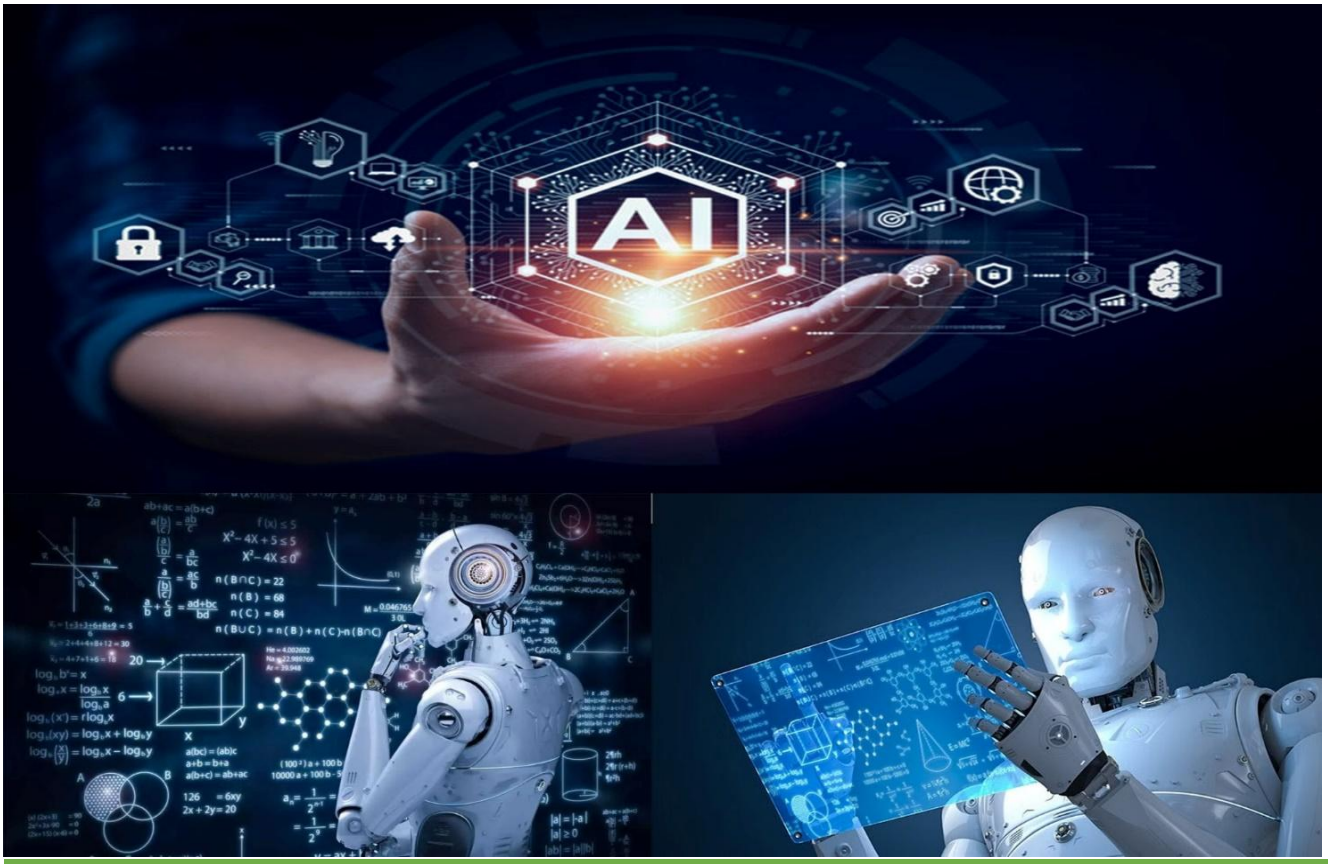

Model Curriculum

MC Name: A.I (Artificial Intelligence) - Technocrat

MC Code: ICE/TT/32/Q1009

Version: 1.0

NSQF Level: 5.0

Model Curriculum Version: 1.0

The Institution of Civil Engineers Society ||

309-310, Suncity Trade Tower, Sector-21, Gurugram, Haryana || E-mail: Ceo@iceskills.in

Table of Contents

Training Parameters

Sector	Information Technology
Sub-Sector	Artificial Intelligence
Occupation	Artificial Intelligence
Country	India
NSQF Level	5.0
Aligned to NCO/ISCO/ISIC Code	**NCO- 2015**/ 2142.0100, 2152.9900, 2144.0100, 2151.0100, 2512.0100, 2146.9900, 2523.0200, 2512.0201
Minimum Educational Qualification and Experience	1. Completed 2nd year of 3 year/4-year UG 2. Pursuing 2nd year of 3 year/4-year UG and continuing education 3. Completed 2-year diploma after 12th 4. Completed 3-year diploma after 10th with 1.5 -year relevant stream experience 5. Pervious relevant Qualification of NSQF Level 4.5 with 1.5 year relevant experience
Pre-Requisite License or Training	NA
Minimum Job Entry Age	18 Years
Last Reviewed On	NA
Next Review Date	NA
NSQC Approval Date	NA
QP Version	1.0
Model Curriculum Creation Date	NA
Model Curriculum Valid Up to Date	NA
Model Curriculum Version	1.0
Minimum Duration of the Course	600 Hours
Maximum Duration of the Course	2100 Hours

Program Overview

This section summarises the end objectives of the program:

Training Outcomes

At the end of the program, the participants should have acquired the listed knowledge and skills to:

- Smart technologies enhance decision-making and automation across all engineering disciplines.
- In computer science, smart systems focus on machine learning, data mining and neural networks.
- In IT, intelligent solutions improve system performance, cyber security and data analysis.
- In electronics, smart tools optimize circuit design, signal processing and communication systems.
- In communication engineering, intelligent networks enhance wireless communication, speech recognition and IoT.
- In electrical engineering, smart grids and automated systems improve power distribution and efficiency.
- In mechanical engineering, smart tools revolutionize robotics, CAD and predictive maintenance.
- Smart manufacturing processes improve efficiency and automation in mechanical systems.
- In civil engineering, intelligent technologies enhance structural analysis, construction management and planning.
- Smart solutions in civil projects help with traffic management and smart city development.
- In materials engineering, intelligent methods optimize the design of new materials with enhanced properties.
- In metallurgy, smart systems aid in failure analysis, defect detection and material testing.
- Intelligent drives in electrical systems improve motor control and energy efficiency.
- Smart technologies accelerate research and development in renewable energy systems.
- Intelligent communication networks enhance bandwidth and signal optimization.
- In IT, smart systems enable predictive analytics for business intelligence and cyber security.
- Intelligent robotics transforms automation in manufacturing and industry.
- Smart solutions in civil engineering enable efficient management of construction projects and resource allocation.
- Intelligent methods in material science enable improved product durability and life cycles.
- Smart systems enable real-time data analysis and monitoring in complex engineering environments.

Compulsory NOS (Common Modules for Technical Trades)

The table lists the modules and their duration corresponding to the Compulsory NOS of the QP.

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1901: Fundamentals of Artificial Intelligence (AI) **NOS Version- 1.0** **NSQF Level- 5.0**	**20:00**	**25:00**	**00:00**	**00:00**	**45:00**
Module 1: Introduction to AI in all Technical Trades	5:00	5:00	00:00	00:00	10:00
Module 2: AI Ethics and Impact on society	5:00	0:00	00:00	00:00	05:00
Module 3: Aptitude & Mathematics Fundamentals	5:00	5:00	00:00	00:00	10:00
Module 4: Data Handling	5:00	15:00	00:00	00:00	20:00
ICE/N1902:Python Programming and Data Science for AI **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**45:00**	**00:00**	**00:00**	**105.00**
Module 5: Introduction to Python	5:00	5:00	00:00	00:00	10:00
Module 6: Data Structures and Algorithms in Python	20:00	14:00	00:00	00:00	34:00
Module 7: Object-Oriented Programming (OOP) in Python	20:00	14:00	00:00	00:00	34:00
Module 8: Libraries for AI and Data Science	15:00	12:00	00:00	00:00	27:00
ICE/N1903: Building Blocks of Artificial Intelligence (A.I) **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**30:00**	**00:00**	**00:00**	**90.00**
Module 9: Fundamentals of Machine Learning (ML)	10:00	5:00	00:00	00:00	15:00
Module10: Basics of Deep Learning	10:00	5:00	00:00	00:00	15:00
Module 11: Fundamentals of Natural Language Processing (NLP)	10:00	5:00	00:00	00:00	15:00
Module 12: Basics of Computer Vision	10:00	5:00	00:00	00:00	15:00
Module 13: Fundamentals of Internet of Things (IoT)	10:00	5:00	00:00	00:00	15:00

Module 14: Basics of Robotics	10:00	5:00	00:00	00:00	15:00
DGT/VSQ/N0102: Employability Skills **NOS Version- 1.0** **NSQF Level -5.0**	**60:00**	**00:00**	**00:00**	**00:00**	**60.00**
Total Duration	**200:00**	**100:00**	**00:00**	**00:00**	**300:00**

Elective Nos

Elective Subject

Elective 1: Computer Science and Information Technology Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1904: Application in CS & IT Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Use AI tools/algorithms Business Intelligence and Data Analysis	10:00	20:00	00:00	00:00	30:00
Module 2: Utilize AI tools/algorithms in Software Development Engineering	10:00	20:00	00:00	00:00	30:00
Module 3 : Utilize AI tools/algorithms in Cyber security	10:00	20:00	00:00	00:00	30:00
Module 4: Use AI tools/algorithms in IoT and Edge Computing	10:00	20:00	00:00	00:00	30:00
Module 5: Utilize AI tools/algorithms in Cloud Computing	10:00	20:00	00:00	00:00	30:00
Module 6: Advancement in AI for CS and IT	10:00	20:00	00:00	00:00	30:00
Module 7: Project	120				120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Elective Subject

Elective 2: Electronics & Communication Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1905: Applications of AI in ECE Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Utilize AI tools /algorithms in Signal Processing	8:00	15:00	00:00	00:00	23:00
Module 2: Use AI tools /algorithms in Communication Systems	8:00	15:00	00:00	00:00	23:00
Module 3: Use AI tools /algorithms in Embedded Systems and IoT	8:00	15:00	00:00	00:00	23:00
Module 4: Utilize AI tools /algorithms in VLSI Design and Hardware Optimization	8:00	15:00	00:00	00:00	23:00
Module 5: Use AI tools /algorithms in Robotics and Autonomous Systems	7:00	15:00	00:00	00:00	22:00
Module 6: Utilize AI tools /algorithms in Wireless Communication and Network Optimization	7:00	15:00	00:00	00:00	22:00
Module 7: Use AI tools /algorithms in Electronic System Design and Optimization	7:00	15:00	00:00	00:00	22:00
Module 8: Advancement in AI for ECE	7:00	15:00	00:00	00:00	22:00
Module 9: Project			120		120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Elective Subject

Elective 3: Electrical Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1906: Applications of AI in Electrical Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Utilize AI tools /algorithms in Power Systems and Smart Grids	8:00	15:00	00:00	00:00	23:00
Module 2: Use AI tools /algorithms in Control Systems and Automation	8:00	15:00	00:00	00:00	23:00
Module 3: Utilize AI tools /algorithms in Signal Processing and Communication Systems	8:00	15:00	00:00	00:00	23:00
Module 4: Use AI tools /algorithms in Electronics and Embedded Systems	8:00	15:00	00:00	00:00	23:00
Module 5: Utilize AI tools /algorithms in Renewable Energy Systems	7:00	15:00	00:00	00:00	22:00
Module 6: Use AI tools /algorithms Utilize in Robotics and Autonomous Systems	7:00	15:00	00:00	00:00	22:00
Module 7: Utilize AI tools /algorithms for Electric Vehicles	7:00	15:00	00:00	00:00	22:00
Module 8: Advancement in AI for Electrical Engineering	7:00	15:00	00:00	00:00	22:00
Module 9: Project			120		120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Elective Subject

Elective 4: Mechanical Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1907: Applications of AI in Mechanical Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Utilize AI tools /algorithms in Product Development	8:00	15:00	00:00	00:00	23:00
Module 2: Use AI tools /algorithms in Manufacturing and Production Systems	8:00	15:00	00:00	00:00	23:00
Module 3: Utilize AI tools /algorithms in Predictive Maintenance and Reliability Engineering	8:00	15:00	00:00	00:00	23:00
Module 4: Use AI tools /algorithms in Control Systems and Automation	8:00	15:00	00:00	00:00	23:00
Module 5: Utilize AI tools /algorithms in Fluid Mechanics and Thermal Systems	7:00	15:00	00:00	00:00	22:00
Module 6: Use AI tools /algorithms in Energy Systems and Sustainability	7:00	15:00	00:00	00:00	22:00
Module 7: Utilize AI tools /algorithms in Materials Science and Additive Manufacturing	7:00	15:00	00:00	00:00	22:00
Module 8: Advancement in AI for Mechanical Engineering	7:00	15:00	00:00	00:00	22:00
Module 9: Project	120				120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Elective Subject

Elective 5: Civil Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1908: Applications of AI in Civil Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Utilize AI tools /algorithms in Structural Engineering	7:00	13:00	00:00	00:00	20:00
Module 2: Use AI tools /algorithms in Construction Management	7:00	13:00	00:00	00:00	20:00
Module 3: Utilize AI tools /algorithms in Geotechnical Engineering	7:00	13:00	00:00	00:00	20:00
Module 4: Use AI tools /algorithms in Transportation Engineering	7:00	13:00	00:00	00:00	20:00
Module 5: Utilize AI tools /algorithms in Environmental and Water Resources Engineering	7:00	13:00	00:00	00:00	20:00
Module 6: Use AI tools /algorithms in Urban Planning and Smart Cities	7:00	13:00	00:00	00:00	20:00
Module 7: Utilize AI tools /algorithms in Construction Automation	6:00	14:00	00:00	00:00	20:00
Module 8: Use AI tools /algorithms for sustainable Civil Engineering	6:00	14:00	00:00	00:00	20:00
Module 9: Advancement in AI for Civil Engineering	6:00	14:00	00:00	00:00	20:00
Module 10: Project			120		120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Elective Subject

Elective 6: Metallurgical and Materials Engineering

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ICE/N1909: Applications of AI in Metallurgy Domain **NOS Version- 1.0** **NSQF Level- 5.0**	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**
Module 1: Use AI tools/algorithms for Materials Design	9:00	18:00	00:00	00:00	27:00
Module 2: Utilize AI tools/algorithms in Process Optimization and Control in Metallurgy	9:00	17:00	00:00	00:00	26:00
Module 3: Use AI tools/algorithms in Computational Techniques for Microstructure Analysis	9:00	17:00	00:00	00:00	26:00
Module 4: Utilize AI tools/algorithms for Predictive Modelling of Material Behaviour	9:00	17:00	00:00	00:00	26:00
Module 5: Use AI tools/algorithms Utilize in Smart Manufacturing and Industry 4.0	9:00	17:00	00:00	00:00	26:00
Module 6: Utilize AI in Materials Recycling and Circular Economy	8:00	17:00	00:00	00:00	25:00
Module 7: Advancement in AI for Metallurgy and Materials Engineering	7:00	17:00	00:00	00:00	24:00
Module 8: Project	120				120:00
Total Duration	**60:00**	**120:00**	**120:00**	**00:00**	**300:00**

Module Details

Compulsory NOS

Common Modules for Technical Sectors

Module 1: Introduction to AI in all Technical Trades

Mapped to ICE/N1901, v1.0

Terminal Outcomes:

- Grasp the core concepts and scope of Artificial Intelligence.
- Explain differentiate between AI, Machine Learning and Deep learning methodologies.
- Recognize the distinctions between Narrow AI, General AI and Super intelligent AI.
- Understand key AI models including decision trees, neural networks and reinforcement Learning.
- Explore the diverse applications of AI in fields like healthcare, finance, robotics and autonomous systems.
- Understand stages of data collection, model training, evaluation and deployment in AI projects.
- Understand the significance of datasets, data preprocessing and feature engineering in AI.
- Get familiar with AI development tools like TensorFlow / PyTorch and OpenAI frameworks.

