Full Stack Development using MERN Stack

Duration: 100 hours
Objective: To acquire the knowledge of Full Stack Web Development using NodeJs, ReactJS and MySQL.
Prerequisites: Students are expected to know any OOP's Based Language. They should have undergone the Web Programming basics which includes HTML, CSS, JavaScript, Knowledge of any database is required.

Module 1: Introduction to Web

- Brief history of the Internet, How does the Internet work?
- Internet Protocol
- Domain Name Service servers
- HTTP Protocol
- Web Server vs Application Server
- Architecture of the Web

Module 2: HTML & HTML5

- Introduction to HTML
- Basic HTML Tags
- HTML Form & Controls
- HTML5: New features in HTML5

Module 3: Cascading Style Sheets (CSS)

- Introduction to CSS, Styling HTML with CSS, Structuring pages with CSS,
- Inline CSS, Internal CSS, External CSS
- CSS Selectors
  - Linking a style to an HTML document
- Responsive Web Design with Bootstrap

Module 4: JavaScript

- Introduction to JavaScript
- Variables in JavaScript
- Statements, Operators, Comments, Expressions, and Control Structures
- JavaScript Scopes
- Strings, Numbers, Date
- Arrays, Array Methods

Module 5: JavaScript

- Objects, Object Definitions, Object Properties, Object Methods, Object Prototypes
- Functions, Function Definitions, Function Parameters, Function Invocation, Function Closures

Module 6: JavaScript

- Document Object Model (DOM)
  - o Object hierarchy in JavaScript
  - o HTML DOM, DOM Elements, DOM Events
  - o DOM Methods, DOM Manipulation, Forms & Forms Validation

Module 7: JSON

- JSON: JavaScript Object Notation (JSON)
  - o Introduction and need of JSON o JSON Syntax Rules
  - o JSON Data - a Name and a Value,
  - o JSON Objects, JSON Arrays, JSON Files, JSON parsing

Module 8: Introduction to Node.js

- Introduction to Node.js, Browser JS vs. Node.js
- ECMAScript 2015 (ES6), Node.js REPL

Module 9: Node.js Asynchronous Programming

- Introduction to Asynchronous programming and callbacks
- Promises and async & await
- The Event Loop and Timers

Module 10: Node.js Modules

- Understanding Node modules, exports, and require
- Introduction to npm
    - o package.json and package-lock.json files
    - o Install, update, and manage package dependencies
    - o Local and global packages

Module 11: Node.js Modules – *fs* and *http*

- File I/O – Sync & Async Methods
- HTTP Module – Building an HTTP server
- Developing a Node web application

Module 12: Introduction to Express

- Introduction to Express, Getting started with Express
- Application, Request and Response Objects
- Routes and Middlewares

Module 13: CURD using Express & MYSQL:

- Working with MYSQL
- Performing CURD operations with Express

Module 14: Introduction to React JS:

- Introduction to React, Getting started with React
- React Elements and React Components
- Function and Class Components
- Working with React Components and Props
    - o Compose components
    - o Render components
    - o Declutter components

Module 15: React JS:

- Introduction to State and Lifecycle
- Stateful components and lifecycle methods
- Props vs. State vs. Context
- Handling events
- Conditional rendering

Module 16: React JS

- Lists and Keys
    - o Rendering Multiple Components
    - o Basic List Component
- Working with forms and inputs

- Composition vs. Inheritance
  - o Containment
  - o Specialization

Module 17: Express & React JS

- Build React App
- Merging React with Express

Module 18: Capstone Project

Artificial Intelligence and Data Science using Python

Duration: 100 hours

Objective: This course is designed to provide a broad overview of AI and its various applications, including machine learning, deep learning, and computer vision & python. Students will learn about AI, and explore the different types of AI systems.

Prerequisites: Familiarity with the basics of Mathematics, Statistics and Python Programming would be helpful for this course.

