford Press, 2011.
2. Michael N DeMers, "Fundamentals of GIS", 2/e, John Wiley, 2008.

22MEO01

PRINCIPLES OF DESIGN THINKING
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Prerequisite: Nil

Course Objectives:
This course aims to:
1. Create awareness of design thinking approaches.
2. Identify a systematic approach for defining/identifying a problem.
3. Create design thinking teams and conduct design thinking sessions collaboratively.
4. Apply both critical thinking and design thinking in parallel to solve problems.
5. Motivate to apply design thinking concepts to their real life scenarios.

Course Outcomes:
Upon completion of this course, the students are able to:
1. Understand design thinking and its phases as a tool of innovation.
2. Empathize on the needs of the users.
3. Define the problems for stimulating ideation.
4. Ideate on problems to propose solutions by working as a design thinking team.
5. Prototype and test the proposed solutions focusing on local or global societal problems.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
CO 2	1	1	2	1	2	2	2	2	1	2	2	2	2	2
CO 3	1	1	2	2	1	2	2	2	1	2	2	2	2	3
CO 4	2	1	2	2	1	2	2	2	1	2	2	2	2	3
CO 5	2	1	2	2	1	2	2	2	1	2	2	2	2	3

UNIT – I
Introduction to Engineering & Thinking: Engineering for social and economic development; impact of science/engineering. Thinking and behaviour; Types of thinking – Linear thinking, lateral thinking, systems thinking, design thinking.
Introduction to Design Thinking: Importance of Design Thinking & Human centric approach – Phases in design thinking process, five-stage model as iterative method, applications of design thinking in various domains.

UNIT – II
Empathize phase: Understanding the unique needs of the user, empathize with the users, steps in empathize phase, developing empathy towards people, assuming a beginner's mind-set (what? why?), steps in immersion activity, body storming; Case studies.

UNIT – III
Define phase: Define the problem and interpret the result, analysis and synthesis, Personas – Four different perspectives on Personas, steps to creating personas, problem statement, affinity diagrams, empathy mapping; Point of View – "How might we" questions, Why-how laddering; Case studies.

UNIT – IV

Ideation phase: What is ideation, need, uses, ideation methods; Brainstorming, rules for brainstorming; Mind maps, guidelines to create mind maps; Ideation games; Six Thinking Hats; Doodling, use of doodling in expressing creative ideas; Case studies.

UNIT – V

Prototyping phase: Types of prototyping, guidelines for prototyping, storytelling, characteristics of good stories, reaching users through stories, importance of prototyping in design thinking; Value proposition, guidelines to write value proposition; Case studies.

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.

Text Books:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires, 1st Edition, HarperCollins, 2009.
2. Michael Luchs, Scott Swan, Abbie Griffin, Design thinking: New product development essentials from the PDMA. John Wiley & Sons, 2015.
3. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solv ing, Penguin Random House India Private Limited, 2020.

Suggested Reading:

1. Jeanne Liedtka, Andrew King, Kevin Bennett, Solving problems with design thinking: Ten stories of what works. Columbia University Press, 2013.
2. Bala Ramadurai, Karmic Design Thinking - A Buddhism-Inspired Method to Help Create Human-Centered Products & Services, Edition 1, 2020.

22MB***

ENGINEERING LEADERSHIP
(Open Elective-I)

Instruction	3L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives:

This course aims to:

1. To develop an understanding of the basics of Leadership and Leadership Behaviour.
2. To introduce them the concepts of Adaptive Leadership and Decision making as a Leader.
3. To discuss the importance and components of Change and Cross-Cultures in the Global era.

Course Outcomes:

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

1. Apply the knowledge of behaviour and effectiveness of Leadership in real time situations.
2. Understand the dynamics of Situations and Adaptive Leadership and its importance in leading.
3. Appraise the process of Decision Making and Empowerment and Leading in the Global Era.
4. Develop understanding towards dealing with Change, Power and Influence Tactics.
5. Interpret and Improve in cross-Cultural Management and Leadership Skills.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	-	1	1	1	-	1	2	1	1	-			
CO 2	1	2	2	2	-	1	-	2	2	2	1			
CO 3	1	1	2	2	1	-	1	1	1	2	-			
CO 4	-	2	1	2	2	1	1	2	2	2	1			
CO 5	-	1	1	1	1	2	1	2	2	2	1			

Unit - I

Nature and Behaviour of leadership: Definitions of Leadership-Indicators of Leadership Effectiveness-Research Methods for Studying Leadership effectiveness-important Types of Leadership Behaviour-Specific Task Oriented Leader Behaviours- Specific Relations Oriented Leader Behaviours.

Unit - II

The leadership Situation and Adaptive Leadership: Different ways Situations affect Leaders-Stewart Model of Situational Determinants-Other Situational Determinants of Leader Behaviour-Guidelines for Coping with Demands and Constraints-Early Contingency theories of Effective Leader Behaviour-Guidelines for flexible, Adaptive Leadership.

Unit - III

Decision Making and Empowerment by Leaders: Decision making- Participative Leadership-Normative Decision Model-Guidelines for Participative Leadership-Delegation-Guidelines for Delegating-Psychological Empowerment-Empowerment Programs-Benefits of Empowering Leadership and Programs.

Unit - IV

Dealing with Change, Power and Influence Tactics: Types of Change in Teams and Organizations-Change Processes-Reasons for Accepting or Rejecting Change-implementing Change-guidelines for Implementing Change-How Visions influence change-Sources of Power-How Power is gained or lost-consequences of Power-Guidelines for using Power-Influence Tactics and Outcomes-Types of Proactive Influence Tactics-Power and influence Behaviour-Effectiveness of Proactive Tactics-guidelines for using Proactive Influence Tactics.

Unit - V

Developing Cross-Cultural Leadership and Skills of Leadership: Cross-Cultural and Global Leadership-Cultural Values and Leadership-Guidelines for Global Leadership-Gender and Leadership-Leadership Training Programs-Learning from Experience-Developmental Activities-Facilitating Leadership Development-Systems Perspective on Leadership Development.

Text Books:

1. Gary Yukl, William L. Gardner and Nishant Uppal, "Leadership in Organizations", Pearson Education, 9th Edition, 2019.
2. Keow Ngang Tang, "Leadership and Change Management", Springer – First Edition, 2019.
3. Patrick Dawson, Constantin Andriopoulos "Managing Change, Creativity and Innovation", Sage Publications ltd., 2nd Edition, 2014.
4. Lee R Beach, "Leadership and the Art of Change", Sage Publications ltd.,1st Edition, 2005.

Suggested Readings:

1. Ranjana Mittal, Leadership Personal Effectiveness and Team building, Vikas Publictaions, 2015
2. Peter G. Northhouse, Leadership Theory and Practice, Sage Publications, 2011.
3. Barbara Senior, Jocelyne Fleming, Organizational Change, 3e, Pearson publications, 2010
4. Mark Hughes, Managing Change, Universities Press, 2011.Alfranch Nahavandi, The Art and science of Leadership, 7e, Pearson, 2018

22MBC01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

COURSE OUTCOMES: After Completion of the Course, Student will be able to:

1. Apply fundamental knowledge of Managerial Economics Concepts and Tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make the best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decisions based on any technique.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	1	1	3	1	1	1	-	1	1	1	-			
CO 2	2	2	2	2	-	1	-	1	-	1	-			
CO 3	1	2	1	2	2	1	-	1	-	1	-			
CO 4	2	2	1	2	2	1	-	3	-	1	-			
CO 5	1	3	1	2	1	1	-	-	-	1	2			

UNIT-I

Introduction to Managerial Economics

Introduction to Economics and Its Evolution - Managerial Economics - Its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic Concepts of Managerial Economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equi-Marginal Principle, Contribution, Negotiation Principle.