Duration (in hours): 05:00	**Duration (in hours): 5:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Comprehend the definition and scope of Artificial Intelligence. • Differentiating between AI, Machine Learning (ML) and Deep Learning (DL). • Distinguishing between Narrow AI, General AI and Super intelligent AI. • Grasp AI models like decision trees, neural networks and reinforcement Learning. • Overview of data collection, model training, evaluation and deployment. • Introduction to AI development tools such as TensorFlow, PyTorch and Open AI frameworks.	• Explain basic functionalities of AI algorithms such as linear regression and decision trees. • Explain working simple models for classification, regression and clustering. • Define functionalities of data cleaning, normalization and feature extraction.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Python, TensorFlow/ PyTorch, Jupyter Notebooks	

Module 2: AI Ethics and Societal Impact

Mapped to ICE/N1901, v1.0

Terminal Outcomes:

- Understand key principles of AI ethics, focus on fairness, accountability, transparency and explainability.
- Explore ethical frameworks and guidelines for responsible AI usage.
- Examine ethical concerns around data privacy, consent and surveillance in AI.
- Discuss the relevance of regulations like GDPR in the context of AI systems.
- Understand the importance of clear responsibility and liability in AI implementations.
- Analyze case studies on ethical challenges in AI, including autonomous vehicles, surveillance and predictive policing.
- Explore global efforts in AI regulation, standards and governance frameworks.

Duration (in hours): 05:00	**Duration (in hours): 00:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Fundamental principles of AI ethics, including fairness, accountability, transparency and explainability. • Understand the ethical frameworks and guidelines for responsible AI. • Explore the ethical concerns related to data privacy, consent and surveillance. • Discuss regulations like GDPR and their relevance to AI systems. • Understand the need for clear responsibility and liability in AI deployments. • Discuss case studies on ethical challenges in AI applications such as autonomous vehicles, surveillance systems and predictive policing. • Explore global efforts in AI regulation, standards and governance frameworks.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements : NIL	

Module 3: Aptitude & Mathematics Fundamentals

Mapped to ICE/N1901, v1.0

Terminal Outcomes:

- Overview how to solve mathematical problems relevant to AI
- Understand how enhance data analysis skills.
- Overview how to manipulate data using linear algebra concepts.
- Application of linear algebra in machine learning contexts.
- Overview how to enhance decision-making skills based on probabilistic models.
- Overview how to analyze and interpret data statistically.
- Overview of skills to draw conclusions from data analysis.

Duration (in hours): 05:00	**Duration (in hours): 05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to algebra, calculus, and statistics. • Overview of vectors and their properties • Introduction of Matrices, matrix operations, and their significance in data manipulation. • Overview of conditional probability and Bayes theorem. • Overview of various probability distributions (normal, binomial, Poisson, etc.) and their applications in AI. • Overview of hypothesis testing, types of tests (t-test, chi-square test, etc.). • Understand of regression analysis: linear and logistic regression. • Overview of descriptive statistics: Mean, median, mode, standard deviation, and variance.	• Explain linear algebra concepts in data preprocessing and transformation tasks. • Define simulations probability concepts and their application in AI.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Octave, Excel	

Module 4: Data Handling

Mapped to ICE/N1901, v1.0

Terminal Outcomes:

- Overview how to ensure high-quality, clean data for AI models.
- Improved model reliability and performance through effective data cleaning.
- Understand how to prepare data for analysis using preprocessing techniques.
- Enhanced model performance through proper data transformation.
- Overview how to explore and visualize data effectively for better analysis.
- Skill in identifying key patterns and insights from data distributions and trends.
- Overview how to split data effectively for model training and validation.
- Skills in building robust AI models that generalize well.
- Overview how to efficiently store and retrieve data for AI applications.
- Gain knowledge of database architectures and data management techniques.

Duration (in hours): 05:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Importance of data quality in AI model accuracy. • Common data issues: missing values, outliers, and duplicates. • Introduction to data preprocessing and its significance. • Concepts of normalization and standardization. • Importance of encoding categorical variables in machine Learning. • Importance of data visualization in identifying patterns and trends. • Key concepts: distributions, correlations, and data trends. • Concept of data splitting and understand the role in machine Learning. • Differences between training, validation, and test sets. • Introduction to data storage architectures (databases, data lakes, data warehouses). • Differences between structured, semi-structured, and unstructured data. • Overview of data retrieval techniques and queries.	• Define missing values (e.g., mean imputation, deletion). • Explain the working of histograms, bar charts, and scatter plots to visualize data distributions. • Explain the different trends and insights using line graphs and box plots. • Explain the use of store data from SQL or NoSQL databases. • Explain use of SQL queries or APIs. • Define large data sets using data lakes or warehouses (e.g., AWS/Azure).
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data cleaning tools (e.g., Pandas in Python), Data validation software (e.g., OpenRefine), Python libraries (e.g., Scikit-learn/ Pandas), Data visualization tools (e.g., Matplotlib/ Seaborn/ Plotly), Database management systems (e.g., MySQL/ MongoDB).	

Module 05: Introduction to Python

Mapped to ICE/N1902, v1.0

Terminal Outcomes:

- Overview how to write basic Python programs using variables, loops, and conditionals.
- Understand Python syntax for effective programming.
- Understand how to select and using appropriate data structures for different tasks.
- Overview how to manipulate and organize data using Python data structures.
- Overview how to write modular and efficient Python code using functions and modules.
- Gain Knowledge how enhanced problem-solving skills through reusable code.
- Understand of reading from and writing to files in Python.
- Overview how to manage file operations efficiently for various tasks.
- Overview how to use NumPy and Pandas for data manipulation.
- Understand how to perform basic data analysis with Python.
- Overview how to debug and fix errors in Python programs.
- Understand how to use error-handling techniques to improve program robustness.

Duration (in hours): 05:00	**Duration (in hours):05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to Python syntax and programming structure. • Understand variables, data types (int, float, string, boolean). • Concepts of control flow: loops (for, while) and conditionals (if, else, elif). • Overview of Python data structures: lists, tuples, dictionaries, sets. • Introduction of comparison between mutable vs. Immutable. • Introduction to Python modules and packages. • Introduction of file handling in Python. • Understand file modes (read, write, append) and file object methods. • Overview of NumPy for numerical computations and array manipulation. • Introduction to Pandas for data manipulation (Dataframes, Series), Key operations in Pandas: indexing, filtering, and data transformation. • Overview of common types of Python errors (syntax, runtime, logical).	• Explain the functionalities of lists (e.g., append, extend, pop). • Define tuples for immutable collections of data and sets for unique element storage. • Explain numerical operations using NumPy arrays. • Explain the functionalities of Pandas dataframes (e.g., filtering and grouping). • Define data analysis tasks using Pandas (e.g., aggregation and summarization).
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Python IDEs (e.g., PyCharm / Jupyter Notebook / VS Code), Python programming environment (e.g., Anaconda/ Jupyter), Python libraries (NumPy, Pandas)	

Module 06: Data Structures and Algorithms in python
Mapped to ICE/N1902, v1.0

Terminal Outcomes:

- Understand how to choose and applying Python built-in data structures to understand solve real-world problems.
- Overview how to implement and choose the right sorting and searching algorithms based on data structure and problem size.
- Understand of algorithm efficiency through hands-on practice and analysis.
- Overview how to evaluate the time and space complexity of algorithms.
- Understand how to choose algorithms based on efficiency criteria for real-world applications.
- Overview how to implement recursive solutions for problems like tree traversal and backtracking.

Duration (in hours): 20:00	**Duration (in hours): 14:00**
Theory – Key Learning Outcomes	**Practical –Key Learning Outcomes**
• Introduction of basic data structures: arrays, linked lists, stack, queues, trees, and graphs. • Overview of Python's built-in data structures: lists, dictionaries, sets, and tuples. • Introduction of sorting algorithms: bubble sort, quicksort, mergesort, and their time complexities. • Understand searching algorithms: linear search, binary search, and their efficiency. • Discuss the applicability of different sorting and searching algorithms based on problem requirements. • Introduction of algorithm complexity: Big O notation, time complexity, and space complexity. • Introduction of recursion and its principles (base case, recursive case). • Understand the application of recursion in tree traversal algorithms (preorder, inorder, postorder) and backtracking algorithms (e.g., solving mazes, n-queens problem).	• Explain the utilization of stack and queue structures using Python lists. • Define using Python's lists for dynamic arrays, dictionaries for mapping, and sets for unique elements and tuples for immutable collections. • Explain the recursive functions for common problems (e.g., factorial, Fibonacci sequence). • Explain the functionalities of recursive algorithms for tree traversal and backtracking (e.g., depth-first search, n-queens problem).
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Python IDEs (e.g., PyCharm/ Jupyter Notebook/VS Code), Python programming environment (e.g., Anaconda/Jupyter), Python libraries (NumPy/Pandas)	

Module 07: Object-Oriented Programming (OOP) in Python

Mapped to ICE/N1902, v1.0

Terminal Outcomes:

- Acquire knowledge concepts of classes and objects, the foundation of OOP.
- Grasp encapsulation for data hiding and restricting access to internal details.
- Gain knowledge of perceive inheritance to promote code reuse by creating new classes from existing ones.
- Understand polymorphism, enabling the same interface to be used for different data types.
- Comprehend how constructors are used for object initialization.
- Discuss differentiate between instance variables and class variables and their uses.
- Explain how to implement method overloading and overriding in Python.
- Understand key OOP design principles like Single Responsibility, Open-Closed and Dependency Inversion.
- Understand common design patterns like Singleton, Factory and Observer in Python.
- Explain how exception handling within classes use tries-except blocks and custom exceptions.

Duration (in hours): 20:00	**Duration (in hours): 14:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the concepts of classes and objects, the building blocks of OOP. • Explain how data hiding works use encapsulation. • Grasp the concept of inheritance to promote code reuse by deriving new classes from existing ones. • Understand polymorphism and how it allows the same interface to be used for different underlying forms data types. • Understand constructors are used for initializing objects. • Explain differentiate between instance variables and class variables and understand their uses. • Understand how to implement method overloading and overriding in Python. • Understand key OOP design principles like single Responsibility, Open-Closed, Liskov Substitution, Interface Segregation and Dependency Inversion. • Explore how to handle exceptions within classes use try-except blocks and custom	• Explain how inheritance works for parent and child classes. • Define the functionalities to call parent class methods in child classes.

exception classes.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
PyCharm / Visual Studio Code/ Jupyter Notebook, Kaggle, Modelio	

Module 08: Libraries for AI and Data Science

Mapped to ICE/N1902, v1.0

Terminal Outcomes:

- Understand how NumPy supports multi-dimensional arrays and provides a range of mathematical functions.
- Grasp the significance of Pandas for data manipulation, analysis and handling structures like Series and dataframes.
- Comprehend essential features of Scikit-learn for machine Learning tasks, including classification, regression and clustering.
- Acquire knowledge deep learning with TensorFlow and PyTorch for building and training neural networks.
- Explain how Keras simplifies deep learning model development with its user-friendly API on top of TensorFlow.
- Explore NLP libraries such as NLTK for text preprocessing and spacy for advanced natural language processing.
- Understand common data formats like CSV, JSON and Excel and how to read/write them use Python libraries.
- Understand how Scipy extends Numpy with added functionality for math, optimization and statistics.
- Understand the role of libraries in cleaning, normalizing and transforming data for AI models.
- Understand Scikit-learn tools for cross-validation, performance metrics and model selection.

Duration (in hours): 15:00	**Duration (in hours): 12:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of Numpy provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays. • Understand the importance of Pandas for data manipulation, analysis and working with data structures like series and data Frames. • Grasp the key features of Scikit-learn for implementing machine learning algorithms	• Explain the working of broadcast in Numpy for handling operations between arrays of different shapes. • Define the functionalities of algorithms like linear regression, decision trees and SVM use Scikit-learn. • Explain how to use simple deep Learning models such as TensorFlow / Keras / PyTorch, on building layers, compiling models and visualizing training progress. • Define how to use NLTK and spaCy for

such as classification, regression, clustering and model evaluation. • Understand the fundamentals of deep learning libraries like TensorFlow and PyTorch for building and training neural networks. • Understand how Keras simplifies the development of deep learning models by providing an easy-to-use API built on top of TensorFlow. • Explore libraries specific to natural language processing (NLP) tasks, like NLTK for text preprocessing and spaCy for advanced NLP applications. • Understand common data formats (CSV, JSON, Excel) and how to read/write them use these libraries.	tokenization, stopword removal, stemming and lemmatization.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Jupyter Notebook/ PyCharm, or VS Code, Anaconda or Miniconda, NumPy / Pandas, Matplotlib / Seaborn, Scikit-learn, TensorFlow or PyTorch or Keras, Kaggle, or Google Dataset, OpenCV.	

Module 09: Fundamentals of Machine Learning (ML)

Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand to use of supervised, unsupervised, or reinforcement learning.
- Understand how to implement regression and classification models to predict both continuous and categorical variables.
- Overview how to pre-process data efficiently using techniques like normalization and feature extraction.
- Understand how to implement decision trees, support vector machines, and k-means clustering to solve various machine learning problems.
- Overview how to effectively evaluate model performance using appropriate metrics and interpret ROC curves for assessing classification models.