Module 1: Introduction of AI

- What is AI?, Terminologies of Artificial Intelligence
- Components of Artificial Intelligence – ML & DL
- Difference between AI, ML, Deep Learning
- History and Evolution of AI, Introduction to Machine Learning
- Find out where AI is applied in Technology and Science.
- Difference between Traditional Programming and ML Programming

Module 2: Basics of Python

- Introduction of python
- Control flow statements (Loops)
- Python Data Structures & Data Types
- Functions , Modules & OOP's Concepts

Module 3: Mathematical Computing using NumPy

- Introduction to NumPy
- Create and Print Numpy Arrays
- Numpy Operations

Module 4: Data Manipulation with Pandas

- Introduction to Pandas
- Pandas Series & DataFrames
- Missing Values, Handling Missing Values
- Various Data Operations

Module 5: Data visualization with Python

- Data Visualization, Considerations of Data Visualization
- Factors of Data Visualization
- Python Libraries
- Create Your First Plot Using Matplotlib
- Line Properties
- Multiple Plots and Subplots,Create a Plot with Annotation
- Create Multiple Subplots Using plt.subplots
- Creating different types of graphs

Module 6: Maths for AI/ML

- Linear Algebra: Vectors, Matrices, Operations, Projections, Dimensionality Reduction
- Calculus: Differentiation & Partial Derivatives, Gradient, Chain Rule, Gradient Descent

Module 7: AI/ML Implementations

- Types of Machine Learning, Labelled Data and Unlabelled Data
- Concept of Supervised & Unsupervised
- Steps of Machine Learning
- Concept of collecting the historic training Data for ML

- Concept of Pre-process data for Machine Learning
- Need for Data Pre-processing
- Data Transforms Steps
- Types of Data Transformation Methods
- Rescale, Standardize & Normalize Data
- Concept of Train the ML model
- Concept of Test the ML Algorithm
- Algos of Regression, Classification & K-Means Clustering
- Concept of Sigmoid Function
- Validation and Evaluations (k-fold, AUC, ROC, Confusion matrix)

Module 8: Introduction to Deep Learning

- A revolution in Artificial Intelligence
- Limitations of Machine Learning
- What is Deep Learning?
- Advantage of Deep Learning over Machine learning

Module 9: Introduction to Neural Networks, Computer Vision & RNN

- Introduction to Neural Networks, Neural Network Architecture, The Neuron
- Introduction to image processing and computer vision,
- Convolutional features for visual recognition
- Object detection, Image classification
- Introduction to RNN & LLM

Module 10: Capstone Project

Cyber Security and Ethical Hacking

Duration: 100 hours

Objective: This course equips participants with hands-on skills to identify, analyze, and mitigate cyber threats**.** It covers digital security, penetration testing, and emerging attack vectors**,** preparing learners to safeguard systems effectively.

Prerequisites: Basic knowledge of IT, networking, and operating systems is required. Familiarity with programming (Python/Bash) is a plus, but not mandatory.

Module 1:

- Introduction to Cyber Security
- Linux Fundamentals

Module 2:

- Understanding Linux Shell
- Working with the Commands

Module 3:

- Navigating through Linux, Exploring the Linux Environment
- Manipulating Files & Directories

Module 4:

- Understanding Permissions
- Processes
- Package Management

Module 5:

- Storage Media
- Basic Networking Commands
- Searching for Files
- Network Security: Defense & Countermeasures

Module 6:

- Understanding Shell Script
- Flow Control
- Basic functions and file manipulations

Module 7:

- Managing User & Groups
- Switching Users
- Configuring User policies

Module 8:

- System Monitoring & Performance Tuning
- Backup & Recovery

Module 9:

- Advanced Networking
- DNS Working & Configurations
- DHCP Working & Configurations

Module 10:

- Network Security: Defense & Countermeasures
- IP Address Configuration

Module 11:

- Firewalls, Network Traffic Monitoring & Analysis – Using Wireshark
- DoS Mitigation Techniques
- Zero Trust Architecture

Module 12:

- Ethical Hacking Fundamentals, Phases of Ethical Hacking
- OWASP Top 10

Module 13:

- Web Application Pen Testing: Burp Suite, Nessus

Module 14:

- Web Application Pen Testing, Exploitation of Vulnerable Machines

Module 15: Capstone Project

Mastering Programming using Core Java

Duration: 100 hours

Objective: To reinforce knowledge of Object Oriented Programming concepts using Core Java.

Prerequisites: Basic knowledge of computer programming.