UNIT-II

Demand and Supply Analysis

Demand Analysis - Concept of Demand, Determinants, Law of Demand – Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple Numerical Problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

UNIT-III

Production and Cost Analysis

Theory of Production - Production function - Isoquants and Iso-costs, MRTS, Input - Output Relations; Laws of Returns. Cost Analysis: Cost Concepts – Types of Costs, Cost - Output Relationship – Short Run and Long Run; Market Structures – Types of Competition, Features of Perfect Competition, Price Output Determination under Perfect Competition, Features of Monopoly Competition, Price Output Determination under Monopoly Competition. Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

UNIT-IV

Accountancy

Book-keeping, Principles and Significance of Double Entry Bookkeeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Ledger Accounts, Trial Balance Concept and preparation of Final Accounts with Simple Adjustments.

UNIT-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and Sources of raising Finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical Problems.

TEXT BOOKS:

1. Mehta P.L., "Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educationalpublishers, 2016.
2. Maheswari S.N. "Introduction to Accountancy", Vikas Publishing House, 12th Edition, 2018.

SUGGESTED READINGS:

1. Panday I.M. "Financial Management", 11th edition, Vikas Publishing House, 2016.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of IndiaPvt Ltd, 2007.
4. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2018

22CAC10N

DEEP LEARNING LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Artificial Intelligence, Machine Learning.

Course Objectives: The objectives of this course are

1. Understand basic concepts of Deep learning and their applications.
2. Evaluating Deep learning methods, models and algorithms.
3. Analysing CNN, RNN, Transformers and GAN along with their applications.

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

1. Implement Perceptron and multiplayer perceptron learning algorithms.
2. Analyze and implement various optimization and Regularization Techniques.
3. Design and Develop various Convolution Neural Networks architectures for image analysis tasks.
4. Analyze various RNNs and Encoder Decoder Models.
5. Apply and evaluate the Transformers and GANs to develop for real-time applications.

CO-PO & PSO Articulation Matrix

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	–	–	–	1	1	1	3	2	1
CO2	3	3	2	2	3	–	–	–	1	1	1	3	3	1
CO3	3	3	3	3	3	–	–	–	2	2	1	3	3	2
CO4	3	3	3	3	3	–	–	–	2	2	1	3	3	2
CO5	3	3	3	3	3	1	1	1	2	2	2	2	3	3

List of Experiments:

1. Installation and Configuration of Deep Learning Frameworks (TensorFlow, PyTorch, and Keras) and implementation of the Perceptron Learning Algorithm for Boolean logic operations.
2. Implementation of a Multilayer Perceptron (MLP) for classification and regression tasks.
3. Implementation and Performance Comparison of Optimization Algorithms, including Gradient Descent (GD), Momentum, RMSProp, and Adam.
4. Implementation of Regularization Techniques, including L1/L2 Regularization, Dropout, Early Stopping, and Hyperparameter Tuning.
5. Implementation of a Convolutional Neural Network (CNN) for image classification.
6. Implementation of Pre-trained CNN Models (VGG16 and ResNet50) and comparison of their performance.
7. Implementation of a Long Short-Term Memory (LSTM) Network for next-word prediction using sequential text data.
8. Implementation of an Encoder–Decoder Model with an Attention Mechanism for neural machine translation.
9. Implementation and Fine-Tuning of a BERT Model for sentiment analysis.
10. Implementation of a Generative Adversarial Network (GAN) for synthetic image generation.

Text Books:

1. Goodfellow. I., Bengio. Y. and Courville. A., “Deep Learning “, MIT Press, 2016.
2. Learning Generative Adversarial Networks: Next-generation deep learning simplified by Kuntal Ganguly, Packt, 2017
3. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
4. Hands-On Computer Vision with TensorFlow 2: Leverage deep learning to create powerful image processing apps with TensorFlow by Benjamin Planche, Eliot Andres, Packt Publishers, 2019
5. Huang, Shih-Chia, and Trung-Hieu Le. Principles and labs for deep learning. Academic Press, 2021.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85/

22CAC11N

FULL STACK WEB DEVELOPMENT LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives : This course aims to

1. Gain hands-on experience in designing modern web pages using HTML5, CSS3, and JavaScript.
2. Develop dynamic front-end applications using React and Angular fundamentals.
3. Integrate and test backend services using Node.js, Express, and MongoDB.

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

1. Explain the structure and behavior of web interfaces
2. Apply ReactJS and Angular to develop front-end applications
3. Analyze external APIs and logic for interactive UI
4. Evaluate REST APIs using Node.js and Express
5. Design and implement MongoDB for full stack applications

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	1	2	1	-	2	2	1	2	2	2	2
CO 2	3	3	3	2	3	1	1	2	2	2	3	3	3	2
CO 3	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO 4	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO 5	3	3	3	3	3	2	1	2	2	2	3	3	3	3

LIST OF EXPERIMENTS

1. Create a personal portfolio site with HTML5, CSS Grid, and Flexbox layout principles.
2. Develop a JavaScript quiz app with a timer and scoring system using DOM manipulation.
3. Design a responsive blog template using Bootstrap 5 components and utilities.
4. Build a weather forecast dashboard using JavaScript fetch API to consume a public weather API.
5. Create a multi-page site using React Router including home, about, and contact pages.
6. Develop a basic ToDo app using React Hooks (useState, useEffect) and local storage.
7. Build a contact form with validation using Angular 16 reactive forms (intro-level Angular usage).
8. Create a RESTful API for book management using Express.js and test with Postman.
9. Implement MongoDB aggregation to summarize student grades, with schema design.
10. Develop a full stack MERN app: Student registration form (React) connected to Express + MongoDB backend, deployed on local server.

Text Books:

1. Jon Duckett, *HTML and CSS: Design and Build Websites*, Wiley India, 1st Edition, 2011.
2. Valeri Karpov, *Professional JavaScript for Web Developers*, Wiley, 4th Edition, 2020.
3. Ethan Brown, *Web Development with Node and Express*, O'Reilly Media, 1st Edition, 2014.

Suggested Reading:

1. Brad Traversy, Modern Full Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker, Packt Publishing, 1st Edition, 2021.
2. Kristina Chodorow, *MongoDB: The Definitive Guide*, O'Reilly Media, 3rd Edition, 2019.

Web Resources:

1. https://developer.mozilla.org
2. https://reactjs.org/docs
3. https://angular.io/docs
4. https://nodejs.org/en/docs
5. https://www.mongodb.com/docs/
6. https://getbootstrap.com/docs/5.0/getting-started/introduction/

22CSC18N

OPERATING SYSTEMS LAB

Instruction	3 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Operating systems, Programming for problem solving.