Duration (in hours): 10:00	**Duration (in hours): 05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction of machine learning paradigms: supervised, unsupervised, and reinforcement Learning. • Overview of supervised learning (e.g., regression, classification), unsupervised learning (e.g., clustering, dimensionality reduction) and reinforcement learning (e.g., reward-based Learning). • Overview of regression models (linear, polynomial, and logistic regression) and classification models (k-nearest neighbors, decision trees). • Introduction to the importance of data pre-processing in machine learning. • Discuss of techniques like normalization, standardization, missing value imputation and feature extraction. • Understand of key machine learning algorithms: Decision Trees: classification and regression tasks. • Overview of model evaluation metrics: Accuracy: Ratio of correctly predicted instances over total instances, Precision: Proportion of true positives over total predicted positives, Recall: Proportion of true positives over all actual positives, F1-Score: Harmonic mean of precision and recall.	• Define suitable usability of datasets to determine which machine learning approach (supervised, unsupervised, or reinforcement). • Explain simple supervised learning algorithms like linear regression and unsupervised techniques like k-means clustering. • Define how to use Scikit-learn for normalization and standardization techniques for datasets. • Explain the functionalities of decision tree classifiers and regressors for structured data. • Define SVM for classification tasks and k-means for clustering tasks.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	

Python IDE with Scikit-learn, visualization libraries (Matplotlib/ Seaborn)

Module 10: Basics of Deep Learning

Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand the fundamental components of ANNs, their structure, and the Understand the role of activation functions in learning complex relationships.
- Understand how to construct and train feed forward neural networks using popular deep Learning frameworks like TensorFlow and PyTorch.
- Understand back propagation process and its importance in training deep Learning models with hands-on understands to optimize models using gradient-based methods.
- Overview how to build and train CNNs for image classification and detection tasks and knowledge of key CNN architectures.
- Understand the building and training RNNs for sequence data with practical applications in time series and natural language tasks.

Duration (in hours): 10:00	**Duration (in hours): 05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction of the structure of artificial neural networks (ANNs), including: Layers**:** Input, hidden, and output layers. Nodes (Neurons)**:** Fundamental units that process inputs and produce outputs, Activation Functions**:** Sigmoid, ReLU, Tanh, and Softmax, which determine neuron output. • Understand how neural networks approximate complex functions using layers of interconnected neurons. • Introduction of TensorFlow and PyTorch for building deep Learning models. • Understand the training process (forward pass, loss calculation, backward pass) and understand the role of optimize like Stochastic Gradient Descent (SGD). • Introduction of the structure and components of Convolutional Neural Networks (CNNs)**,** including convolutional layers, pooling layers, and fully connected layers. • Introduction of popular CNN architectures like AlexNet, VGG, and ResNet. • Understand of the vanishing gradient problem in RNNs and the introduction of more advanced architectures like Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU).	• Explain how to design and visualize simple neural network architectures (using tools like TensorFlow/Keras). • Explain step-by-step backpropagation process through coding exercises. • Explain how to use simple CNN using tools like as TensorFlow/PyTorch for image classification (e.g., CIFAR-10 or MNIST dataset). • Define how to use NLP datasets (e.g., text generation or sentiment analysis) LSTM or GRU models for language modelling tasks.
Classroom Aids	

Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Python IDE with TensorFlow or PyTorch, Visualization libraries (Matplotlib / Seaborn)

Module 11: Fundamentals of Natural Language Processing (NLP)

Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand the basic text pre-processing techniques to prepare text data for NLP tasks.
- Understand of build and apply language models for text prediction and generation tasks.
- Understand how to use word embeddings to represent text data for various NLP applications.
- Overview how to apply NLP techniques to solve real-world tasks like sentiment analysis, text classification, and NER.
- Understand how to develop and applying seq2seq models for translation, summarization, and similar NLP tasks.
- Overview how to evaluate machine translation models using BLEU scores.
- Overview how to assess text summarization models with ROUGE metrics.
- Explain how to evaluate the performance of NLP models using key metrics like BLEU, ROUGE.

Duration (in hours): 10:00	**Duration (in hours):05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to text pre-processing techniques in NLP: Tokenization**:** Splitting text into words, sentences, or subwords, Stemming**:** Reducing words to their base forms, Lemmatization**:** converting words to their dictionary. • Overview of key language model architectures like n-grams, RNNs, LSTMs and modern approaches such as transformers**.** • Understand of popular embedding techniques like Word2Vec, GloVe**,** and modern contextual embeddings (e.g., BERT). • Overview of common NLP tasks: Sentiment Analysis**:** Identifying the sentiment (positive, negative, neutral) in text, Text Classification**:** Categorizing text into predefined classes (e.g., spam vs. not spam), Named Entity Recognition (NER)**:** Identifying and classifying entities (people, organizations, locations) in text. • Introduction of sequence-to-sequence (seq2seq) models, including encoder-decoder architectures. • Overview of common evaluation	• Define tokenization, stemming, and lemmatization using libraries like NLTK or spaCy for text datasets. • Explain the functionalities of simple language models (n-grams, RNNs) to predict the next word in a sequence. • Define how to use word embeddings Word2Vec or Glove for text corpus and visualize word similarities. • Explain how to use libraries like scikit-learn or Keras to make models for text classification tasks. • Define how to use TensorFlow or PyTorch to make seq2seq models for tasks like machine translation.

metrics in NLP: BLEU (Bilingual Evaluation Understand)**:** Measures the precision of machine-generated text compared to reference text**.** ROUGE (Recall-Oriented Understand for Gisting Evaluation)**:** Focuses on recall in text generation tasks like summarization.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Python IDE with TensorFlow or PyTorch, Python IDE with libraries like scikit-learn, spaCy	

Module 12: Basics of Computer Vision

Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand the image filtering, edge detection techniques for image processing tasks.
- Understand how to build and apply CNNs for tasks like image classification and object detection.
- Understand of image segmentation techniques for various applications.
- Explain how to use image augmentation techniques to improve model performance in image-based tasks.
- Understand how to implement object tracking and motion detection in video streams.
- Understand how to apply feature extraction techniques like SIFT, SURF, and ORB for computer vision applications.

Duration (in hours): 10:00	**Duration (in hours): 05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction of image processing techniques: Filtering: Techniques like Gaussian, median, and bilateral filtering to remove noise, Edge Detection: Methods such as Sobel, Canny, and Laplacian operators for detecting object boundaries, Image Enhancement: Improving image quality using histogram equalization, contrast adjustment, and sharpening. • Overview of Convolutional Neural Networks (CNNs) and their application in image classification, object detection,	• Explain how to use libraries like OpenCV or scikit-image for image filtering to remove noise and enhance images • Define how to use frameworks like TensorFlow or PyTorch make CNNs for image classification. • Explain how to use pre-trained models like YOLO or Faster R-CNN for object detection tasks. • Define how to use libraries like Keras or Albumentations for image augmentation techniques.

and recognition tasks. • Understand of CNN architecture: convolutional layers, pooling layers, fully connected layers, and activation functions. • Introduction of popular CNN models like VGG, ResNet, and YOLO for object detection. • Introduction of image segmentation techniques: partitioning an image into meaningful regions or objects. • Overview of methods like region-based segmentation, and advanced techniques like semantic segmentation (e.g., U-Net, Mask R-CNN). • Overview of image augmentation techniques to artificially expand datasets and improve model performance. • Understand the common augmentation methods like rotation, flipping, cropping, brightness adjustment, and scaling to prevent overfitting and improve generalization. • Understand the key techniques like Kalman filters, optical flow, mean shift, and deep Learning-based trackers (e.g., SORT, DeepSORT). • Understand of feature extraction methods in computer vision: SIFT (Scale-invariant Feature Transform), SURF (Speeded-Up Robust Features), ORB (Oriented FAST and Rotated BRIEF).	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Python IDE with OpenCV, scikit-learn, Python IDE with TensorFlow or PyTorch for CNN development	

Module 13: Fundamentals of Internet of Things (IoT)

Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand how sensors, actuators, and communication protocols interact within an IoT system.
- Introduction of setting up and configuring IoT devices for effective data collection and remote monitoring.
- Understand how to integrate edge computing into IoT systems to perform in time-sensitive applications.
- Understand how to apply MQTT, CoAP, and HTTP protocols for seamless IoT device communication.
- Overview of data security and best practices for securing IoT systems and protecting user privacy.
- Overview how to design and implement IoT systems for smart applications like home automation or industrial monitoring.

Duration (in hours): 10:00	**Duration (in hours): 05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of the Internet of Things (IoT) architecture: Sensors: Devices that collect data from the environment (e.g., temperature, humidity, motion sensors), Actuators: Devices that act upon data by controlling systems or processes (e.g., motors, switches), Communication protocols: Key protocols like MQTT, CoAP, and HTTP for IoT data transmission. • Understand the principles of connecting IoT devices for data collection and transmission. • Introduction to edge computing and its integration into IoT systems. • Overview of data security challenges in IoT systems: Encryption: Techniques to secure data transmitted over IoT networks (e.g., SSL/TLS), Authentication: Ensuring to be authorized devices can access IoT systems, Privacy concerns: Risks associated with the collection and misuse of personal data. • Exploration of IoT applications in various domains: Smart homes: Automating household devices (e.g., smart thermostats, lighting), Industrial automation: IoT for predictive maintenance, equipment monitoring, and Environmental monitoring: IoT systems for tracking air quality, temperature and humidity levels.	• Explain how to collect and monitor real-time data to connect and configure IoT devices (e.g., sensors, cameras). • Define how to make device connectivity with platforms like AWS IoT or ThingSpeak for cloud data collection. • Explain how to communicate between IoT devices using MQTT, CoAP, and HTTP protocols. • Define how to use MQTT broker and connect multiple devices for data exchange and publish subscribe models. • Explain how to encryption and authentication in IoT devices to secure data.

Classroom Aids
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
IoT kits (e.g. ESP32) equipped with sensors and actuators, Access to software tools (e.g., Node-RED/ MQTT Broker),IoT communication platforms (e.g., MQTT Broker/ CoAP libraries)

Module 14: Basics of Robotics
Mapped to ICE/N1903, v1.0

Terminal Outcomes:

- Understand of robot kinematics principles, enabling accurate control of robot positioning.
- Overview the program and control robotic systems for various applications.
- Understand how to integrate and utilizing sensors for robot perception, and Overview to interact with environment.
- Understand the principles of robot dynamics, enabling the design of robotic systems.
- Understand how to develop and implement effective path planning strategies for robots in dynamic environments.
- Understand of robotic Learning techniques.

Duration (in hours): 10:00	**Duration (in hours):05:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Definition and importance of kinematics in robotics, Forward kinematics: Calculating the position and orientation of the end effect or given joint angles, Inverse kinematics: Determining joint angles needed for a desired end effect or position and orientation. • Overview of robot control systems, including open-loop and closed-loop control. • Understand programming languages and frameworks commonly used in robotics (e.g., Python/C++/ ROS). • Overview of different sensors used in robotics: Cameras: For vision-based applications, LIDAR: For distance measurement and mapping, Ultrasonic sensors: For proximity detection. • Overview of path planning concepts and algorithms (e.g., A*, Dijkstra's algorithm). • Overview of other learning techniques in robotics, including supervised and unsupervised Learning.	• Define the functionalities of different sensors into a robotic system and calibrate them for accurate readings. • Explain the effects of different forces and torques on robot movements using simulation tools. • Define the functionalities of path planning algorithms in simulation environments to navigate robots through obstacles. • Explain how to use simple reinforcement learning algorithms to train robots for specific tasks (e.g., maze solving).
Classroom Aids	

Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Software tools for kinematics simulation (e.g., Octave/ Gazebo), Development environment for programming (e.g., IDEs like PyCharm or Visual Studio), Sensors (eg. cameras), Software libraries for sensor data processing (e.g., OpenCV for image processing), Machine Learning frameworks (e.g., TensorFlow/ PyTorch).

Employability Skills

Mapped to DGT/VSQ/N0102, v1.0

Duration (in hours):60:00

Key Learning Outcomes

Introduction to Employability Skills

After completing this programme, participants will be able to:

1. Discuss the Employability Skills required for jobs in various industries.
2. List different Learning and employability-related GOI and private portals and their usage.

Constitutional values-Citizenship

3. Explain the constitutional values, including civic rights and duties, citizenship, responsibility towards society and personal values and ethics such as honesty, integrity, caring and respecting others that are required to become a responsible citizen.
4. Show how to practice different environmentally sustainable practices.

Becoming a Professional in the 21st Century

5. Discuss the importance of relevant 21st-century skills.
6. Exhibit 21st-century skills like Self-Awareness, behaviour skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, Learning to Understand etc. in personal or professional life.
7. Elucidate the appropriate code of conduct.

Basic English Skills Duration

8. Show how to use basic English sentences for every day conversation in different contexts, in person and over the telephone.
9. Read and interpret text written in basic English.
10. Write a short note/paragraph/letter/e –mail using basic English.

Career Development &Goal Setting Duration

11. Discuss the difference between job and career.
12. Create a career development plan with well-defined short-and long-term goals.

Communication Skills Duration

13. Elucidate the importance of communication and professional communication.
14. Explain the importance of following verbal and non-verbal communication etiquette in various settings.
15. Elucidate the process of interacting with reporting superiors regarding job order, work output requirements, targets, performance indicators and incentives.
16. Discuss how effective coordination ensures the timely completion of tasks in accordance with quality standards.
17. Describe the steps involved in ensuring the timely resolution of problems, complaints and delays through coordination with relevant personnel and superiors.
18. Determine the Understand the role of active communication and respect in achieving a smooth workflow and resolving work standards and quality-related concerns with personnel and superiors.

19. Explain the significance of maintaining appropriate documentation concerning completed work schedules as per organizational requirements.
20. Elucidate the importance of prioritizing teamwork and supporting team members in achieving shared goals.

Diversity & Inclusion Duration

21. Describe the recommended practices for preventing sexual harassment, physical and verbal abuse and the objectification of women in the workplace.
22. Discuss the appropriate safety precautions to follow while utilizing transportation facilities and during night trips, particularly concerning women's safety.
23. Elucidate the process for escalating issues related to abuse and sexual harassment in the workplace according to the POSH Act and organizational procedures.
24. Determine how to effectively educate co-workers on women's rights and the importance of showing respect to all genders, including persons with disabilities.

Financial and Legal Literacy Duration

25. Outline the importance of selecting the right financial institution, product and service.
26. Demonstrate how to carry out offline and online financial transactions, safely and securely.
27. List the common components of salary and compute income, expenditure, taxes, investments etc.
28. Discuss the legal rights, laws and aids.
29. Elucidate the purchase, inspection, indenting and recordkeeping procedure for stores.