Module 1:

- Introduction of Java programming language.
- History of Java language, Types of languages.
- Features of Java language.
- Different Editions of Java Language.
- Java Development Tool Kit.
- Java Development Environment Setup.
- Compilation & Execution of a Java Program.
- First Java Program.

Module 2:

- Java Programming Fundamentals.
- Keyword & Identifiers.
- Java Data Types and Literals.
- Variable and Constants.
- Java Comments.
- Java Programming Naming Conventions.
- Programming Indentation Techniques
- Operators
- Java Flow Controls (conditional, looping)

Module 3:

- OOP's Concept
- Class and Object.
- Concept of Encapsulation, Abstraction, Inheritance & Polymorphism
- Class Deceleration.
- Object Construction.
- Data Fields & Methods

Module 4:

- Constructors, initializing reference variables using constructors
- Pass by value v/s pass by reference
- Re-assigning a reference variable
- Passing reference variable to method
- Initializing reference variable of different class
- Heap memory and stack memory

Module 5:

- Inheritance and It's types
- Association, Aggregation and Composition
- Polymorphism: Compile time and runtime polymorphism
- Rules of overriding and overloading of methods
- super and this keywords
- Reference Assignment compatibilities.
- Class Casting Rules

Module 6:

- Abstract class and abstract methods
- Interface (implementing multiple interfaces)
- Final variables, final methods and final class
- Functional interface
- New interface features (Java 8 & above)

Module 7:

- Access modifiers (public, private, protected and default)
- Packages and import statements
- Static imports
- Constructor chaining (with and without packages)
- Accessing protected variables and methods outside the package

Module 8:

- Introduction to Arrays in JAVA
- Declaring Array Variables & Construction of Array
- Array's Memory Representation
- Initializing an Array – static and dynamic
- Single & Multi-dimensional Arrays
- Anonymous Arrays
- Using methods from java.util.Arrays class
- Method Overloading Issues : using var-args methods

Module 9:

- Garbage collection in java, Requesting JVM to run garbage collection
- Different ways to make object eligible for garbage collection: (Nulling a reference variable, Re-assigning a reference variable & island of isolation)
- Finalize method

Module 10:

- Wrapper classes and constant pools
- String class, StringBuffer & StringBuilder class, String constant pool

Module 11:

- Exception hierarchy, Errors, Checked and un-checked exceptions

- Exception propagation try-catch-finally block, throws clause and throw keyword
- Multi catch block
- Creating user defined checked and unchecked exceptions

Module 12:

- Understanding Streams and stream operation
- Types of Stream – character and Binary streams
- Input and Output Streams, Reader and Writer interfaces
- File Reading writing operations
- Serialization and de-serialization
- Shallow copy and deep copy

Module 13:

- Object Class & java.util Package
- Date, DateTime, Calendar class
- Converting Date to String and String to Date using SimpleDateFormat class
- Object Class: Overriding to String, equals & hashcode method

Module 14:

- Introduction to collections: Collection hierarchy
- List, Queue, Set and Map Collections
- List Collection: ArrayList, LinkedList
- Collections class,Comparable and Comparator interfaces
- Queue collection

Module 15:

- Set Collection: HashSet, LinkedHashSet & TreeSet collection, Backed set collections
- Map Collection:HashTable, HashMap, LinkedHashMap & TreeMap classes, Backed Map collections
- Generics

Module 16:

- MultiThreading : Thread class and Runnable Interface
- sleep, join, yield, setPriority, getPriority methods
- Thread Synchronization, deadlock,Wait, notify and notifyAll methods

Module 17:

- Inner Class (Regular, Method local, Anonymous & static inner class)
- Lambda Expression

Module 18: Capstone Project

Deep Learning: Neural Networks to GenAI

Duration: 100 hours

Objective: To equip learners with core and advanced knowledge of deep learning - from neural networks to generative AI - and develop practical skills for real-world AI applications and innovations.

Prerequisites: Good understanding for Python Programming and Machine Learning is mandatory.