Course Objectives: This course aims to:

1. Explore Unix/Linux operating system.theory
2. Analyze various system calls available in Linux/Unix.

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

1. Understand Linux/Unix environment.
2. Identify and interpret various system programs.
3. Understand and implement shell programming.
4. Simulate memory management, file allocation techniques and process schedules.
5. Analyze process and file management system calls by creating and/or modifying concurrent programs.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	2	-	1	2	1	2	2	2	-	2	1	1	-
CO 2	-	1	1	-	2	2	2	2	2	1	2	1	2	-
CO 3	1	1	1	-	1	2	2	1	2	2	1	1	3	1
CO 4	1	2	2	2	2	1	1	1	1	2	2	1	2	1
CO 5	1	1	-	2	2	1	1	2	2	1	2	1	1	1

List of Experiments: (Implement the following experiments in C Programming Langugage)

1. Demonstration of Linux/Unix file related system calls: mkdir, link, unlink, mount, unmount, users+, chown, chmod, open, close, read, write, lseek, stat, sync.
2. Demonstration of Linux/Unix process related system calls: fork, wait, exec, exit, getpid, getuid, setuid brk, nice, sleep.
3. Shell programming.
4. Implement CPU scheduling algorithms (a) Round Robin (b) SJF (c) FCFS.
5. Implement page replacement algorithms (a) FIFO (b) LRU.
6. Programs to illustrate threads.
7. Demonstration of GNU/Linux IPC mechanisms- Pipes, Semaphores, Shared memory, Message Queues.
8. Implementation of Classical Problems for synchronization (Dining philosopher problem and Producer-Consumer problem).
9. Implementation of Bankers algorithm for Deadlock detection and avoidance.
10. Implementation of Linked, Indexed and Contiguous file allocation methods.

Text Books:

1. Galvin, Silberschatz, “Operating System Concepts”, 10th Edition, John Wiley & Sons, 2018.
2. Dhananjay Dhamdhare, “Operating Systems-A Concept Based Approach”, 3rd Edition, McGraw Hill Education, 2017.

Suggested Reading:

1. Ekta Walia, “Operating System Concepts”, Khanna Book Publishing, 2020.
2. William Stallings, “Operating Systems Internals and Design Principles”, Pearson Ed., 2012.
3. Charles Crowley, “Operating Systems –A Design Oriented Approach”, McGraw Hill Education, 2017.
4. Andrew S. Tanenbaum, Albert S Woodhull, “Operating systems Design and Implementation”, Pearson Ed., 2009.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs88/preview
2. https://onlinecourses.swayam2.ac.in/aic20_sp05/preview

22CAI02N

INDUSTRIAL / RURAL INTERNSHIP-2

Instruction / Demonstration / Training	3-4 Weeks / 90 Hours
Duration of Semester End Presentation	-
Semester End Evaluation	-
Continuous Internal Evaluation	50 Marks
Credits	2

Prerequisite : Knowledge of Basics Sciences and Engineering Science

COURSE OBJECTIVES :

This course aims to:

1. Expose students to industrial environments, contemporary technologies, and real-world work conditions.
2. Enhance students' technical and managerial skills through practical learning opportunities and interaction with industry professionals and society.
3. Develop awareness of current technological trends, engineering responsibilities, and professional ethics relevant to their domain.

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Learn new technologies and solve real time projects.
2. Expose to the industrial environment problems and technologies
3. Gain knowledge on contemporary technologies industrial requirements.
4. Identify , Design and Develop solutions for real world problems
5. Communicate their ideas and learning experiences through reports and presentation.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	2	3	1	2	1	2	2	2	2	2	2	2
CO 2	2	2	2	1	1	2	1	2	1	2	2	2	2	2
CO 3	3	2	1	2	2	2	1	2	1	2	2	2	2	2
CO 4	1	3	3	3	1	2	1	2	3	2	2	2	2	2
CO 5	1	1	1	1	1	1	-	2	3	2	1	2	2	2

PROCESS TO BE FOLLOWED FOR CARRYING OUT INSTRUCTIONS TO STUDENTS:

1. Students may apply for internships through the AICTE Portal or through CDC of the institute by filling the application form IAP-101.
2. Industry shall scrutinize the students based on their criteria and communicate a provisional offer or confirmation letter to the student.
3. If students apply through CDC, then CDC shall nominate the students for various opportunities accordingly by issuing NOC (IAP-104).
4. The respective head of the department shall assign a faculty mentor.
5. Student shall undergo internship/industrial training at the concerned Industry/Organization by submitting the form, IAP-103.
6. During the internship, Faculty Mentor will evaluate the performance of students twice either by visiting the Industry/Organization or through obtaining periodic reports from students.
7. Student shall submit internship report to the industry/organization at the end of internship program.
8. On successful completion of the Internship, Industry/Organization shall issue Internship Certificate to the students
9. All the students should maintain discipline, professional ethics and follow the health and safety precautions during internship

Student shall maintain diary during the internship and submit the internship report at the end of the internship. The report will be evaluated by the supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Evaluation of Internship: The internship of the students will be evaluated in three stages:

1. Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
2. Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks)
3. Evaluation through seminar presentation/Viva-Voce at the Institute(This can be reflected through marks assigned by Faculty Mentor (25 marks)

R22-A

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

AICTE Model Curriculum R 22-A with effect from AY 2026-27

B.E. CSE (Artificial Intelligence and Machine Learning)

SEMESTER – VI

S. No	Course Code	Category	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
				Hours per Week			Duration of SEE in Hours	Maximum Marks		
				L	T	P/D		CIE	SEE	
THEORY										
1	22CAC12N	PCC	Data Communication and Computer Networks	3	1	-	3	40	60	4
2	22CAC13N	PCC	Automata and Compiler Design	3	1	-	3	40	60	4
3	22CAC14N	PCC	Natural Language Processing	3	-	-	3	40	60	3
4	22*****	PEC	Professional Elective – II	3	-	-	3	40	60	3
5	22MTC18	PCC	Quantum Computing for Machine Learning	3	-	-	3	40	60	3
6	22EEM01		Universal Human Values-II: Understanding Harmony	-	1	-	-	50	-	1
PRACTICAL										
7	22CAC15N	PCC	Natural Language Processing Lab	-	-	3	3	50	50	1.5
8	22EGC03	BS	Employability Skills	-	-	2	3	50	50	1
9	22CAC16N		Mini Project	-	1	2	-	50	-	2
10	22CAU02		Upskill Certification Course-II	-			-	25	-	0.5
TOTAL				**15**	**4**	**7**	**-**	**425**	**400**	**23**

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

PE2(T) Semester-VI	
22CAE04N	Data and Visual Analytics using AI
22CAE05N	Advanced Machine Learning
22CSE21	Extended Reality
22CSE09N	High Performance Computing
22CIE51N	Industrial Internet of Things

22CAC12N

DATA COMMUNICATION AND COMPUTER NETWORKS

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Programming for problem solving, basic knowledge of logic circuits and application in digital system.

Course Objectives: The objectives of this course are,

1. To understand the principles of data communication and organization of computer networks,
2. To analyze various routing protocols and congestion control algorithms.
3. To study the functions of the transport layer and to understand application layer protocols.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Describe the communication protocol suites like ISO-OSI and TCP/IP.
2. Illustrate and explain Data link layer protocols.
3. Distinguish the internet protocols like IP, ARP, ICMP, IGMP, routing protocols and DHCP.
4. Understand the transport protocols like TCP, UDP, RTCP and Congestion control Algorithms.
5. Summarize Application layer protocols like HTTP, DNS, FTP and Firewalls.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	-	-	-	-	1	1			
CO 2	3	3	2	1	3	-	-	-	1	1	1			
CO 3	3	3	2	1	3	-	-	-	1	1	1			
CO 4	3	3	2	2	3	-	-	-	-	1	2			
CO 5	2	2	2	1	3	1	1	-	2	2	2			

UNIT - I

Introduction: Data communication, network types and models, TCP/IP and OSI Protocol Suite, transmission impairment, transmission modes, Transmission media (wired and wireless) and switching.