Essential Digital Skills Duration

30. Describe the Understand the role of digital technology in today's life.
31. Demonstrate how to operate digital devices and use the associated applications and features, safely and securely.
32. Discuss the significance of displaying responsible online behaviour while browsing, using various social media platforms, e-mails, etc., safely and securely.
33. Create sample word documents; excel sheets and presentations using basic features.
34. Utilize virtual collaboration tools to work effectively.

Entrepreneurship Duration

35. Explain the types of entrepreneurships and enterprises.
36. Discuss how to identify opportunities for potential business, sources and associated financial and legal risks with its mitigation plan.
37. Describe the 4Ps of Marketing-Product, Price, Place and Promotion and apply the m as per requirement.
38. Create a sample business plan, for the selected business opportunity.
39. Describe the best practices for leading teams.
40. Explain the 5S Standards and their implementation for organize the workplace and create a productive work environment.
41. Explain how to manage clients, contractors, subordinates and labourers.

Customer Service Duration

42. Explain the importance of implementing appropriate hygiene, grooming standards and professional dress code at work to cater to different types of customers.
43. Elucidate the significance of practicing and encouraging active listening for effective communication with both customers and co-workers.

44. Discuss the methods used to ensure effective probing of customers to identify their needs and expectations.
45. Describe the strategies for maintaining effective communication with customers, keeping them informed regarding any issues and developments involving them.
46. Determine the steps involved in identifying and addressing customer dissatisfaction and complaints promptly and effectively.
47. Explain the importance of being fair and firm with staff to achieve work objectives and describe leave and attendance management.
48. Explain the importance of upskilling self and staff for continuous improvement.

Getting Ready for apprenticeship & Jobs Duration

49. Create a professional Curriculum Vitae(CV)
50. Use various offline and online job search sources such as employment exchanges, recruitment agencies and job portals respectively.
51. Discuss the significance of maintaining hygiene and confidence during an interview.
52. Elucidate how to give a personal introduction and present oneself.
53. Perform a mock interview.
54. List the steps for searching and registering for apprenticeship opportunities.

Elective NOS

Elective 1: Computer Science and Information Technology

Module 1: Use AI tools/algorithms Business Intelligence and Data Analysis

Mapped to ICE/N1904, v1.0

Terminal Outcomes:

- Overview to effectively integrate and pre-process diverse data sources, providing a solid foundation for business intelligence and analysis.
- Understand to develop predictive models that provide insights into business trends and customer behaviours for better decision-making.
- Overview to design and present insightful and interactive visualizations that communicate complex data.
- Understand to apply NLP techniques to derive meaningful insights from unstructured data, enhancing business decision-making capabilities.
- Overview to effectively implement anomaly detection techniques to ensure data integrity and enhance fraud detection capabilities.
- Understand how to apply AI-driven optimization techniques to improve business processes and operational efficiency, contributing to cost savings and enhanced performance.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of various data sources (structured and unstructured) such as databases, APIs, spreadsheets, and social media. • Concepts of ETL (Extract, Transform, Load) processes in data integration. • Overview of common machine Learning algorithms (e.g., linear regression, decision trees, random forests, neural networks). • Overview of AI-powered visualization tools and techniques (e.g., Tableau, Power BI, Google Data Studio). • Understand techniques for text pre-processing (tokenization, stemming, and lemmatization). • Overview of various anomaly detection algorithms (e.g., Isolation Forest, Local Outlier Factor and DBSCAN). • Overview of optimization techniques in the context of business operations (e.g., linear programming and genetic algorithms).	• Define how data extraction from multiple sources and integrate them into a unified dataset. • Explain how AI tools to clean and pre-process the integrated data for analysis. • Explain how to use predictive models for historical business data to forecast trends and behaviours. • Define to use model performance metrics like accuracy, precision and recall. • Define how to display key performance indicators (KPIs) and insights derived from data analysis. • Explain how NLP techniques to analyze unstructured text data for sentiment and trend analysis. • Define how sentiment analysis tools and libraries (e.g., NLTK, SpaCy) to extract insights from customer reviews and social media interactions.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	

Data integration tools (e.g., Talend/ Apache NiFi),Programming languages (e.g., Python/ R) with libraries for data manipulation (e.g., Pandas), Machine Learning libraries (e.g., Scikit-learn/TensorFlow/ Keras), Development environment (e.g., Jupyter Notebook/ Google Colab), Data visualization tools (e.g., Apache superset), NLP libraries (e.g., NLTK/ SpaCy), Anomaly detection libraries (e.g., Scikit-learn / PyOD), Data analysis tools (e.g., Excel/ Python libraries for optimization).

Module 2: Utilize AI tools/algorithms in Software Development Engineering

Mapped to ICE/N1904, v1.0

Terminal Outcomes:

- Understand to use AI-driven code completion tools to enhance coding productivity and minimize syntax errors.
- Overview how to leverage AI to automate testing processes, ensuring reliable software through efficient regression testing.
- Understand to use machine Learning techniques to improve software quality by predicting and fixing bugs.
- Overview to utilize AI for performance analysis and optimization, leading to improved software efficiency.
- Understand to use AI to analyze commit history for actionable insights into development processes and code quality.
- Overview how to leverage AI for analyzing user interactions to inform UX design and feature enhancements.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI in software development, specifically in code completion. • Overview of different AI-driven code completion tools (e.g., GitHub / Copilot and TabNine). • Overview of automated testing and its importance in software development. • Understand AI algorithms that aid in test case generation (e.g., reinforcement learning and genetic algorithms). • Overview of common machine Learning techniques (e.g., supervised Learning, anomaly detection) used in software quality assurance. • Overview of AI tools used for performance monitoring and analysis. • Overview of user interaction data and its importance in UX design. • Understand AI algorithms that analyze user behaviour (e.g., clustering, regression analysis).	• Define how to install and configure AI code completion tools in a development environment. • Explain how AI algorithms to generate and run automated test cases for a software application. • Define how automated testing into CI/CD pipelines to ensure continuous software quality assurance. • Explain how AI algorithms to analyze commit history data from version control systems. • Explain to analyze machine learning models code repositories for common bug patterns. • Explain different types of tools for automatic bug detection and fixing based on identified patterns. • Define to analyze AI user interaction data and derive insights for improving UX and feature development.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment,	

PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Development environment (e.g., Visual Studio Code/ PyCharm), Testing frameworks (e.g. Selenium/JUnit/TestNG), CI/CD tools (e.g., Jenkins/GitLab / CI), Machine Learning libraries (e.g., Scikit-learn / TensorFlow), Code analysis tools (e.g., SonarQube / CodeClimate), Performance monitoring tools (e.g., Grafana), Version control systems (e.g., Git/GitHub).

Module 3: Utilize AI tools/algorithms in Cyber security

Mapped to ICE/N1904, v1.0

Terminal Outcomes:

- Understand how to implement real-time threat detection systems to enhance incident response capabilities.
- Overview how to utilize machine learning to detect anomalies of cyber threats.
- Understand how to use AI tools for automated vulnerabilities.
- Overview of scanning and effective remediation planning.
- Overview how to utilize NLP techniques for effective phishing detection in email communications.
- Understand how to implement AI-based biometric authentication to enhance security measures.
- Overview to utilize predictive analytics for forecasting cyber incidents to make defence strategies.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the components and architecture of AI-driven threat detection systems. • Overview of network traffic analysis techniques and user behaviour monitoring. • Importance of real-time detection in cyber security. • Understand machine learning concepts relevant to behaviour analysis. • Overview of anomaly detection techniques and their applications in cyber security. • Overview scanning and its importance in cyber security. • Overview AI tools assess and prioritize vulnerabilities based on risk factors. • Understand NLP techniques relevant to cyber security, especially in email analysis. • Overview of phishing tactics and the importance of early detection. • Understand the role of email content and metadata in identifying threats. • Understand biometric authentication technologies and their applications. • Overview of facial recognition systems and behavioural biometric analysis.	• Define how AI-driven threat detection system using available tools and frameworks. • Explain how machine learning algorithms to analyze historical user and system behaviour. • Define how anomalies in data to detect potential security threats. • Define how NLP algorithms to analyze email datasets for phishing attempts. • Explain how to configure AI-based biometric authentication systems. • Define how to analyze predictive models using historical cyber security data.

• Importance of enhancing security protocols through biometrics. • Overview of predictive analytics and its significance in cyber security.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Network traffic analysis tools (e.g., Wireshark / Suricata), Machine Learning libraries (e.g., Scikit- learn / TensorFlow), NLP libraries (e.g., SpaCy), Email filtering and analysis tools (e.g., Apache Spam Assassin), Software for biometric data analysis (e.g., OpenCV), Predictive analytics tools (e.g., RapidMiner/KNIME)	

Module 4: Use AI tools/algorithms in IoT and Edge Computing

Mapped to ICE/N1904, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms at the edge for real-time data processing and decision-making.
- Overview how to implement machine Learning models for predicting equipment failures and enabling proactive maintenance.
- Understand AI tools for optimizing energy consumption in IoT and edge environments.
- Overview an how to implement AI-driven anomaly detection for monitoring IoT device behaviour.
- Understand how to use AI algorithms for filtering and prioritizing IoT data before cloud transmission.
- Overview how to implement AI-powered analytics at the edge for local decision-making in IoT applications.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand edge computing architecture and understand the role in IoT. • Overview of AI algorithms suitable for real-time data processing. • Overview of machine Learning concepts relevant to predictive maintenance. • Understand the types of data collected from IoT sensors and their significance. • Understand energy consumption metrics in IoT and edge computing. • Overview of AI techniques for analyzing usage patterns. • Importance of energy optimization in sustainable IoT solutions. • Overview of anomaly detection techniques in AI. • Importance of monitoring IoT device behaviour for security and maintenance. • Discussion of common security threats and malfunctions in IoT devices.	• Define how to process edge computing environment data from IoT devices. • Explain how to analyze AI algorithms for incoming data and make real-time decisions. • Define how to use machine learning models for IoT sensor data. • Explain how to analyze energy consumption data from IoT devices. • Explain the functionalities of anomaly detection algorithms to monitor IoT device data. • Explain the functionalities of AI algorithms to filter and prioritize data from IoT devices. • Define how to test the effectiveness of the filtering process to reduce bandwidth usage. • Explain AI analytics solutions to analyze data locally at the edge.

• Understand data filtering and prioritization techniques in IoT. • Overview of bandwidth usage issues in IoT communications. • Overview of AI-powered analytics and its significance in edge computing. • Understand the benefits of local decision-making in IoT applications.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI libraries (e.g., TensorFlow Lite/ PyTorch), Machine Learning frameworks (e.g., Scikit-learn / Keras), Anomaly detection frameworks (e.g., Autoencoders) and A.I analytics tools (e.g., Apache Kafka).	

Module 5: Utilize AI tools/algorithms in Cloud Computing

Mapped *to ICE/N1904, v1.0*

Terminal Outcomes:

- Understand how to implement AI algorithms for dynamic resource management and auto-scaling in cloud environments.
- Overview how to use machine Learning models for analyzing usage patterns and predicting resource requirements in cloud environments.
- Overview to describe and implement AI algorithms for data classification and storage optimization in cloud environments.
- Understand AI-driven security tools for real-time monitoring and incident response in cloud environments.
- Understand software development lifecycle.
- Overview how to implement AI-powered analytics for monitoring and optimizing cloud resource allocation.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the principles of cloud computing and resource management. • Overview of auto-scaling techniques and their significance in cloud environments. • Fundamentals of machine Learning and its applications in resource prediction. • Understand different techniques for analyzing usage patterns in cloud environments. • Overview of cloud security challenges and threats. • Understand AI-driven security tools and their functionalities. • Importance of real-time monitoring and anomaly detection in cloud environments. • Overview of AI algorithms for storage	• Define auto-scaling policies based on workload metrics. • Explain how machine Learning models to analyze historical usage data. • Define how AI-driven security solutions for continuous monitoring of cloud environments. • Explain the functionalities of automated responses to detect security incidents. • Explain how AI algorithms to classify and optimize data storage in the cloud. • Explain how AI tools to automate testing and deployment processes. • Define how to set up monitoring systems to track application performance of post-deployment.

optimization and retrieval. • Importance of efficient data management in cloud environments. • Understand the role of AI in automating develop tasks. • Understand cloud cost management principles and analytics.	• Explain how AI-powered analytics to track and forecast cloud spending.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis tools (e.g., Pandas, NumPy), Machine Learning frameworks (e.g., Scikit-learn / TensorFlow), CI/CD tools (e.g., Jenkins/ GitLab CI), AI tools for automation (e.g., Ansible), Analytics and visualization tools (e.g., Apache Superset)	

Module 6: Advancement in AI for CS and IT
Mapped to ICE/N1904, v1.0

Terminal Outcomes:

- Understand about research and developing advanced AI algorithms.
- Understand about to develop and deploying AI-powered decision support.
- Overview how to explore and demonstrate AI technologies application.
- Overview how to implement AI solutions that modernize and enhance legacy IT systems.
- Overview how to design AI systems capable of continuous Learning.