Module 1: Introduction of AI

- What is AI?, Terminologies of Artificial Intelligence
- Components of Artificial Intelligence – ML, DL, NLP & CV
- Difference between AI, ML, Deep Learning
- History and Evolution of AI, Introduction to Machine Learning & its Types
- Application of AI in Technology and Science
- Difference between Traditional Programming and ML Programming
- Overview of AI Workflow (Data → Model → Deployment)

Module 2: Fundamentals of Machine Learning

- What is Machine Learning and Why Do We Need It?
- Types of Machine Learning: Supervised, Unsupervised, Reinforcement
- Steps in Building a Machine Learning Model
- Data Preprocessing: Cleaning, Normalization, Feature Engineering
- Understanding Datasets and Splitting Data
- Popular ML Algorithms: Linear Regression, Logistic Regression
- Evaluation Metrics: Accuracy, Precision, Recall, F1-score
- Overfitting, Underfitting, Bias-Variance Tradeoff

Module 3: Introduction to Deep Learning

- What is Deep Learning and How it Differs from ML
- Biological Neurons vs Artificial Neurons
- Concept of Neural Networks
- Architecture of an Artificial Neural Network (ANN)
- Activation Functions: Sigmoid, ReLU, Tanh, Softmax
- Forward Propagation and Loss Functions
- Gradient Descent and Backpropagation Algorithm
- Hyperparameters: Learning Rate, Batch Size, Epochs
- Challenges in Deep Networks: Overfitting, Vanishing Gradients

Module 4: Deep Learning with PyTorch

- Introduction to PyTorch Framework
- PyTorch Tensors and Computation Graphs
- Dataset and DataLoader Classes, Building a Neural Network with nn.Module
- Forward and Backward Pass in PyTorch
- Loss Functions and Optimizers (SGD, Adam, RMSProp)
- Training and Evaluation Loops

Module 5: Convolutional Neural Networks (CNNs)

- Why Convolution? Understanding Spatial Features
- Convolution Operation, Padding, Stride, Pooling
- Architecture of CNN: Convolution + Pooling + Fully Connected Layers
- Popular CNN Architectures: LeNet, AlexNet, VGG, ResNet
- Transfer Learning and Fine-Tuning Concepts
- Batch Normalization, Dropout, Regularization
- Applications: Object Recognition, Classification, Detection

Module 6: Recurrent Neural Networks (RNNs), LSTMs, and GRUs

- Sequential Data and Temporal Dependencies
- Architecture of RNNs and Vanishing Gradient Problem
- LSTMs: Gates, Memory Cells, and Working Mechanism
- GRUs: Simplified RNN Variant
- Applications: Time Series Forecasting, Text Generation, Sentiment Analysis
- Sequence-to-Sequence Models

Module 7: Attention Mechanisms and Transformers

- Limitations of RNNs and Need for Attention
- Concept of Self-Attention
- Scaled Dot-Product Attention and Multi-Head Attention
- Positional Encoding and Sequence Representations
- Transformer Architecture: Encoder-Decoder Model
- Overview of BERT and GPT Architectures
- Applications of Transformers in NLP and Vision

Module 8: Generative Models

- Introduction to Generative Learning
- Autoencoders and Variational Autoencoders (VAE)
- Encoder-Decoder Mechanism, Generative Adversarial Networks (GANs)
- Diffusion Models: Basic Concepts, Applications: Image Generation, Data Augmentation

Module 9: Introduction to Generative AI

- What is Generative AI? From Deep Learning to Generative Modeling
- Introduction to Large Language Models (LLMs)
- Tokenization, Embeddings, and Transformers Recap
- Prompt Engineering: Zero-shot, Few-shot, Chain of Thought
- Retrieval-Augmented Generation (RAG) Concepts

Module 10: Capstone Project

Drone Technology

Duration: 100 hours

Objective: To provide learners with a comprehensive understanding of drone technology, design, and operation while developing practical skills in assembly, calibration, and autonomous flight control. It aims to prepare participants for real-world applications and innovations in the UAV domain.

Prerequisites: To successfully participate in this program, learners should have:

1. **Basic Technical Knowledge**
    - Familiarity with electronic components and basic electrical circuits.
    - Understanding of physics concepts such as force, motion, and energy.
    - Basic knowledge of computers and operating systems
2. **Mathematical Skills**
    - Ability to perform basic calculations involving ratios, proportions, and trigonometric concepts.
    - Understanding of units, measurements, and conversions.
3. **Programming Awareness (Preferred)**
    - Basic exposure to any programming language (Python preferred).
    - Logical thinking and problem-solving ability.
4. **Interest in Drone Technology**
    - Curiosity about UAV systems, sensors, and flight mechanisms.
    - Enthusiasm to work with hardware, software, and real-world drone systems.