UNIT - II

Data Link Layer: Design issues, error detection and correction, elementary data link protocols, sliding window protocols, HDLC, multiple access protocols.

LAN: Wired LAN, wireless LAN, connecting devices and Virtual LAN.

UNIT - III

Network Layer: Network layer design issues, routing algorithms, congestion control algorithms, Quality of service, IPV4, IPV6, network layer protocols: ARP, RARP, ICMP, IGMP and DHCP.

UNIT - IV

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), quality of service.

UNIT - V

Application Layer: DNS, DDNS, SMTP, POP, IMAP, SSH, SFTP, WWW, HTTP, SNMP, Firewalls.

Text Books:

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw Hill, Fifth Edition,
2. 2017.
3. S. Tanenbaum, "Computer Networks", Pearson Education, Fifth Edition, 2013.
4. William Stallings, “Data and Computer Communication”, Eighth Edition, Pearson Education, 2007.

Suggested Reading:

1. Larry L.Peterson, Peter S. Davie, “Computer Networks”, Elsevier, Fifth Edition, 2012.
2. James F. Kurose, Keith W. Ross, “Computer Networking: A Top–Down Approach Featuring the Internet”, Pearson Education, 2005.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105081/
2. https://nptel.ac.in/courses/106/106/106106091/

22CAC13N

AUTOMATA & COMPILER DESIGN

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

1. Understand the central concepts of automata theory, including finite automata and their variants such as DFA & NFA.
2. Explore context-free grammars, parse trees, and pushdown automata, discerning their role in formal language theory and their equivalence with context-free grammars.
3. Analyze Turing machines and their relation to computability, recognizing the significance of undecidable problems in theoretical computer science.
4. Familiarize with the structure of a compiler and its phases, with a specific emphasis on lexical analysis and syntax analysis techniques.
5. Understand syntax-directed translation and its applications, including the generation of intermediate code and syntax-directed translation schemes.
6. Gain proficiency in designing run-time environments and mastering code generation principles. They'll also acquire knowledge of machine-independent optimizations, equipping them to design efficient compilers and runtime systems.

Course Outcomes:

Upon completing this course, students will be able to:

1. Solve computational problems using finite automata and regular expressions.
2. Develop a strong understanding of context-free grammars, pushdown automata, Turing machines.
3. Gain skills in constructing compilers, focusing on lexical analysis, syntax analysis, and top-down parsing, to translate source code into executable machine instructions.
4. Master bottom-up parsing, syntax-directed translation, and intermediate-code generation to design and implement sophisticated compilers for translating high-level programming languages.
5. Learn how to manage the run-time environment, perform code generation, and apply optimizations to build efficient, high-performance compilers for different architectures.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	-	-	-	-	2	-	1	-			
CO 2	3	-	-	3	3	-	-	-	-	-	-			
CO 3	-	3	3	-	-	2	3	-	-	-	-			
CO 4	-	-	3	3	-	2	-	-	1	-	-			
CO 5	-	-	3	3	-	-	-	-	1	1	1			

UNIT-I

Automata: Introduction, The Central Concepts of Automata Theory - Alphabets, Strings, Languages, Problems.
Finite Automata: Definition, Applications, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA) – Equivalence of Deterministic and Nondeterministic Finite Automata, Finite Automata with Epsilon-Transitions- Eliminating Epsilon-Transitions.
Regular Expressions and Languages: Definition, applications; Finite Automata and Regular Expressions – Converting Regular Expressions to Automata, Converting DFA's to Regular Expressions. Pumping Lemma for Regular Languages.

UNIT-II

Context-Free Grammars and Languages: Context free grammar, derivation trees, right most and left most derivation of strings, Ambiguity in context free grammars.
Pushdown Automata(PDA): Definition ,Languages of a PDA, Equivalent of PDA's and CFG's, DPDA.

UNIT-III

Turing Machines: Definition, Types of Turing Machines, Turing Machines problems, Chomsky Hierarchy of languages.

Introduction to Compilers- Lexical Analysis: The structure of a compiler – Phases of compiler. The Role of the Lexical Analyzer, Specification and Recognition of Tokens, The Lexical-Analyzer Generator Lex.

Syntax Analysis / Parsing: Introduction, Top-Down Parsing method, Recursive-Descent Parsing, FIRST and FOLLOW, LL (1) Grammars, Non-recursive Predictive Parsing.

UNIT-IV

Bottom-Up Parsing: Reductions, Handle Pruning, Shift-Reduce Parsing, Introduction to LR Parsing - Simple LR, More Powerful LR Parsers - CLR Parser and LALR Parser. Parser Generators – Yacc.

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax Directed Translation, Syntax-Directed Translation Schemes.

Intermediate-Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Type Checking.

UNIT-V

Run – Time Environments: Storage Organization, Stack Allocation, Heap Management.

Code - Optimization: The Principal Sources of Optimization, Basic Blocks and Flow Graphs, Constant Propagation, Loop Optimizations.

Code Generation: Issues in the Design of a Code Generator, A Simple Code Generator, Peephole Optimization.

TEXT BOOKS:

1. Introduction to Automata Theory, Languages, and Computation, 3nd Edition, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
2. Compilers: Principles, Techniques & Tools, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffry D. Ullman, 2nd Edition, Pearson.

SUGGESTED READING:

1. Introduction to Formal languages Automata Theory and Computation, Kamala Krithivasan, Rama R, Pearson.
2. Kenneth C Louden, Thomson, "Compiler Construction Principles and Practice", PWS Publishing 1st edition.

NPTEL Resources:

1. Theory of Automata and Formal Languages, IIT Guwahati
   https://nptel.ac.in/courses/106103070
2. Theory of Automata, Formal Languages and Computation, IIT Madras
   https://nptel.ac.in/courses/106106049
3. Formal Languages and Automata Theory, IIT Guwahati
   https://nptel.ac.in/courses/111103016
4. NOC: Introduction to Automata, Languages and Computation, IIT Kharagpur
   https://nptel.ac.in/courses/106105196
5. Principles of Compiler Design, IISc Bangalore
   https://nptel.ac.in/courses/106108113
6. Compiler Design, IISc Bangalore
   https://nptel.ac.in/courses/106108052
7. Compiler Design, IIT Madras
   https://nptel.ac.in/courses/106106237
8. NOC: Compiler Design, IIT Kharagpur
   https://nptel.ac.in/courses/106105190

22CAC14N

NATURAL LANGUAGE PROCESSING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. Understand various Natural Language Processing Fundamentals.
2. Understand probabilistic NLP and classification of text using Python's NLTK Library
3. Understand various text representations and labelling techniques.
4. Understand various NLP models and named entities.
5. Learn RNN for NLP.
6. Understand usage of GRU and LSTM models for translation.
7. Understand various applications of NLP.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand the fundamentals of Natural Language Processing, manipulate and analyse language data.
2. Demonstrate key concepts from NLP, text representation and linguistics to describe and analyse language.
3. Demonstrate the word embedded techniques and classification of the text.
4. Make use of the Deep learning and Transformers for NLP.
5. Develop NLP applications using appropriate NLP tools and techniques.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	2	2	2	2	2	3	2
CO 2	2	2	3	2	2	2	2	2	2	3	2	2	3	2
CO 3	2	2	3	2	2	2	2	2	2	3	2	3	3	3
CO 4	2	3	2	2	2	2	2	2	2	2	2	3	3	3
CO 5	2	2	3	2	2	2	2	2	2	3	2	3	3	3

Unit-I: Introduction to NLP: Definition, History, NLP in the real world, Approaches to NLP, NLP Pipeline. Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency, Computing with Language: Simple Statistics.