Duration (in hours): 10:00	**Duration (in hours): 20:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Fundamentals of algorithm design and optimization in AI. • Overview of neural network architectures and their advancements. • Understand principles of computational efficiency in algorithm development. • Overview of decision support systems and understand the role in organizations. • Overview of AI applications in different industries (healthcare, finance and transportation). • Understand industry-specific challenges and opportunities for AI implementation. • Fundamentals of continuous Learning and adaptive AI systems. • Overview of algorithms and techniques for real-time data processing.	• Explain how to design and develop AI-powered decision support systems. • Explain how to develop prototype or project demonstrating AI solutions for a specific industry. • Explain how to design and implement AI systems to support continuous learning capabilities.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment,	

PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Programming languages (e.g., Python) and libraries (e.g., TensorFlow / PyTorch/keras), AI and data analytics tools (e.g., TensorFlow / R /Python), Visualization tools for presenting insights (e.g., Apache Superset)

Elective 2: Electronics & Communication Engineering

Module 1: Utilize AI tools /algorithms in Signal Processing

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Overview how to effectively employ adaptive filtering algorithms to enhance signal quality in response to noise and signal characteristics.
- Understand how to utilize machine Learning techniques for automated feature extraction from complex signals, enhancing classification and analysis performance.
- Overview how to implement deep Learning models for effective noise reduction in signals, enhancing clarity and quality in audio and communication systems.
- Understand of AI techniques for classifying modulation schemes, facilitating improved spectrum management and efficient signal processing.
- Overview how to leverage AI-driven tools for real-time signal analysis, enabling immediate detection of anomalies in various applications.
- Understand how to utilize predictive analytics powered by AI to monitor signal processing equipment health, enabling timely maintenance and minimizing downtime.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand of algorithms used for adaptive filtering (e.g., LMS, RLS) applications. • Understand of machine learning methods for automated feature extraction (e.g., PCA, wavelet transforms). • Introduction to deep Learning and its applications in signal processing. • Overview of modulation schemes used in communication systems (E.g., AM, FM and QAM). • Understand of AI techniques for classification tasks (e.g., supervised Learning and neural networks). • Overview of real-time signal analysis and its significance in telecommunications and radar systems. • Understand of AI tools and techniques for anomaly detection (E.g., unsupervised Learning and clustering).	• Explain how filter performance for real or simulated noisy signals. • Explain how to apply machine Learning algorithms to extract features from complex signal datasets. • Explain how to design and implement deep learning models for noise reduction tasks. • Define how to evaluate model performance using metrics such as Signal-to-Noise Ratio (SNR). • Explain the functionalities of classification models to identify different modulation schemes from signal data. • Define how to validate model accuracy using performance metrics (e.g., accuracy and confusion matrix). • Explain the functionalities of predictive models to monitor signal processing equipment health using historical data. • Define how to use AI tools for real-time signal processing systems for anomaly detection.
Classroom Aids:	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Octave or Python with signal processing libraries (e.g., SciPy), Python with machine Learning	

libraries (e.g., scikit-learn/ TensorFlow), Software tools for visualizing extracted features (e.g., Matplotlib), Deep Learning frameworks (e.g., TensorFlow / Keras), AI-driven analytics platforms (e.g., Apache Kafka / TensorFlow), Data analytics and machine Learning tools (e.g., Python with scikit-learn).

Module 2: Use AI tools /algorithms in Communication Systems

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Overview how to effectively utilize AI algorithms to improve channel estimation and equalization techniques, enhancing signal integrity and reducing interference.
- Understand how to implement AI-driven strategies for dynamic resource allocation, optimizing bandwidth usage, and improving network efficiency based on real-time traffic demands.
- Overview to describe and implement machine Learning algorithms develop intelligent routing protocols, optimizing data paths and enhancing network performance.
- Understand how to use AI techniques to monitor and manage QoS parameters, ensuring optimal performance.
- Overview how to leverage AI tools to detect and respond to security threats in communication systems, ensuring data integrity and confidentiality.
- Understand how to integrate AI algorithms into signal processing chains, enabling adaptive modulation and interference management for enhanced signal robustness and clarity.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss AI algorithms (e.g., neural networks and support vector machines) for improving channel estimation and equalization. • Understand AI-driven strategies (e.g., reinforcement Learning and predictive modelling) for dynamic resource allocation. • Overview routing protocols and understands the role in communication networks. • Understand machine Learning algorithms (e.g., decision trees and genetic algorithms) used develop intelligent routing protocols. • Understand AI techniques (e.g., predictive analytics and clustering) for monitoring and managing QoS. • Understand AI tools and techniques (e.g., anomaly detection and machine learning classifiers) used for threat detection and response. • Overview of signal processing chains in communication systems and understand the role of modulation and coding techniques.	• Explain the functionalities of AI algorithms to enhance channel estimation and equalization in simulated communication environments. • Define how to measure and analyze bandwidth usage for network efficiency improvements. • Explain how to use machine Learning algorithms to design and simulate intelligent routing protocols. • Explain how to perform traditional vs. AI-optimized routing protocols in terms of latency. • Define how AI techniques for monitoring QoS parameters in a simulated communication network.
Classroom Aids:	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	

Tools, Equipment and Other Requirements
Simulation tools (e.g., Octave/ Python), Network simulation software (e.g., NS3 / OPNET), AI libraries for implementing dynamic resource allocation (e.g., TensorFlow / PyTorch), Network simulation platforms (e.g., Cisco Packet Tracer/ GNS3), Network monitoring tools (e.g., Wireshark), AI frameworks for managing QoS (e.g., TensorFlow / Scikit-learn), Machine Learning libraries for developing intrusion detection systems (e.g., Scikit-learn), Simulation environments for signal processing (e.g., Octave/ Python).

Module 3: Use AI tools /algorithms in Embedded Systems and IoT

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Overview how to effectively employ AI algorithms for processing and analyzing data from smart sensors, enabling real-time decision-making in IoT applications.
- Understand how to utilize machine learning techniques to optimize energy consumption in embedded devices, enhancing battery life and performance in IoT applications.
- Overview how to implement AI-driven predictive analytics in embedded systems, enabling proactive maintenance and reducing downtime in IoT networks.
- Understand to describe and implementing AI algorithms for efficient data compression in IoT devices, ensuring reduced bandwidth usage and faster data transmission.
- Overview how to leverage AI tools for detecting anomalies in IoT data streams, enhancing security and reliability in embedded systems.
- Understand how to integrate AI algorithms into embedded control systems, improving responsiveness and functionality in dynamic environments for IoT devices.

Duration (in hours): 08:00	Duration (in hours): 15:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of smart sensors and their Understand the role in IoT applications. • Understand of AI algorithms (e.g., neural networks and decision trees) used for data processing and analysis. • Overview of machine Learning techniques (e.g., regression analysis, reinforcement Learning) for adaptive power management. • Overview of predictive analytics and its importance in IoT device maintenance. • Understand of AI techniques (e.g., time series analysis and regression models) used for performance monitoring and failure prediction. • Overview of data compression techniques and their significance in IoT applications. • Understand of AI algorithms (e.g., autoencoders and clustering techniques) used for efficient data compression. • Introduction to anomaly detection and its importance in securing IoT environments. • Understand of AI tools and algorithms (e.g., clustering and supervised Learning)	• Explain the functionalities of AI algorithms to analyze data from smart sensors in a simulated IoT environment. • Explain how machine Learning models to analyze energy consumption data from embedded devices. • Explain the functionalities of AI algorithms to achieve data compression in IoT device data streams. • Explain how to use AI tools for anomaly detection systems for IoT data streams.

used for detecting anomalies in data streams. • Overview of embedded control systems and their Understand the role in IoT applications. • Understand of AI algorithms (e.g., fuzzy logic and reinforcement Learning) that enable adaptive and intelligent control.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Simulation tools for IoT environments (e.g., Cisco Packet Tracer), Machine Learning libraries (e.g., Scikit-learn / PyTorch) for model development, AI frameworks (e.g., TensorFlow/ Keras), Data analysis tools (e.g., Jupyter Notebook), Arduino IDE.	

Module 4: Utilize AI tools /algorithms in VLSI Design and Hardware Optimization

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Overview how to utilize AI algorithms to automate the circuit design process, leading to faster design iterations and improved accuracy in VLSI layout generation.
- Understand how to implement machine Learning techniques for efficient design rule checking in VLSI designs, ensuring compliance and reducing fabrication errors.
- Overview to describe and implement AI-driven strategies to optimize power consumption in VLSI circuits, enhancing energy efficiency based on workload requirements.
- Understand how to leverage predictive analytics powered by AI to forecast the performance of VLSI designs.
- Overview to employ AI algorithms for fault detection and diagnosis in VLSI circuits.
- Understand how to use AI tools to optimize the physical layout of VLSI components, improving efficiency and signal integrity.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms (e.g., genetic algorithms and reinforcement Learning) for circuit design automation. • Understand of machine Learning techniques (e.g., supervised Learning and anomaly detection) applied to DRC. • Overview of power consumption challenges in VLSI circuits. • Introduction to predictive analytics and understand the role in VLSI design. • Understand AI techniques (e.g., regression models and neural networks) for	• Explain the functionalities of AI algorithms in a software environment to automate circuit design tasks. • Define how machine Learning models for DRC in a VLSI design environment. • Explain the functionalities of AI algorithms for fault detection in VLSI designs. • Explain how AI tools to optimize the physical layout of VLSI components. • Define how genetic algorithms and simulated annealing are using for layout

performance forecasting. • Overview of fault detection and diagnosis in VLSI design. • Understand AI algorithms (e.g., classification algorithms and unsupervised Learning) used for fault detection.	optimization.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI frameworks (e.g., TensorFlow/ Keras), Design verification tools (e.g. Calibre), and Machine Learning libraries (e.g., Scikit-learn / PyTorch), , Development environments (e.g., Octave), Data analysis tools (e.g., Python/ R), Visualization tools (e.g., Tableau/ Matplotlib), Fault simulation tools for VLSI designs (e.g., ATPG tools), AI libraries (e.g., TensorFlow/Scikit-learn)	

Module 5: Use AI tools /algorithms in Robotics and Autonomous Systems

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for efficient path planning and navigation, enabling autonomous robots to navigate complex environments in real-time.
- Overview how to implement machine Learning techniques for integrating data from multiple sensors, enhancing the accuracy and reliability of environmental perception in robotics.
- Understand to describe AI-driven decision-making algorithms, enabling robots to analyze situations.
- Overview how to leverage NLP and computer vision algorithms for facilitating intuitive human-robot interaction, allowing robots to understand and respond to human commands effectively.
- Understand how to use AI tools to develop robust control systems in robotics, ensuring stability and performance under varying operational conditions.
- Overview to employ reinforcement learning techniques to enable robots to Understand and improve their skills autonomously over time, enhancing their capability to perform complex tasks.

Duration (in hours): 07:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of path planning algorithms (e.g., A*, Dijkstra's algorithm, Rapidly-exploring Random Tree (RRT)). • Discuss importance of real-time navigation and obstacle avoidance in autonomous systems. • Overview of sensor fusion techniques and their significance in robotics. • Introduction of machine Learning models (e.g., Kalman filters, neural networks) for data integration. • Introduction of decision-making	• Explain the functionalities of AI path planning algorithms in a simulated environment for autonomous robots. • Explain how machine learning models to integrate data from various sensors. • Explain the functionalities of NLP algorithms to process and understand human commands. • Explain the functionalities of computer vision algorithms to enable gesture recognition and response capabilities. • Explain the functionalities of control

frameworks (e.g., Markov Decision Processes and decision trees). • Discuss on risk assessment techniques and their application in autonomous robotics. • Introduction to NLP concepts and their application in robotics. • Overview of computer vision techniques for recognizing human gestures and expressions. • Discuss on the significance of human-robot interaction in autonomous systems. • Overview of control theory and its application in robotics. • Introduction of AI tools for developing adaptive control systems (e.g., PID controllers and fuzzy logic controllers). • Discuss on the importance of trial and error in autonomous Learning.	algorithms in robotic systems. • How reinforcement learning models using for robotic applications.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Robotics simulation software (e.g., Gazebo), Programming languages (e.g., Python/ C++), Sensor hardware (e.g., cameras), Machine Learning libraries (e.g., TensorFlow/Scikit-learn), Simulation software (e.g., Octave)), Programming tools for implementing algorithms (e.g., Python/C++), NLP libraries (e.g., NLTK/ SpaCy), Computer vision frameworks (e.g., OpenCV/TensorFlow), Control system design software (e.g., Octave)	

Module 6: Utilize AI tools /algorithms in Wireless Communication and Network Optimization

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for dynamic allocation and management of spectrum resources, optimizing frequency usage and minimizing interference in wireless communication.
- Overview how to implement machine Learning techniques for predicting network traffic patterns.
- Understand how to describe and implementing AI-driven methods to enhance QoS in wireless networks.
- Overview how to leverage AI tools to implement adaptive modulation and coding schemes, optimizing data transmission rates according to channel conditions.
- Understand how to use AI algorithms to detect anomalies in wireless network traffic, facilitating rapid identification of security threats and performance issues for timely interventions.
- Overview to employ AI techniques to optimize energy consumption in wireless communication systems, enhancing battery life and reducing energy costs while maintaining performance.

Duration (in hours): 07:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction of AI algorithms for dynamic spectrum allocation (e.g., reinforcement Learning and genetic algorithms). • Overview of machine Learning techniques for traffic prediction (e.g., time series analysis, supervised Learning). • Overview of Quality of Service (QoS) concepts in wireless communication. • Introduction to AI-driven methods for enhancing QoS (e.g., adaptive resource allocation, machine learning for QoS metrics). • Discuss on the importance of real-time performance metrics in QoS management. • Overview of modulation and coding schemes in wireless communication. • Introduction to adaptive modulation and coding techniques and their significance. • Discuss on AI tools and algorithms that facilitate adaptive modulation based on channel conditions. • Introduction of anomaly detection techniques in network security. • Overview of AI algorithms for detecting anomalies (e.g., supervised and unsupervised Learning techniques). • Introduction of AI techniques for optimizing energy usage (e.g., predictive modelling and energy-efficient protocols).	• Explain the functionalities of AI algorithms for dynamic spectrum allocation in a simulated wireless environment. • Define how machine learning models to analyze and predict network traffic patterns. • Explain AI-driven methods to adjust bandwidth allocation and latency management in a simulated wireless environment. • How adaptive modulation and coding schemes work in a wireless communication simulation. • Explain the functionalities of AI algorithms for anomaly detection in simulated wireless network traffic. • Explain AI techniques to analyze and optimize energy consumption in wireless communication systems.

Classroom Aids
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Wireless communication simulation software (e.g., NS3/Octave), Programming languages (e.g., Python/R), Machine Learning libraries (e.g., TensorFlow / Scikit-learn), Communication simulation software (e.g., Octave)), Machine Learning frameworks (e.g., Scikit-learn / Keras).

Module 7: Use AI tools /algorithms in Electronic System Design and Optimization

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for automatic design rule verification in electronic circuit layouts, ensuring compliance with industry standards and reducing manufacturing errors.
- Overview to describe and implement machine Learning techniques that enhance the speed and accuracy of circuit simulations, facilitating better design predictions.
- Understand how to leverage AI-driven optimization methods for effective resource allocation in electronic systems, improving performance while minimizing costs and material usage.
- Overview how to use AI tools to optimize PCB layouts, enhancing signal integrity, reducing electromagnetic interference, and improving overall circuit performance.
- Understand how to implement AI algorithms that enable adaptive adjustments during the design process, allowing for real-time modifications based on performance feedback.