Module 1: Introduction

- Course overview, objectives, and outcomes
- Importance of drones in modern applications
- Safety briefing and expectations

Module 2: Basic Principles of Flight

- Forces acting on an aircraft: lift, weight, thrust, and drag
- Bernoulli's principle and Newton's laws of motion in flight
- Stability and control of an aircraft
- Power and performance factors in flight
- Application of flight principles in drone movement

Module 3: Basic Principles of Aerodynamics and Their Application to Drones

- Airflow over airfoils and propellers
- Angle of attack, drag coefficient, lift-to-drag ratio
- Aerodynamics of multirotor drones
- Induced, profile, and parasite drag
- Propeller efficiency and thrust curves
- Aerodynamic limitations in hovering and high-speed flight

Module 4: Introduction to Drones, Types, and Their Characteristics

- Classification of drones: multirotor, fixed-wing, and hybrid VTOL
- Payload capacity, endurance, and flight envelope
- Overview of flight controllers and communication systems
- Identification of drone types and components
-

Module 5: Current and Future Applications of Drone Technology

- Applications in agriculture, defense, surveillance, mapping, delivery, and inspection
- Drone-as-a-Service and integration of AI in drone operations
- Emerging trends in autonomous and swarm drones
- Real-world use case

Module 6: Safety Guidelines and Regulations

- DGCA drone rules and UAS certification overview
- NPNT (No Permission, No Takeoff) concept
- Drone registration and pilot licensing
- Airspace classification and no-fly zones

Module 7: Building Drones – Components and System Architecture

- Overview of drone architecture: frame, ESCs, motors, propellers, flight controller, GPS, telemetry
- Power distribution, wiring diagrams, and control systems
- Component identification and functional testing
- Power system setup and verification

Module 8: Advanced Drone Sensors and Payloads

- Drone sensor types: IMU, barometer, GPS, magnetometer, LiDAR, camera, ultrasonic
- Payload integration, balancing, and weight considerations
- Real-time data acquisition from sensors
- Sensor calibration and performance testing

Module 9: Drone Designing

- Understanding design requirements based on application (surveillance, mapping, delivery, agriculture, etc.)
- Selection of components:
    - Frame type and size
    - Motor KV rating and thrust calculation
    - Propeller size and pitch matching
    - ESC rating and compatibility
    - Battery type, voltage, and capacity calculation
    - Flight controller and GPS selection
- Estimation of payload capacity, endurance, and power requirement

Module 10: Introduction to Mission Planner

- Overview of the Mission Planner interface
- Understanding flight modes and parameters
- Planning and configuring autonomous missions
- Creating and simulating waypoint missions
- Reviewing flight logs and tuning parameters

Module 11: Drone Simulation for Remotely Piloted and Autonomous Flight

- Fundamentals of simulation and SITL (Software In The Loop)
- PX4 and ArduPilot simulation environments
- Simulating takeoff, hovering, waypoint navigation, and return-to-launch (RTL)
- Using joysticks or RC transmitters for simulation control

Module 12: Assembly of Drones and Calibration

- Pre-assembly checklist and preparation

- Firmware setup for flight controller (PX4 / ArduPilot)
- Component integration: frame, motors, ESCs, FC, GPS, power module
- Calibration of sensors, ESCs, and compass
- Motor direction testing and PID tuning
- Ground testing and maiden flight procedures
- Post-flight inspection and maintenance practices

Module 13: Python Programming Fundamentals

- Introduction to Python
- Control Flow & Operators
- Data Structures
- Functions & File Handling

Module 14: AI, ML, and Deep Learning for Drone Technology

- Introduction to AI and Drones
- Data Collection and Processing in Drone Data Analysis
- Data Analysis and Interpretation
- AI vs ML vs DL
- Processes involved in Machine Learning
- Types of ML Algorithms
- Popular Algorithms in Machine Learning
- Introduction to Deep learning
- Perceptron
- Activation Function
- CNN Algorithm

Module 15: Capstone Project