Unit-II: Basic Vectorization approaches of Text Representation: One-Hot Encoding, Bag of Words, Bag of N-Gram, TF-IDF; Neural language models, N-gram language model.
Processing Raw Text: Accessing Text from the Web and from Disk, Text Processing with Unicode.
Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging.

Unit-III: Word Embedding's: Distributed universal text and handcrafted feature Representations, Count Vector, Frequency based Embedding, Prediction based Embedding, Word2Vec and Glove.
Learning to Classify Text: Supervised Classification and Text classification with Machine learning algorithms.

UNIT-IV: Deep learning for NLP: RNN for language model, Sequence Labelling and Sequence Classification, Encoder-Decoder with RNNs, GRUs and LSTMs for machine translation, Convolutional neural networks for sentence classification and Evolution metrics for NLP.
Transformers for NLP: Attention, Transformers and BERT.

UNIT-V: Case Study on NLP: Sentiment analysis, Machine translation, Question-answering based systems, Topic modelling, Text Generation and Summarization.

Text Books / Suggested Reading:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. O"Reily,2009.
2. Deep Learning for Natural Language Processing Develop Deep Learning Models for Natural Language in Python (Jason Brownlee), Machine Learning Mastery,2017.
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf - Natural Language Processing with Transformers_ Building Language Applications with Hugging Face-O'Reilly Media (2022).
4. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019.
5. Sudharsan Ravichandiran ,Getting Started with Google BERT Build and train state-of-the-art natural language processing models using BERT.

Online Resources:

1. https://models.quantumstat.com/
2. https://www.coursera.org/learn/attention-models-in-nlp
3. https://github.com/keon/awesome-nlp

22CAE04N

DATA AND VISUAL ANALYTICS USING AI
(Professional Elective-II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Fundamentals of Data Science, Mathematical Foundation for Data Science & Security.

Course Objectives: The objectives of this course are

1. To develop design literacy for crafting effective, aesthetic, and ethical data visualizations.
2. To foster logical reasoning and problem-solving through exploration of high-dimensional and noisy datasets.
3. To master state-of-the-art data visualization tools and AI-driven analytics techniques.
4. To stimulate creative thinking through interactive dashboards and storytelling-based projects.
5. To apply computational thinking to real-world domains using dynamic, scalable, and interpretable visual solutions.

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

1. Identify suitable visual encoding techniques and perceptual guidelines based on data types and user goals
2. Analyze, preprocess, and transform raw data for meaningful visualization using Python and AI methods.
3. Apply dimensionality reduction, clustering, and other ML algorithms for exploratory visual analytics.
4. Design interactive dashboards with visual storytelling for real-world datasets using modern tools.
5. Build real-time, scalable analytics systems using APIs, streaming data, and visualization frameworks.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	2	1	1	1	1	2	1			
CO 2	3	3	3	3	3	1	1	1	1	2	2			
CO 3	3	3	3	3	3	2	1	2	2	2	2			
CO 4	3	2	3	3	3	2	2	1	3	3	2			
CO 5	3	3	3	3	3	2	2	2	3	3	3			

UNIT - I: Foundations of Visualization & Creative Design Thinking : Purpose and principles of visualization,Human visual perception: Gestalt laws, preattentive attributes,Data types: categorical, time-series, multivariate, hierarchical, geographical,Design principles: alignment, contrast, color theory, hierarchy,Visualization tools overview: Tableau, Power BI, Python (Matplotlib, Seaborn), Looker Studio,Re-design of misleading graphs using ethical guidelines

UNIT - II: Data Wrangling and Visual Encoding Logics : Data cleaning, joining, reshaping with Pandas,Visual encodings: position, shape, color, motion,Graphical integrity, lie factors, ethics in design,Visual grammar: ggplot, Altair, Vega-Lite basics,Case study on transforming a raw dataset into visual insights

UNIT – III: Exploratory AI Techniques for Visual Analysis: Dimensionality reduction: PCA, t-SNE, UMAP,Clustering: K-Means, DBSCAN,Correlation and heatmaps, scatter matrix,Visualization of classification/regression models,Feature importance and SHAP explanations

UNIT – IV: Interactive Dashboards, Real-Time Streams & Storytelling : Designing dashboards: filters, KPIs, layout,Real-time data visualization using APIs/streaming,Storytelling with data: narrative + visuals,Tools: Streamlit, Dash, Power BI, Google Looker Studio,Case study: live data dashboard for public data (e.g., air quality, COVID)

UNIT – V: Network, Geospatial, and Text Visual Analytics : Graph/network visualization: centrality, clustering,Social data analysis: influencer detection, hashtag mapping,Geospatial visualization: choropleth maps, heat maps using Folium,Text visualization: word clouds, sentiment, topic modeling using NLTK/spaCy Applications in public policy, marketing, and healthcare.

Textbooks:

1. **Tamara Munzner**, *Visualization Analysis and Design*, CRC Press, 2014. ISBN: 9781466508910.
2. **Claus O. Wilke**, *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, O'Reilly Media, 2019. ISBN: 9781492031086.

References:

1. **Nathan Yau**, *Data Points: Visualization That Means Something*, Wiley, 2013. ISBN: 9781118462195.
2. **Jeffrey Heer, Mike Bostock, and Vadim Ogievetsky**, *Interactive Data Visualization for the Web*, 2nd Edition, O'Reilly Media, 2014. ISBN: 9781491921289
3. **Alberto Cairo**, *The Truthful Art: Data, Charts, and Maps for Communication*, New Riders, 2016. ISBN: 9780321934079

Online Resources:

1. **Data Visualization** https://nptel.ac.in/courses/106106224
2. **Visual Analytics for Decision Making** https://nptel.ac.in/courses/106106215
3. **Introduction to Data Analytics** https://nptel.ac.in/courses/110106064
4. **Data Science for Engineers**
5. https://nptel.ac.in/courses/106106179
6. **Applied Machine Learning**
7. https://nptel.ac.in/courses/106106202

22CAE05N

ADVANCED MACHINE LEARNING

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Probability theory, Machine Learning

Course Objectives: The objectives of this course are to

1. Understand the need for Machine Learning
2. Study various machine learning techniques and its applications
3. Design solutions for real world problems using machine learning techniques.

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

1. Define the concepts related to Advanced Machine Learning.
2. Recognize the underlying mathematical relationships across ML algorithms and their paradigms.
3. Determine the various applications of Machine Learning.
4. Model, design and develop solutions to real world problems using Advanced Machine Learning Algorithms.
5. Evaluate and interpret the results of the various Advanced machine learning tools.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	-	3	2	2	2	2	3			
CO 2	2	3	2	2	-	3	2	2	2	2	3			
CO 3	2	3	3	2	-	3	3	3	2	3	3			
CO 4	2	2	3	3	-	2	2	3	2	3	3			
CO 5	2	2	3	3	-	2	2	2	3	2	3			

UNIT-I

Introduction to Advanced Machine Learning:

Introduction, Categories of Machine Learning, Ensemble Learning, Meta Learning, Representation Learning, and Multi-Modal Machine learning.

Mathematical Representation: Matrix Analysis: Eigen analysis and Probability: Exponential family of distribution.

UNIT-II

High-Dimensional Machine Learning: Curse of Dimensionality, Parametric and Non-Parametric High-Dimensional Regression and Classification.

Kernel Methods: Common Kernel Functions and Kernel SVM for classification and regression.