Duration (in hours): 07:00	Duration (in hours): 15:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms for design rule verification (e.g., rule-based systems and neural networks). • Introduction of machine learning techniques for enhancing simulation speed and accuracy (e.g., surrogate modelling and regression analysis). • Overview of AI-driven optimization methods (e.g., genetic algorithms and particle swarm optimization). • Introduction of AI tools and algorithms for layout optimization (e.g., layout generation algorithms and optimization heuristics). • Overview of AI algorithms that facilitate real-time adjustments (e.g., reinforcement Learning and adaptive filtering).	• Explain the functionalities of AI algorithms to automatically verify design rules in electronic circuit layouts using simulation tools. • Define how machine Learning models to improve circuit simulation accuracy and speed. • Explain AI tools to optimize the layout of electronic components on PCBs. • Explain AI techniques to analyze and predict the reliability of electronic systems based on design parameters and environmental factors.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	

Tools, Equipment and Other Requirements
Programming languages (e.g., Python / C++), , Machine Learning frameworks (e.g., TensorFlow / Scikit-learn), Optimization software (e.g., Octave), PCB design software (e.g., KiCad), Programming languages (e.g., Python/ Octave

Module 8: Advancement in AI for ECE

Mapped to ICE/N1905, v1.0

Terminal Outcomes:

- Understand to develop advanced machine Learning algorithms tailored for ECE applications, particularly CNNs and RNNs for specific tasks in image and signal processing.
- Understand the advancements in AI-driven smart antenna technologies, enabling improved signal quality and capacity through adaptive techniques.
- Overview how to utilize AI for optimizing the design and management of 5G networks, enhancing performance metrics such as throughput and latency.
- Overview how to implement AI algorithms for real-time decision-making in robotics, enhancing navigation and task execution capabilities.
- Understand how to leverage AI for real-time fault detection and diagnosis, improving reliability, and implementing predictive maintenance strategies.
- Overview how to integrate AI with IoT devices for intelligent data processing and decision-making, enhancing communication efficiency in various applications.

Duration (in hours): 7:00	Duration (in hours): 15:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand CNNs architecture, functionalities, and applications in image processing. • Overview of RNNs architecture, time-series data processing, and relevance in signal processing. • Introduction of 5G network architecture and challenges. • Discuss AI techniques for optimizing network design: machine learning models for predicting network demand and traffic patterns. • Overview of smart antenna technologies and their importance in wireless communication. • Understand beamforming techniques and their impact on signal quality. • Understand of spatial multiplexing and its advantages for capacity enhancement. • Introduction of real-time decision-making in robotics and its significance. • Understand AI algorithms applicable for navigation and obstacle avoidance (e.g., Dijkstra's algorithm, A* algorithm). • Discuss on the importance of sensor data integration for task execution. • Discuss on the applications of AI and IoT in	• Explain the functionalities of CNNs for image classification tasks. • Define how RNN models using for analyzing and predicting time-series data. • Explain how to simulate 5G network scenarios using AI tools to analyze performance metrics. • Explain the functionalities of adaptive beamforming algorithms in simulated environments. • Explain the functionalities of AI algorithms for real-time fault detection in electronic systems. • Explain how to use AI models for processing data collected from IoT devices.

smart cities, healthcare, and industrial sectors.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Network simulation software (e.g., Octave/NS2), Robotics simulation platforms (e.g., Gazebo), Sensor hardware (e.g., cameras), Development environments for algorithm implementation (e.g., Python / C++), Data analytics tools (e.g., Python with Pandas/ Scikit-learn) for fault detection, AI tools for data processing (e.g., TensorFlow Lite/ Keras)	

Elective 3: Electrical Engineering

Module 1: Utilize AI tools /algorithms in Power Systems and Smart Grids

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand how to implement AI algorithms for real-time load forecasting in power systems, enhancing demand response and resource allocation.
- Overview how to utilize AI-driven techniques for automated fault detection and diagnosis in power systems, enhancing issue identification speed and accuracy.
- Understand how to apply machine Learning models for optimizing smart grid operations, enhancing energy distribution, and integrating renewable sources effectively.
- Understand how to utilize AI tools for analyzing consumption patterns and optimizing energy usage in energy management systems.
- Overview how to leverage AI algorithms for predictive maintenance of power system components, enhancing reliability and reducing maintenance costs.
- Understand how to implement AI techniques for analyzing smart meter data, enhancing billing accuracy, and supporting dynamic pricing models.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand various AI algorithms suitable for load forecasting (e.g., regression analysis and neural networks). • Understand AI-driven techniques, including supervised and unsupervised learning for fault detection. • Discuss on the benefits of automation in reducing downtime and improving maintenance strategies. • Overview of machine Learning models and their applications in optimizing energy distribution. • Understand AI tools for analyzing consumption patterns and their importance in demand-side management. • Overview of AI algorithms used for predictive maintenance (e.g., regression models and time-series analysis). • Understand AI techniques for analyzing smart meter data and their implications for consumer behaviour.	• Explain the functionalities of AI algorithms for real-time fault detection in power systems. • How machine Learning models to simulate smart grid operations and analyze energy distribution. • Explain how AI tools to analyze energy consumption data from different sources. • Explain how AI techniques to analyze data collected from smart meters.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics software (e.g., Python with Pandas, NumPy), Machine Learning frameworks (e.g., TensorFlow/ Scikit-learn), Software for data analysis and machine Learning (e.g., Octave/ Python), Machine Learning libraries (e.g., TensorFlow / Scikit-learn), Data analytics software (e.g., Python/ SQL), AI frameworks (e.g., TensorFlow/Keras), OpenDSS, PSCAD(Lite)	

Module 2: Use AI tools /algorithms in Control Systems and Automation

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand how to implement AI algorithms to develop adaptive control strategies, improving system performance and stability.
- Overview how to utilize machine Learning techniques to enhance Model Predictive Control.
- Understand to apply AI-driven fault detection and isolation algorithms to develop fault-tolerant control systems.
- Overview of AI tools to automate industrial processes, optimizing efficiency, reducing downtime, and enhancing safety.
- Understand how to leverage AI techniques to design robust control systems that handle uncertainties.
- Overview how to implement data-driven approaches in control systems to utilize AI algorithms to analyze historical data for improving strategies and designs.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand various AI algorithms (E.g., reinforcement Learning and fuzzy logic) for real-time adaptation. • Overview of performance metrics for assessing system stability and performance. • Overview of Model Predictive Control (MPC) and its applications in control systems. • Introduction of machine Learning techniques (e.g., neural networks and regression models) to enhance MPC. • Introduction to fault detection and isolation (FDI) concepts in control systems. • Understand AI-driven algorithms (E.g., decision trees, Bayesian networks) for fault tolerance. • Overview of automation concepts in industrial processes. • Overview AI tools (e.g., neural networks and genetic algorithms) for intelligent control. • Introduction to robust control design and its importance in engineering applications. • Understand AI techniques (e.g., fuzzy logic and robust optimization) for handling uncertainties. • Overview AI algorithms (e.g., clustering and classification) for analyzing historical data.	• Explain how machine learning techniques to improve MPC algorithms. • Explain the functionalities of AI-driven fault detection and isolation algorithms in a control system. • How to enhance safety for automated control systems. • Explain how to use AI techniques for robust control systems.
Classroom Aids	

Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Simulation software (e.g., Octave), Software for control system design (e.g., Octave/ Python with SciPy), Machine Learning libraries (e.g., TensorFlow / Scikit-learn), Data analytics tools for performance evaluation (e.g., Python / Excel), Control design software (e.g., Octave), Data analysis software (e.g., Python/R), , OpenModelica

Module 3: Utilize AI tools /algorithms in Signal Processing and Communication Systems

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Overview to develop and implement AI algorithms for advanced filtering techniques that improve communication system signal quality and clarity.
- Understand to implement machine Learning models for automatic modulation classification, enabling adaptive responses to different communication channel conditions.
- Understand how to leverage AI techniques for adaptive equalization to maintain signal integrity in communication systems.
- Understand to utilize AI-driven methods for speech recognition and audio processing, enhancing applications in voice communication and audio quality.
- Overview to apply deep Learning algorithms in image and video signal processing, improving compression, resolution, and enabling real-time analysis.
- Understand the functionalities of AI-based algorithms for cognitive radio networks, optimizing spectrum resource allocation and reducing interference among users.

Duration (in hours): 08:00	**Duration (in hours): 15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of filtering techniques, including traditional and AI-based approaches (e.g., Kalman filters and neural networks). • Discuss machine Learning models (e.g., support vector machines, decision trees) for modulation classification. • Introduction to image and video signal processing concepts. • Overview of deep Learning algorithms (e.g., Convolutional neural networks) for processing images and videos. • Introduction to cognitive radio networks and their significance in wireless communications.	• Explain the functionalities of AI-driven methods for speech recognition and audio processing. • Explain the functionalities of deep Learning algorithms for image and video signal processing tasks. • Explain the functionalities of AI-based algorithms for dynamic spectrum allocation in cognitive radio networks.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	

Tools, Equipment and Other Requirements
Signal processing software (e.g., Octave/Python with SciPy), Equipment for real-time signal acquisition (e.g., microphones/sensors), Machine Learning frameworks (e.g., TensorFlow/ PyTorch), Simulation tools for generating communication signals (e.g., Octave), Simulation software for communication systems (e.g., Octave / GNU Radio), Speech recognition libraries (e.g., Google Speech-to-Text /CMU Sphinx), Audio processing tools (e.g., Audacity), Deep Learning frameworks (e.g., TensorFlow / Keras), Image and video processing software (e.g., OpenCV), Cognitive radio simulation tools (e.g.Octave/ NS-3).

Module 4: Use AI tools /algorithms in Electronics and Embedded Systems

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Overview how to utilize AI algorithms in embedded systems, enabling smart sensors.
- Understand how to implement AI techniques in electronics design to optimize power consumption in embedded systems.
- Overview machine learning models to predict failures and maintenance needs in embedded systems.
- Understand how to apply AI-driven algorithms to automate the configuration and tuning of embedded systems.
- Understand how to use AI tools for real-time data processing in embedded systems.
- Overview how to develop adaptive control algorithms for embedded systems.

Duration (in hours): **08:00**	**Duration (in hours)**: **15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to embedded systems and smart sensors. • Overview of AI algorithms for data processing and decision-making (e.g., neural networks, decision trees). • Understand the role of smart sensors in environmental monitoring and healthcare. • Overview of AI techniques for optimizing energy efficiency (e.g., predictive modelling and optimization algorithms). • Overview of machine learning models suitable for failure prediction (e.g., regression analysis and time-series forecasting). • Overview of AI tools and algorithms suitable for immediate response (e.g., reinforcement Learning and neural networks). • Discussion on applications in robotics, automotive systems, and home automation.. • Understand of AI-driven algorithms for automation (e.g., genetic algorithms, gradient descent). • Discussion on the benefits of automation in performance enhancement. • Fundamentals of adaptive control algorithms in embedded systems.	• Explain the functionalities of AI algorithms in embedded systems for smart sensor applications. • Explain how AI techniques work in the design phase of embedded systems for power optimization. • Explain the functionalities of power consumption in battery-powered devices and IoT applications. • Explain the functionalities of AI-driven algorithms for automating configuration and tuning of embedded systems.

• Overview of learning techniques (e.g., supervised Learning, reinforcement learning) applicable to adaptive control.	

Classroom Aids
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
AI development frameworks for optimization (e.g., Keras/Scikit-learn), Machine Learning software (e.g., Python with Pandas/SciPy), , Simulation tools for embedded systems (e.g., Octave), AI development tools and libraries (e.g., TensorFlow / PyTorch).

Module 5: Utilize AI tools /algorithms in Renewable Energy Systems

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand how to implement AI algorithms to forecast renewable energy generation, optimizing energy dispatch and storage strategies effectively.
- Overview how to use AI tools for the integration of renewable energy sources into smart grids, enhancing load balancing and energy distribution efficiency.
- Understand how to apply AI-driven strategies for demand response programs, aligning consumer energy usage with renewable energy supply and enhancing grid stability.
- Overview how to leverage machine Learning models to optimize energy storage system management and operations.
- Understand how to utilize AI techniques for predictive maintenance in renewable energy systems, enabling early fault detection and minimizing operational downtime.
- Understand how to implement AI algorithms to optimize the performance of hybrid renewable energy systems, ensuring efficient energy production, consumption, and cost minimization.

Duration (in hours): 07:00	**Duration (in hours):15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms for forecasting (e.g., time-series analysis, regression models). • Overview of AI tools for load balancing and energy distribution (e.g., reinforcement Learning, optimization algorithms). • Overview of machine learning models applicable to energy management (e.g., supervised Learning and predictive analytics). • Understand of AI techniques for fault detection (e.g., anomaly detection, machine learning classification). • Fundamentals of hybrid renewable energy systems and their components.	• Explain the functionalities of renewable energy sources into smart grid systems. • Define the strategies of simulations to test dynamic load balancing and energy distribution. • Explain how machine learning models to analyze energy storage system performance and optimize operations. • Explain the functionalities of AI algorithms to analyze and optimize the performance of hybrid renewable energy systems.

• Overview of AI algorithms for performance optimization (e.g., multi-objective optimization and genetic algorithms).	

Classroom Aids
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Data analysis software (e.g., Python/R) with libraries for machine Learning (e.g., Scikit-learn / TensorFlow), Smart grid simulation software (e.g., Octave/ GridLAB -D), AI development environments for implementing algorithms (e.g., Python / Octave), Machine Learning frameworks (e.g., TensorFlow/Keras), Machine Learning software (e.g., TensorFlow/ Python), Hybrid energy system modelling software (e.g., Octave), eQuest.

Module 6: Use AI tools /algorithms in Robotics and Autonomous Systems

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand how to implement AI algorithms for real-time path planning and obstacle avoidance, enhancing navigation capabilities in autonomous vehicles and robotic systems.
- Overview how to use computer vision techniques powered by AI for robot perception, enabling effective object recognition and manipulation.
- Understand how to leverage AI for sensor data integration in robotic systems, enhancing environmental perception and decision-making accuracy.
- Understand how to apply machine Learning algorithms for adaptive control in robotics, enabling systems and optimize performance.
- Overview how to utilize AI tools to enhance human-robot interaction through NLP and gesture recognition, facilitating intuitive communication and collaboration.
- Understand how to implement AI-driven strategies for coordinating multiple robotic units in swarm robotics, optimizing task distribution and improving efficiency.

Duration (in hours): **07:00**	**Duration (in hours)**:**15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Fundamentals of path planning algorithms (e.g., A*, Dijkstra's algorithm). • Overview of real-time systems and their requirements for navigation. • Basics of computer vision and its importance in robotics. • Understand AI techniques for object recognition and classification (e.g., convolutional neural networks). • Overview of sensor fusion techniques and their applications in robotics.	• Explain the functionalities of AI algorithms for real-time drone path planning. • Explain the functionalities of computer vision algorithms for object recognition and classification. • Explain the functionalities of sensor fusion algorithms to integrate data from LiDAR, cameras, and IMUs. • Explain the functionalities of NLP algorithms for processing and interpreting human language commands.