Bayesian Representation: Core Concepts of Bayesian Representation, Bayesian Inference Techniques

UNIT-III

Graph Machine Learning:

Graph as a Universal Data Structure, Laplacian Matrix, Smoothness, Graph Construction, Learning from Data, Graph-based ML Algorithms(Semi-supervised, Supervised and Unsupervised), and Graph Regularization.

UNIT -IV

Multi-Modal Machine Learning (MMML)

Fundamentals of Multi-Modal Learning, Core Challenges in MMML, Fusion Techniques(Early, Late, Intermediate and Hybrid Fusions) , Model Architectures for MMML.

UNIT–V

AutoML and MLOps : Frameworks, Architectures, Pipelines, and Concepts. Case Studies and Industrial Applications.

Text Books:

1. Giuseppe Bonaccorso, “Advanced Machine Learning Algorithms”, 3nd Edition, Packt.
2. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. MIT Press, 2021.
3. "Multimodal Machine Learning: Techniques and Applications" by Paul Pu Liang, Louis-Philippe Morency, Ruslan Salakhutdinov, and Barnabás Póczos – CMU lecture-based textbook, released in 2022.

Suggested Reading:

1. Tom Mitchel “Machine Learning”, Tata McGraW Hill, 2017.
2. John Hopcroft and Ravi Kannan, Foundations of Data Science, Hind Book Agency, TRIM Series, (2014).
3. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The Elements of Statistical Learning, Springer series in statistics, 2001.
4. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. MIT Press, 2021.
5. Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. Mathematics For Machine Learning. Cambridge University Press, 2020.
6. Koller, Daphne, and Nir Friedman. Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
7. Boumal, Nicolas. "An Introduction to Optimization on Smooth Manifolds." Available online, Aug (2020).
8. Laurence Moroney,” AI and Machine Learning for Coders”, O'Reilly Media,October 2020.
9. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing Company, 2020.
10. M N Murty and Ananthanarayana V S, “Machine Learning: Theory and Practice”, Universities Press; First Edition,2024.
11. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

OnlineResources:

1. Introduction to Advanced Machine Learning: https://www.youtube.com/watch?v=r4sgKrRL2Ys&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77 and https://onlinecourses.nptel.ac.in/noc23_cs18/preview

22CSE09N

HIGH PERFORMANCE COMPUTING

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Computer Architecture, Computer Networks Operating Systems

Course Objectives: This course aims to:

1. Understand the relevance of High performance computing, architectures and various computational models.
2. Learn basic of Open MP.
3. Learn basics of GPU.

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

1. Understand the significance of High Performance Computing and HPC Architecture, Systems and Technologies.
2. Apply models and methodologies for parallel programming and application development.
3. Describe the message passing interface concepts.
4. Explain the architecture of GPU and Edge Computing on SoC.
5. Describe about high performance storage technologies.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	1	1	2	1	-	-	-	1	-	-			
CO 2	2	2	3	1	1	-	-	-	1	-	-			
CO 3	2	1	1	1	1	-	-	-	1	-	-			
CO 4	2	1	2	1	1	-	-	1	1	2	-			
CO 5	2	2	-	2	1	-	-	-	1	2	1			

UNIT – I

Introduction – High Performance Computing Disciplines, impact of supercomputing on science, society and security; anatomy of a super computer, compute performance, a brief history of Supercomputing.

UNIT - II

HPC Architecture, Systems and Technologies: Key properties of HPC, Architecture, Parallel architecture families, Flynn's taxonomy, enabling technology, Van Neumann sequential processors, vector and pipelining, Single instruction Multiple Data Array, Multiprocessors, Heterogeneous computer structures. Commodity Clusters: Hardware architecture, Programming interfaces, Software environments.

UNIT – III

Symmetric Multiprocessor Architecture: Architecture overview, Amdahl's Law Plus, Processor Core architecture, memory hierarchy, PCI Bus, external interfaces. OpenMP: Overview of OpenMP programming model, parallel threads and loops, synchronization, reduction.

UNIT-IV

Distributed memory parallel Programming with MPI: Message passing interface standards, MPI basics, communicators, point-to-point messages, synchronization collectives, communication collectives, non-blocking point-to-point communication, user-defined data types.

UNIT – V

Accelerator Architecture: Historic perspective, introduction to Graphics Processing Units, evolution of GPU functionality, modern GPU architecture, heterogeneous system architecture, introduction to System on Chip SoC), HPC on SoC, types of SoC, Edge Computing, High Performance on Edge devices. Mass Storage: Brief history of storage, storage device technology, aggregated storage, high performance storage, all flash/SSD.

Text Books:

1. Thomas Sterling, Mathew Anderson, "High Performance Computing: Modern Systems and Practices", 1st Edition, Morgan Kaufman Publishers, 2017

Suggested Reading:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science Series, 2011.
2. Charles Severance, Kevin Dowd, "High Performance Computing", OpenStx CNX, 2021.

Online References:

1. https://nptel.ac.in/courses/106108055.
2. https://prace-ri.eu/wp-content/uploads/Edge-Computing-An-Overview-of-Framework-and-Applications.pdf.

22CSE21

EXTENDED REALITY
(Professional Elective-II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basic knowledge on computer hardware and software components.

Course Objectives: This course aims to:

1. To understand immersive technology current state of development for designing and developing immersive experiences.
2. To understand the sensory, emotional and narrative immersion for best practice user interface and experience design.
3. To understand the intersection of AI and VR/XR, looking at how AI is being used to improve everything from graphics rendering to user interaction.
4. To understand the applications of VR/XR in healthcare, discussing the latest research, challenges and opportunities for healthcare professionals.
5. To understand the design principles that guide the creation of immersive experiences, from 3D modelling to user interface design.

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

1. Define and explain principles in immersive technology for designing and developing immersive experiences.
2. Explain the sensory, emotional and narrative immersion for best practice user interface and experience design.
3. Model and create intersection of AI and VR/XR to user interaction.
4. Design the applications of VR/XR in healthcare, discussing the latest research, challenges and opportunities for healthcare professionals.
5. Choose the creation of immersive experiences, from 3D modelling to user interface design.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	3	3	3	1	-	-	-	-	-	3			
CO 2	3	3	3	3	2	-	-	-	-	-	3			
CO 3	3	3	3	3	3	-	-	-	-	-	3			
CO 4	3	3	3	3	3	-	-	-	-	-	3			
CO 5	3	3	3	3	3	-	-	-	-	-	3			

UNIT -I

Immersive Technology: Introduction Promise and Potential, Knowing immersive technologies - AR/VR/ExR, Overview of immersive technologies, AR/VR Milestones and breakthroughs, Current state, Statistical data, Potential and Limitations of immersive technologies. 3D UI and Hardware requirements. Software Technologies used. AR and VR Environment..

UNIT-II

Designing Immersive Experience - Introduction, designing for sensory immersion, Designing for emotional immersion, Designing for narrative immersion, Best practices for user interface and experience design. Evolution of VR Hardware - Introduction to virtual reality hardware, The rise of consumer virtual reality, Virtual reality hardware design challenges, The future of virtual reality hardware, Role of haptic feedback on virtual reality hardware, Tools of VR kits and Case studies.

UNIT-III

AI in AR/VR/XR: -Introduction, AI and its usage in VR/AR, Graphic rendering, Natural language processing, User interaction, Predictive analytics. Business Landscape of AR/VR/XR- Introduction, Funding and investment, Funding and its challenges for VR/XR industry, Monetization strategies, User adoption and marketing, Technology challenges, Case studies.