• Fundamentals of Kalman filters and other sensor fusion algorithms. • Fundamentals of natural language processing (NLP) and its application in robotics. • Overview of gesture recognition techniques and their importance for interaction. • Introduction to swarm robotics and its principles.	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Simulation software (e.g., Gazebo), Programming languages (e.g., Python/C++), Sensor hardware for obstacle detection (e.g., ultrasonic sensors/cameras), Computer vision libraries (e.g., OpenCV/TensorFlow), Camera systems for image acquisition (e.g., RGB cameras/depth cameras), Development environment for algorithm implementation (e.g., Jupyter Notebook/PyCharm), , Machine Learning frameworks (e.g., TensorFlow/PyTorch), Simulation tools for testing control algorithms (e.g., Octave), NLP libraries (e.g., NLTK/ SpaCy), Swarm robotics simulation tools (e.g., Webots), Development platforms for algorithm implementation (e.g., Python/C++).	

Module 7: Utilize AI tools /algorithms for Electric Vehicles

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms to optimize battery performance in electric vehicles, leading to improved charge/discharge cycles and extended battery life.
- Overview how to implement machine Learning models for predicting failures and maintenance needs in critical EV components, thereby reducing downtime and operational costs.
- Understand how to leverage AI tools to optimize real-time energy consumption in electric vehicles, maximizing driving range based on conditions and user preferences.
- Understand how to apply AI algorithms to develop autonomous driving features in electric vehicles, enhancing functionalities such as lane-keeping and collision avoidance.
- Overview AI-driven solutions to optimize EV charging station placement and utilization, enhancing accessibility and reducing waiting times.
- Understand how to utilize AI tools to improve regenerative braking efficiency in electric vehicles, enabling adaptive systems that recover energy during deceleration.

Duration (in hours): 07:00	**Duration (in hours):15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI in optimizing battery management systems. • Overview of machine learning models applicable to failure prediction (e.g., regression models, neural networks). • Overview of autonomous driving systems and their components. • Understand the role of AI in perception,	•Explain how to monitor and analyze energy efficiency improvements in electric vehicles. •Explain the functionalities of AI algorithms for lane-keeping, collision avoidance, and parking assistance. •Explain the functionalities of AI algorithms to analyze driving patterns and optimize regenerative braking. •Explain the functionalities of AI algorithms for optimizing charging station placement based on

decision-making, and control for autonomous vehicles. • Understand the role of AI in adapting regenerative braking strategies for maximum energy recovery.	usage data and geographical factors.

Classroom Aids
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software
Tools, Equipment and Other Requirements
Programming languages (e.g., Python/Octave), Data analysis tools (e.g., R/ Python libraries like Scikit-learn), Development platforms for autonomous vehicle simulations (e.g., Webots), Sensor hardware (e.g., camera), Programming languages and tools for AI implementation (e.g., Python / TensorFlow).

Module 8: Advancement in AI for Electrical Engineering

Mapped to ICE/N1906, v1.0

Terminal Outcomes:

- Understand advanced AI algorithms for real-time monitoring, control, and optimization of smart grids, enhancing power distribution and renewable energy integration.
- Fundamentals how to utilize AI tools to predict and manage voltage and frequency fluctuations, enhancing grid stability and preventing blackouts.
- Overview how to apply AI-driven solutions for optimizing the integration of renewable energy sources, managing variability, and improving storage efficiency.
- Understand to develop AI-based adaptive systems that dynamically adjust energy consumption and distribution, enhancing overall energy efficiency.
- Overview of AI tools to analyze large datasets from electrical grids, predicting faults or cyber threats, and improving grid resilience.
- Understand how to implement AI algorithms to manage and optimize electric vehicle charging networks, ensuring efficient load balancing and enhancing user experience.

Duration (in hours): 07:00	**Duration (in hours):15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of advanced AI algorithms (e.g., reinforcement Learning and neural networks) used for real-time monitoring and control. • Overview of AI tools and techniques (e.g., predictive analytics, time series forecasting) used for fluctuation management. • Introduction to AI-driven solutions for energy management (e.g., optimization algorithms, machine learning models). • Overview of AI techniques for real-time data analysis and decision-making (e.g., fuzzy logic, adaptive control). • Introduction to grid resilience and the impact of faults and cyber threats • Introduction of AI algorithms for load	• Explain the functionalities of AI algorithms to monitor power flow and control grid operations in real time. • Explain the functionalities of AI algorithms to optimize renewable energy generation and storage management. • Explain the functionalities of AI algorithms to analyze large datasets for fault and threat detection.

balancing and optimization (e.g., linear programming and neural networks).	
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Programming environments (e.g., Python/Octave), Data analysis software (e.g., R/Python), and Data processing tools (e.g., Apache Spark / TensorFlow).	

Elective 4: Mechanical Engineering

Module 1: Utilize AI tools /algorithms in Product Development

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to enhance product design processes, optimizing mechanical components for efficiency, performance, and cost-effectiveness.
- Overview of AI tools to generate innovative design solutions automatically, fostering creativity in product development.
- Understand AI tools to predict product performance through simulations, allowing for early identification of design flaws and reducing the need for physical prototypes.
- Overview how to implement AI algorithms to analyze material properties, aiding in the selection of appropriate materials for product development.
- Understand AI tools to streamline the prototyping process, reducing lead time and costs through efficient 3D printing and manufacturing simulations.

Duration (in hours): **08:00**	**Duration (in hours)**: **15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms applicable in design optimization (e.g., genetic algorithms and gradient descent). • Concepts of generative design and the Understand the role of AI in exploring design alternatives. • Overview of simulation techniques such as finite element analysis (FEA) and computational fluid dynamics (CFD). • Overview of AI algorithms used for material property analysis (e.g., machine Learning and decision trees). • Overview of 3D printing technologies and understand the role in rapid prototyping. • Understand the integration of AI in manufacturing simulations to enhance efficiency. • Overview of AI techniques for data analysis (e.g., predictive analytics and clustering).	• Explain the functionalities of AI algorithms to run performance simulations, including stress tests and fatigue analysis. • Explain the functionalities of AI algorithms to analyze and compare various materials based on specific performance criteria. • Explain the different case studies on material selection processes using AI. • Define how AI tools to optimize 3D printing processes and manufacturing simulations.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI tools for data analysis and predictive modeling (e.g., TensorFlow/Octave), Data analysis software (e.g., R/ Python), AI tools for predictive modelling and analytics (e.g., Scikit-learn), FreeCAD, Blender	

Module 2: Use AI tools /algorithms in Manufacturing and Production Systems

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to predict equipment failures, enabling proactive maintenance scheduling and extending equipment lifespan.
- Overview how to apply AI tools to optimize manufacturing processes.
- Understand how to integrate AI with robotics to automate complex manufacturing tasks, enhancing efficiency and flexibility in production lines.
- Understand how to use AI-driven visual inspection systems to automatically detect defects, improving product reliability and quality assurance.
- Overview of AI tools for demand forecasting and inventory management, optimizing supply chain operations.
- Understand how to implement AI for creating adaptive manufacturing systems.

Duration (in hours): 08:00	**Duration (in hours):15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms used for failure prediction (e.g., regression models and neural networks). • Understand key performance indicators (KPIs) in manufacturing and how AI can enhance them. • Overview of data analysis techniques in the context of production optimization. • Overview of robotics in manufacturing and the Understand the role of AI in automation. • Understand the integration of AI with robotic systems for enhanced performance. • Overview of AI techniques used for image recognition and defect detection (e.g., Convolutional neural networks). • Understand the impact of reducing human error in quality assurance processes. • Overview of AI algorithms used for forecasting (e.g., time series analysis, machine Learning).	• Explain the functionalities of AI algorithms to analyze historical data for predicting equipment failures. • Explain how AI tools to monitor and analyze real-time production data. • Explain how to work AI-driven visual inspection systems in manufacturing processes. • Explain how AI models work on defect detection using historical product images. • Explain how to use inventory management strategies based on AI predictions to minimize delays. • Explain how simulations to evaluate the effectiveness of AI-driven supply chain optimizations.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics software (e.g., Octave/ Python), Data visualization tools (e.g., Apache Superset), Imaging systems (e.g., cameras and scanners), AI image processing software (e.g., TensorFlow / OpenCV)	

Module 3: Utilize AI tools /algorithms in Predictive Maintenance and Reliability Engineering

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Overview how to implement AI tools for continuous equipment monitoring, enabling the early prediction of potential failures based on abnormal patterns.
- Understand how to utilize AI algorithms for developing predictive models, allowing timely maintenance of mechanical components.
- Overview how to apply machine Learning techniques for analyzing operational datasets, enhancing equipment reliability, and reducing unexpected breakdowns.
- Overview of AI-powered anomaly detection systems to identify early signs of machinery wear or degradation, facilitating timely interventions.
- Understand how to leverage AI tools for optimizing maintenance planning, ensuring effective repairs and replacements while minimizing downtime.

Duration (in hours): **08:00**	**Duration (in hours)**: **15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of key parameters to monitor (vibration and temperature, etc.) • Discuss of various AI algorithms suitable for predictive modelling (e.g., regression analysis and neural networks). • Discuss of AI techniques for anomaly detection (e.g., clustering, statistical methods). • Overview of AI algorithms used for optimization in maintenance scheduling. • Understand how AI can facilitate automated analysis of failures. • Discuss how algorithms are suitable for root cause identification (e.g., decision trees and random forests).	• Explain how AI tools to analyze data and identify abnormal patterns indicating potential failures. • Explain how AI-powered anomaly detection systems in manufacturing environments. • Explain how AI tools to analyze maintenance data and predict optimal repair or replacement times. • Explain the functionalities of AI algorithms for conducting root cause analysis on equipment failures.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics software (e.g., Python/ R), Statistical software (e.g. Octave), Access to machine learning platforms (e.g., TensorFlow/ Scikit-learn), Machine Learning frameworks (e.g., Keras/ PyTorch), Data processing tools (e.g., Hadoop / Apache Spark), Visualization software (e.g., Apache Superset), Data analysis tools (e.g., Python/ R).	

Module 4: Use AI tools /algorithms in Control Systems and Automation

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Overview how to utilize AI algorithms to create adaptive control systems that autonomously adjust operational parameters for optimized performance and efficiency.
- Understand how to apply AI-based predictive models to enhance control actions, improving response times and reducing errors in automated processes.
- Understand how to implement AI tools for self-optimizing control systems, enhancing accuracy while reducing the need for manual interventions in automation processes.
- Overview how to utilize AI algorithms for detecting faults and anomalies in control systems, enabling timely diagnosis and corrective actions to prevent downtime.
- Overview how to integrate AI into automation systems, enhancing robustness and flexibility for efficient task handling with minimal human oversight.
- Understand AI tools for analyzing control system data, optimizing energy consumption without compromising performance.

Duration (in hours): **08:00**	**Duration (in hours)**:**15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Principles of adaptive control systems and their importance in automation. • Overview of AI algorithms used for real-time data processing and decision-making. • Overview of predictive modelling concepts in automation. • Discussion of AI algorithms suitable for predictive modelling in control systems. • Principles of self-optimizing systems and their relevance in automation. • Overview of machine learning techniques for continuous Learning and optimization. • Understand the principles of integrating AI into automation systems and its benefits. • Overview how AI can analyze data for energy efficiency.	• Explain how to utilize AI algorithms for adaptive control systems. • Explain how AI tools to facilitate continuous learning in control systems. • Define different strategies for minimizing manual intervention through automation. • Explain the functionalities of AI algorithms for real-time fault detection and anomaly diagnosis. • Explain how AI integration in existing automation systems to enhance flexibility and robustness.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Control system software (e.g., Octave), AI development platforms (e.g., TensorFlow/ PyTorch), Machine Learning platforms (e.g., Scikit-learn/ Keras), Data analysis tools for interpreting control system performance (e.g., Python/Octave), OpenSim.	

Module 5: Utilize AI tools /algorithms in Fluid Mechanics and Thermal Systems

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Overview how to utilize AI algorithms to predict complex flow patterns, enhancing the design and optimization of fluid transport systems.
- Understand how to apply AI tools to optimize the performance of thermal systems, improving heat transfer efficiency and energy consumption.
- Overview how to integrate AI with CFD simulations to enhance accuracy while reducing computational time and cost.
- Understand how to use AI algorithms for real-time monitoring of fluid and thermal systems, enabling predictive maintenance and anomaly detection.
- Understand the concept how to leverage AI tools to analyze operational data in thermal systems, improving energy efficiency and reducing costs and environmental impact.
- Understand of AI-driven optimization techniques to enhance the design of fluid mechanics components, ensuring better performance across varying conditions.

Duration (in hours): **07:00**	**Duration (in hours)**: **15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms used for predictive modelling in fluid systems. • Understand heat transfer principles and the role of AI in enhancing system efficiency. • Overview of AI techniques that enhance CFD simulations. • Overview of AI algorithms suitable for monitoring fluid and thermal systems. • Overview of energy efficiency metrics and the importance of data analysis in thermal systems. • Overview of AI-driven optimization techniques applicable in fluid mechanics.	• Explain the functionalities of AI algorithms to analyze and predict flow patterns in fluid systems. • Explain how AI tools to analyze data from thermal systems for performance optimization. • Explain the functionalities of simulation software to model thermal system performance pre- and post-optimization. • Explain the functionalities of AI algorithms to improve the efficiency of CFD simulations. • Explain the functionalities of AI algorithms for real-time monitoring of fluid and thermal systems.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI development platforms (e.g., Python with TensorFlow / Keras), AI frameworks for data analysis (e.g., R/ Octave), AI tools for machine Learning and data analysis (e.g., Scikit-learn/Octave), AI development environments (e.g., Python/ TensorFlow), Data visualization tools (e.g., Apache Superset), Data analytics platforms (e.g., Octave/ Python with Pandas), OpenFoam, Salome,	

Module 6: Use AI tools /algorithms in Energy Systems and Sustainability

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to analyze energy usage patterns, optimizing mechanical systems for enhanced energy efficiency.
- Overview of AI tools to enhance the integration of renewable energy sources into existing energy systems, optimizing storage and distribution.
- Understand how to use AI for real-time monitoring and optimization of smart grids, ensuring efficient energy distribution and load balancing.
- Understand the concept how to leverage AI-driven predictive maintenance techniques to enhance the reliability and sustainability of energy systems.
- Understand how to implement AI tools to identify inefficiencies in mechanical processes, enhancing sustainability through waste and emissions reduction.
- Understand how to utilize AI to optimize energy storage systems, improving operational efficiency and ensuring energy availability.