UNIT-IV

Applications of AR/VR/XR in Healthcare: -Introduction, Diagnosis and treatment, Rehabilitation and physical therapy Medical education and training, Use of immersive technology in patient education and engagement, Case studies, Design principles, Medical realities. Applications of AR/VR/XR in Education: Introduction, Immersive learning environment, Simulations and training, Personalized learning, Collaborative learning, Case studies.

UNIT -V

Ethics in Immersive Technologies: Introduction to ethics in immersive technologies, Safety and physical health Psychological and emotional impact, Case studies. 3D Modeling and User Interface Design: Introduction to 3D modelling, Modelling technique, User interface design principles, User interface design software and workflow, Implementing UIs in 3D environment, Case Study: Building VR Applications with Unity.

Text Books:

1. Immersive Realm of Extended Reality, Author Suman Dutta, First Edition 2024, Copyright © BPB Publications, India, ISBN: 978-93-55517-227

Suggested Reading:

1. Virtual Reality, Steven M. LaValle, University of Oulu, Cambridge University Press.
2. Virtual and Augmented Reality- An Educational Handbook, By Zeynep Tacgin, Cambridge Scholars Publishing Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK
3. Virtual Reality Technology, Grigore C. Burdea, Philippe Coiffet, John Wiley & Sons, 30 Jun 2003 - Computers - 464 pages
4. Handbook of Augmented Reality, Borko Furht, Springer New York, NY, Hardcover ISBN 978-1- 4614-0063-9, eBook ISBN 978-1-4614-0064-6

Online Resources:

1. https://axisxr.gg/the-future-of-xr-trends-to-look-for-in-2024/
2. https://www.interaction-design.org/literature/topics/extended-reality-xr
3. https://www.accenture.com/us-en/services/technology/extended-reality
4. https://www.sngular.com/insights/235/extended-reality-will-it-be-more-widespread-in-2024

22CIE51N

INDUSTRIAL INTERNET OF THINGS
(Professional Elective-II)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-Requisites : Computer Architecture and Micro Processor, Programming for Problem Solving.

Course Objectives:
1. Understand the basics of IoT and IIOT.
2. Impart necessary and practical knowledge in Industrial Internet of Things.
3. Develop skills required to build real-time IIoT based projects.

Course Outcomes:
By the end of this course, students should be able to:
1. Understand Internet of Things and IIOT basics components.
2. Analyzing IoT Systems: Sensor Interfaces, Protocols, and Communication Modules.
3. Applying Raspberry Pi in IoT: Interface Sensors and Actuators
4.Understanding Arduino Basics
5. Develop real-time IoT-based projects.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	-	1	-	-	1	1	1	1
CO 2	1	-	-	-	-	-	-	1	-	-	1	1	2	-
CO 3	1	1	1	-	1	-	-	1	1	-	1	1	1	-
CO 4	1	1	1	-	1	-	-	1	1	-	1	1	1	-
CO 5	2	2	1	1	2	1	1	1	1	1	1	1	1	1

Unit – I

Internet of Things: The Third Wave? Definition of IoT, and M2M, Advantages and Disadvantages of IoT.More than Smart "Things": IoT key attributes, Three Major Challenges Facing IoT, Architecture of IoT.

Industrial Internet of Things (IIoT): Definition of IIoT, IoT, and M2M, IIoT Challenges, IIoT Requirements.

Unit – II
Physical design of IoT: Sensors, Networks, Standards.Things in IoT, IoT protocols,Intelligent analysis, Intelligent actions
Logical Design of IoT: IoT Functional Blocks,IoTCommunication Models, IoT Communication APIs.

Unit – III

Raspberry Pi: IoT Physical Devices and Endpoints:Introduction to Raspberry Pi-Interfaces (serial, SPI, I2C), Programming Raspberry PI with Python- Controlling LED with Raspberry PI, interfacing an LED and Switch with Raspberry PI, and Interfacing a light sensor (LDR) with Raspberry Pi

Unit – IV

Programming Arduino: Introduction, Arduino Boards, Programming Variables, if, loops, functions, digital inputs and outputs, the serial monitor, analog inputs and outputs, using libraries, Arduino data types and commands. Programming Arduino Uno with Arduino- Controlling LED with Arduino, interfacing an LED and a Switch with Arduino.

Unit – V

Domain-specific applications of IoT:Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health, and lifestyle.

Textbooks:

1. Ahmed Banafa by Introduction to Internet of Things (IoT) Published 2023 by River Publishers
2. Jivan S. Parab · MadhusudanGanujiLanjewar · Marlon Darius Sequeira · GourishNaik · Arman Yusuf Shaikh by Python Programming Recipes for IoTApplications , Springer Nature Singapore Pte Ltd. 2023.
3. ArshdeepBahga, Vijay Madisetti, Internet of Things: A hands on approach, 2014, VPT publishers
4. Simon Monk, Programming Arduino Next Steps: Going Further with Sketches, Second Edition,2019.

Reference Books:

1. Dr. SRN Reddy, RachitTirnkral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs, 2018.
2. Adrian McEwen, "Designing the Internet of Things", Wiley, 2013.
3. he Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
4. R2. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly (SPD), 2014.
5. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
6. CunoPfister, "Getting Started with the Internet of Things", O Reilly Media, 2011.

Web References:

1. Li Da Xu, Wu He, and Shancang Li, "Internet of Things in Industries: A Survey", IEEE Transactions on Industrial Informatics, Vol. 10, No. 4, Nov. 2014.
2. T. Winter, P. Thubert, A. Brandt, J. Hui, R. Kelsey, P. Levis, K. Pister, R. Struik , JP. Vasseur, R. Alexander, "RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks", IETF, Standards Track, Mar. 2012.
3. Z. Shelby, K. Hartke, C. Bormann, "The Constrained Application Protocol (CoAP)", Internet Engineering Task Force (IETF), Standards Track, 2014.
4. L.Fenzel, "What"s The Difference Between IEEE 802.15.4 And ZigBee Wireless?", Electronic Design (Online), Mar. 2013.

22MTC18

QUANTUM COMPUTING FOR MACHINE LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To learn basic mathematical Concept for Quantum Computing.
2. To understand the evaluation of the quantum bits. & building blocks.
3. To know the basics of Quantum logic gates and circuits.
4. To learn Quantum Algorithms by various Techniques.
5. To Introduce Quantum Machine Learning Concepts and Application

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

1. Compute basic mathematical operations on Quantum bits.
2. Solve Quantum operations.
3. Apply quantum Logical gates and circuits.
4. Implement quantum algorithm.
5. Solve machine learning problems using Quantum computations.

CO-PO & PSO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	1	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	2	2	2	-	-	-	-	2	2	-	-	2	2
CO 5	2	2	2	2	-	-	-	-	2	2	-	-	2	2

UNIT-I: Math Foundation for Quantum Computing:
Introduction to Vector Space, Subspaces, Linear Independent and dependent Vectors, Basis and Finite Dimensions. Orthogonality of Vectors, Inner product and Outer product of Hilbert Spaces. Unitary operators and projections, Eigenvalues and Eigenvectors. Introduction to GCD and Congruence.

UNIT-II: Introduction to Quantum Computing:
Quantum Mechanics (Huygens wave theory, Photo electric effect, De-Broglie hypothesis and Heisenberg's Uncertainty Principle), Origin of Quantum Computing, Qubits and multi-qubits states, Bra-ket notation, Quantum Superposition Motivation for Studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave). Block sphere representations, Multi-qubits, Inner and outer product of Multiple of qubits, Tensor product.

UNIT-III: Quantum Logical gates and Circuits:
Single Qubit gates: Pauli, Hadamard, Phase shift, Controlled gates: C-NOT, CCNOT. Quantum Entanglement, Quantum Teleportation (EPR Model) and Bell State, Introduction to Discrete Fourier transform.

UNIT-IV: Quantum Algorithms:
Quantum Fourier Transform and Quantum Phase estimation. Major Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm and Deutsch-Jozsa Algorithm.

UNIT-V: Quantum Machine Learning:
Quantum Un-Supervised Learning Algorithm: K-means algorithm, Quantum K- means, Quantum Supervised Learning Algorithm: Quantum HLL algorithm, Quantum Linear Regression, Quantum Support Vector Machine.

Text Books:

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley.
3. Quantum Machine Learning: An Applied Approach: The Theory and Application of Quantum Machine Learning in Science and Industry by Santanu Ganguly, Apress.

Reference Books:-

1. Quantum Machine Learning: What Quantum Computing Means to Data Mining by Peter Wittek, Academic Press.

Online Resources:

Course Code	Course Name	Resource Links
22MTC18	Quantum Computing for Machine Learning	1. https://archive.nptel.ac.in/courses/115/101/115101092/ 2. https://coursera.org/share/b8b4d63cfbb5ff0eb6a070e16a758e40

22EEM01

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY
(Need to get from EEE)
(**B.E/B. Tech** - Common to all Branches)

Instruction		1 Hour per week
Duration of SEE		-
SEE	-	
CIE		50 Marks
Credits		1

INTRODUCTION:
This course discusses the role of human values in one's family, in society and in nature. During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

COURSE OBJECTIVES: This course aims to
1. Understand the concept of universal human values
2. Cultivate empathy and respect for diversity
3. Inspire the social responsibility and global citizenship

COURSE OUTCOMES After the completion of this course, the student will be able to
1. Become familiar about themselves, and their surroundings (family, society, nature).
2. Develop empathy and respect for diversity by gaining an appreciation for different cultures, perspectives, and identities
3. Exhibit responsible and ethical behavior by adhering to principles of integrity, honesty, compassion, and justice.
4. Recognize their role as global citizens.
5. Exhibit a sense of social responsibility.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	-	-	1	-	-	1	-	-	1	-	-			
CO 2	-	-	1	-	-	1	1	-	1	-	1			
CO 3	-	-	-	-	-	1	-	-	-	1	-			
CO 4	-	-	-	-	-	1	1	1	-	-	-			
CO 5	-	-	-	-	-	1	1	1	-	-	-			

MODULE -1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education
- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and
- Experiential Validation- as the process for self-exploration.
- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE- 2: Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE-3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
- Understanding the meaning of Trust; Difference between intention and competence.
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- Strategy for transition from the present state to Universal Human Order:

a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers.
b. At the level of society: as mutually enriching institutions and organizations.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss scenarios. Elicit examples from students' lives.

MODULE -4: Understanding Harmony in Nature and Existence - Whole existence as Coexistence.

- Understanding the harmony in Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Holistic perception of harmony at all levels of existence.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability Identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability Identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

MODE OF CONDUCT (L-T-P-C 0-1-0-0)

- While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection, and self- exploration.

- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors, in a group sitting.
- **Tutorials (experiments or practical) are important for this course**. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on basic human values.
- **It is advised to share the experience of the Faculty to the class in a capsule form.**
- **Involve more in evaluating the student by different activities with proper RUBRCCS**

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

EXAMPLE:

Module-1:	10 M
Module -2:	10 M
Module- 3:	10 M
Module-4:	10 M
Attendance & Attitude:	10 M

The overall pass percentage is 50%. In case the student fails, he/she must repeat the course.

TEXT BOOKS:

1. "A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.
2. "Teacher's Manual for A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.

REFERENCE BOOKS:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi

22CAC15N

NATURAL LANGUAGE PROCESSING LAB

Instruction	3P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: The objectives of this course are,

1. To learn the fundamentals of natural language processing.
2. To understand the various text processing techniques in NLP.
3. To understand the role Text Classification, Deep Learning for Text Classification techniques of NLP.
4. Using Topic Modeling, Case Studies and apply the NLP techniques to IR applications.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Understand the basic concepts of Natural language processing pipeline.
2. Implement various feature engineering and text representation techniques in NLP.
3. Illustrate text classification techniques to build NLP models.
4. Explore text summarization methods and example systems.
5. Develop strong problem solving skills by working on real world datasets and projects.

CO-PO & PSO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	2	2	2	2	2	2	2	2	2	2	2	2	3	2
CO 2	2	3	3	3	2	2	2	2	3	3	2	3	3	3
CO 3	2	3	2	3	2	2	2	2	2	2	2	3	3	3
CO 4	2	3	2	3	2	2	2	2	3	2	2	3	3	3
CO 5	2	3	3	3	2	2	2	2	3	3	2	3	3	3

List of Experiments:

1. Demonstrate the NLP Pipeline, Workflow of the NLP Project and NLP all libraries.
2. Implement preprocessing steps: Tokenization, Stop Word Removal, Stemming and lemmatization.
3. Develop an application to explore Text Representation techniques: One-hot encoding, Bag of Words, TF-IDF and N Gram.
4. Develop the word embedded techniques: Word2Vec and Glove.
5. Build a text classification with sentiment analysis: Apply the text preprocessing techniques and classification algorithms.
6. Implement the text classification with RNN: LSTM and GRU, CNN.
7. Implement the text classification with Attention: Self – Attention and Multi Head Attention.
8. Implement the Text classification with Transformers.
9. To Build a Text Summarization using NLP techniques.
10. To build a Text generation using NLP Techniques.

Text Books / Suggested Reading:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. O‟Reily, 2009.
2. Deep Learning for Natural Language Processing Develop Deep Learning Models for Natural Language in Python (Jason Brownlee), Machine Learning Mastery, 2017.
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf - Natural Language Processing with Transformers_ Building Language Applications with Hugging Face-O'Reilly Media (2022).
4. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019.
5. Sudharsan Ravichandiran , Getting Started with Google BERT Build and train state-of-the-art natural language processing models using BERT.

Online Resources:

https://models.quantumstat.com/
https://www.coursera.org/learn/attention-models-in-nlp
https://github.com/keon/awesome-nlp

22EGC03

EMPLOYABILITY SKILLS

(BE/BTech - Common to all Branches)

Instruction	2 P Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Basic Knowledge of Soft skills in the professional setting.

Course Objectives: To help the students

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

Course Outcomes: By the end of the course, the students will be able to

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

CO-PO & PSO Articulation Matrix:

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	-	1	-	-	-	1	2	3	3	1	3	-	-	-
CO 2	-	-	-	-	-	-	1	-	2	-	1	-	-	-
CO 3	-	-	-	-	-	1	1	2	1	1	3	-	1	-
CO 4	-	1	1	-	-	1	2	3	3	1	3	-	1	-
CO 5	-	-	-	-	-	-	2	3	2	1	3	-	-	-

UNIT I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT.

UNIT III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management- Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Text Books:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.

Suggested Reading:

1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

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MINI PROJECT

Instruction	2P+1T Hours per Week
Duration of SEE	- Hours
SEE	- Marks
CIE	25 Marks
Credits	2

22CAU02

UPSKILL CERTIFICATION COURSE-II

Instruction	• Hours per Week
Duration of SEE	- Hours
SEE	- Marks
CIE	25 Marks
Credits	0.5