Duration (in hours): **07:00**	**Duration (in hours)**:**15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms and machine learning techniques applicable for energy analysis. • Overview of AI tools for predicting energy generation and availability from renewable. • Overview of smart grid technology and its Understand the role in modern energy distribution. • Understand load balancing and its importance in minimizing energy losses. • Understand inefficiencies in mechanical processes and their impact on sustainability. • Importance of reducing waste and emissions in energy systems. • Overview of AI applications in optimizing charge/discharge cycles.	• Explain the functionalities of AI algorithms to collect and analyze energy usage data from mechanical systems. • Explain the functionalities of AI algorithms for real-time monitoring of smart grid performance and efficiency. • Explain how optimization techniques to achieve load balancing in response to demand fluctuations. • Define different AI-driven techniques for monitoring the health of energy systems.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI platforms for data analysis (e.g., Python with Scikit-learn /Octave), AI development platforms for predictive modeling (e.g., TensorFlow/ R), Data analysis tools (e.g., Python/Octave), AI frameworks for anomaly detection (e.g., TensorFlow/Keras), AI tools for data analysis and optimization (e.g., R/Python), AI frameworks for optimization modelling (e.g., SciPy/Octave).	

Module 7: Utilize AI tools /algorithms in Materials Science and Additive Manufacturing

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms for predicting the properties of new materials, enabling the design of advanced materials with specific characteristics.
- Overview how to apply AI tools to optimize additive manufacturing processes, enhancing print quality and minimizing waste.
- Understand how machine learning analyzes large datasets, accelerating the discovery of new materials for mechanical applications.
- Overview how to utilize AI for real-time monitoring and control of additive manufacturing processes, ensuring consistent product quality.
- Understand how to implement AI algorithms for life cycle assessments, identifying opportunities for sustainability in materials science.
- Fundamentals AI techniques to predict potential material failures, enabling proactive maintenance and improving reliability in mechanical components.

Duration (in hours): **07:00**	**Duration (in hours)**:**15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms used for predictive modelling (e.g., regression models and neural networks). • Importance of material property prediction in the development of advanced materials. • Principles of additive manufacturing and key parameters affecting print quality (e.g., temperature, speed and layer height). • Importance of minimizing defects and material waste in manufacturing. • Basics of machine Learning and its applications in materials science. • Principles of life cycle assessment (LCA) and its significance in materials science. • Overview of AI techniques applicable for conducting LCA (e.g., regression models and optimization algorithms).	• Define how AI tools to analyze and optimize parameters in 3D printing processes. • Explain the functionalities of algorithms to predict the potential of new materials based on existing data. • Define how AI techniques to analyze stress and strain data to predict potential material failures. • Explain the functionalities of AI systems for real-time monitoring of additive manufacturing processes.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Software for machine Learning (e.g., TensorFlow/Scikit-learn), Data analysis software (e.g., Python/ R/ Octave), AI tools for data analysis and optimization (e.g., Python / R), AI frameworks for predictive modelling (e.g., TensorFlow / Scikit-learn), Slic3r.	

Module 8: Advancement in AI for Mechanical Engineering

Mapped to ICE/N1907, v1.0

Terminal Outcomes:

- Understand how to utilize advanced machine Learning algorithms to analyze historical design data.
- Overview how to utilize AI technologies to enhance robotic systems in manufacturing and assembly lines.
- Understand how to implement AI-driven data analytics to optimize manufacturing processes.
- Overview how to develop AI-integrated smart materials.
- Understand how to develop predictive maintenance algorithms.
- Overview how to leverage AI technologies in simulation tools to create virtual prototypes.

Duration (in hours): **07:00**	**Duration (in hours)**: **15:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand of advanced machine Learning algorithms (e.g., neural networks and decision trees) and their applications in design analysis. • Fundamentals of robotic systems and their applications in manufacturing. • Overview of AI technologies relevant to robotics (e.g., computer vision and reinforcement Learning). • Overview of AI-driven data analytics and its significance in manufacturing. • Overview of AI algorithms suitable for failure prediction (e.g., regression analysis and clustering). • Importance of virtual prototyping in mechanical engineering design.	• Explain how AI technologies to improve robotic systems object recognition and task execution capabilities. • Define how AI-driven analytics tools to monitor manufacturing processes in real time. • Explain the functionalities of AI algorithms to enable smart materials to adapt environmental changes. • Define how AI-integrated smart materials for mechanical applications. • Explain how to use AI technologies to enhance simulation models for virtual prototyping. • Explain the functionalities of AI algorithms to forecast potential equipment failures.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Machine Learning software (e.g., TensorFlow / Scikit-learn), Data visualization tools for presenting analysis results (e.g., Apache Superset), Robotics simulation software (e.g., Gazebo), AI frameworks for object recognition and adaptive Learning (e.g., OpenCV / PyTorch), AI development platforms for integrating algorithms with materials (e.g, Octave), Data analytics platforms for algorithm development (e.g., Python/R)	

Elective 5: Civil Engineering

Module 1: Utilize AI tools /algorithms in Structural Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to analyze sensor data for monitoring structural health, enabling timely maintenance and enhancing safety.
- Overview how to utilize machine Learning models to predict structural responses, aiding in the optimization of design and enhancement of structural integrity.
- Understand how to utilize AI tools for optimizing structural designs, leading to more efficient, cost-effective solutions that comply with safety standards.
- Overview how to analyze material performance using AI algorithms, facilitating informed decisions about material selection for structural applications.
- Understand how to implement AI for risk assessment in structural engineering.
- Overview how to utilize AI in robotic systems for automated construction tasks, improving efficiency and reducing human error in construction projects.

Duration (in hours): **07:00**	**Duration (in hours)**: **13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand of structural health monitoring (SHM) and understand the role of AI in analyzing sensor data. • Concepts of anomaly detection and its significance in maintaining structural integrity. • Overview of machine Learning models and their applications in structural engineering. • Introduction to structural optimization techniques and the Understand the role of AI in evaluating design parameters. • Importance of compliance with safety standards in design processes. • Understand the properties of different construction materials and their performance under various conditions. • Understand the role of robotics in construction and the benefits of automation. • Overview of AI technologies that enhance robotic capabilities (e.g., computer vision and path planning).	• Explain the functionalities of AI algorithm analysis the sensor data from structural health monitoring systems. • Explain how AI tools to evaluate multiple design parameters and identify optimal solutions. • Explain the functionalities of AI algorithms to analyze material performance data collected from experimental tests. • Explain the functionalities of AI algorithms in robotic systems for automated construction tasks. • Explain how AI models to assess risks associated with structural failures based on historical data and environmental conditions.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python/Octave), Machine Learning platforms (e.g., TensorFlow/Scikit-learn), Data analytics tools for modelling and simulation (e.g., Octave/ Python), FreeCAD, OpenSees	

Module 2: Use AI tools /algorithms in Construction Management

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for scheduling optimization, leading to improved project timelines and reduced delays.
- Overview to use AI tools for automating cost estimation, leading to more accurate budgets and effective financial management throughout project lifecycles.
- Understand how to implement AI-driven risk assessment models, facilitating proactive risk mitigation strategies and enhancing project safety.
- Understand how to utilize AI for optimizing resource allocation, ensuring efficient use of resources and reducing waste in construction projects.
- Understand how to use AI-powered image recognition tools to monitor construction quality, enabling quicker defect detection and adherence to project specifications.

Duration (in hours): 07:00	**Duration (in hours): 13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss the concepts of AI in data analysis and its application in predicting task durations. • Explain the importance of resource allocation in maintaining project timelines and efficiency. • Overview of cost estimation techniques in construction project management. • Concepts of risk assessment in construction project management. • Explain the importance of proactive mitigation strategies in enhancing project safety. • Understand how resource allocation principles work in construction management. • Explain the importance of reducing waste for cost efficiency and sustainability in projects.	• Define how AI can analysis to enhance project timelines and reduce delays. • Define how AI tools to automate cost estimation processes. • Explain how AI-driven risk assessment models to identify potential project risks. • Explain the functionalities of AI algorithms to predict demand for labor, materials and equipment. • Define how AI-powered image can recognition tools for real-time quality monitoring.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Project management software (e.g., Microsoft Project/ Primavera), AI data analysis tools (e.g., Python/ R), AI modelling tools (e.g., Python/Octave), AI analytics platforms (e.g., TensorFlow/ R), Image recognition software (e.g., OpenCV/ TensorFlow), Cameras and sensors for real-time monitoring, Communication tools (e.g., Slack/Microsoft Teams).	

Module 3: Utilize AI tools /algorithms in Geotechnical Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for predicting soil properties, enhancing geotechnical assessments while reducing reliance on laboratory tests.
- Overview how to apply machine Learning models for processing geological survey data, leading to improved site characterization and identification of subsurface conditions.
- Understand how to use AI tools for simulating environmental conditions, enabling engineers to assess slope stability and mitigate risks effectively.
- Explain the concept how to apply AI algorithms to optimize foundation design, resulting in efficient and cost-effective solutions tailored to site conditions.
- Understand how to utilize AI for monitoring geotechnical structures, enabling early detection of issues and effective maintenance scheduling.
- Overview how to utilize AI tools for comprehensive risk assessment, enabling the development of effective risk mitigation strategies for safer construction practices.

Duration (in hours): 07:00	**Duration (in hours): 13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of geological surveys and remote sensing technologies used in site characterization. • Explain the importance of understand subsurface conditions for effective design and construction. • Understand slope stability analysis and the factors influencing it. • Overview of environmental conditions and loading scenarios relevant to slope stability. • Overview of foundation design principles and the importance of load distribution and soil properties. • Discuss the benefits of considering site constraints in foundation design. • Understand the importance of monitoring geotechnical structures for performance evaluation. • Overview of risk assessment principles in geotechnical engineering.	• Explain the functionalities of AI algorithms to analyze soil sample data and historical records. • Explain how framework works in AI to predict in geotechnical assessm ents. • Explain how machine Learning models to analyze data from geological surveys and remote sensing. • Explain how AI tools to analyze data related to risks in geotechnical projects. • Explain the functionalities of AI algorithms to analyze factors affecting foundation design. • Define how AI monitoring systems to assess the performance of geotechnical structures.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python/ R/ Octave), Machine Learning platforms (e.g., TensorFlow/ Scikit-learn)	

Module 4: Use AI tools /algorithms in Transportation Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to predict traffic patterns, leading to more effective traffic management and reduced congestion.
- Overview how to implement AI in smart transportation systems, enhancing real-time monitoring and control of infrastructure.
- Understand how to utilize AI tools for optimal routing solutions, improving efficiency and reducing travel times in logistics and public transport.
- Discuss the concept how to utilize AI for predictive maintenance of transportation infrastructure, ensuring safety and extending the lifespan of assets.
- Understand of automate traffic management processes using AI, enhancing decision-making and response to incidents.
- Overview how to utilize AI to evaluate environmental impacts, promoting informed decisions for sustainable transportation solutions.

Duration (in hours): 07:00	**Duration (in hours): 13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of traffic flow theory and the significance of understand traffic patterns. • Introduction to AI algorithms used for data analysis and prediction. • Understand smart transportation systems and their components. • Understand the role of AI in real-time monitoring and control of traffic infrastructure. • Understand the role of AI in analyzing multiple factors affecting routing decisions. • Overview of traffic management processes and the importance of data integration. • Understand the role of AI in automating decision-making in traffic management. • Understand different data sources used in traffic management systems.	• Explain the functionalities of AI algorithms to analyze historical and real-time traffic data. • Define how AI tools to analyze traffic conditions, road closures, and vehicle capacities for routing solutions. • Explain the functionalities of AI algorithms to analyze sensor data from transportation infrastructure. • Explain how AI tools to analyze emissions, noise, and land use data for transportation projects. • Explain the functionalities of AI algorithms to integrate and analyze data from various traffic sources.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python/R), cameras, sensors, RoadEngCivil10, QGIS	

Module 5: Utilize AI tools /algorithms in Environmental and Water Resources Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand to employ AI algorithms for real-time water quality monitoring.
- Overview how to utilize machine Learning models for flood prediction, enhancing preparedness and resource allocation in flood-prone areas.
- Understand how to utilize AI to enhance water distribution network efficiency, leading to reduced water loss and improved urban service delivery.
- Discuss the concept how to utilize AI tools for streamlining environmental impact assessments, facilitating effective risk identification and mitigation strategies.
- Understand how to apply AI algorithms for predictive maintenance in water treatment plants and distribution systems.
- Overview how to utilize AI tools for modelling ecosystems and hydrological systems.

Duration (in hours): 07:00	**Duration (in hours): 13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the water quality parameters and their significance in environmental monitoring. • Overview of AI algorithms and their application to analyze sensor data. • Introduction of flood prediction models and their importance in disaster management. • Overview of machine learning techniques used for predicting flood events. • Overview of AI applications in analyzing flow data and leak detection. • Understand how AI can process and analyze large datasets related to environmental impacts. • Overview of AI algorithms used for analyzing equipment performance data. • Overview of AI applications in modelling environmental systems.	• Explain how deploy sensors in water bodies to collect data on water quality parameters. • Define how machine Learning models work for flood prediction. • Explain how AI tools to analyze flow data from water distribution networks. • Explain sorts of AI solutions in reducing water loss and improving service delivery. • Explain how AI tools to analyze data from various environmental sources (e.g., land use, ecosystems). • Explain the functionalities of AI algorithms to analyze performance data and predict maintenance needs.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python/ R), Machine Learning frameworks (e.g., TensorFlow/ Scikit-learn), Data analysis software (e.g., Octave/ Python), AI analysis software (e.g., R/ Python), Data analysis tools (e.g., Octave/ Python), GrassGIS, HES-RAS.	

Module 6: Use AI tools /algorithms in Urban Planning and Smart Cities

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms for optimizing traffic flow and reducing congestion in urban areas, improving overall transportation efficiency.
- Overview how to apply AI tools for urban planning, enabling accurate demand predictions and efficient resource management.
- Understand how to utilize AI to analyze urban heat islands, proposing effective interventions to enhance residents' quality of life.
- Overview of machine learning algorithms for identifying high-risk areas and optimizing public safety resource allocation.
- Understand how to utilize AI tools for monitoring urban infrastructure health, enabling proactive maintenance and reducing the risk of failures.
- Discuss the concept how to use AI tools for community engagement, enabling urban planners to understand community needs and to develop effective strategies.

Duration (in hours): **07:00**	**Duration (in hours)**: **13:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the traffic flow theories and the impact of congestion on urban environments. • Overview of AI algorithms for real-time data analysis and adaptive signal control. • Introduction to urban planning principles and essential services management. • Overview of AI tools used for demand forecasting and resource allocation. • Overview of satellite imagery analysis techniques and weather data interpretation. • Overview of AI applications in predictive analytics for infrastructure health. • Explain the importance of proactive maintenance for preventing infrastructure failures. • Overview of community engagement principles in urban planning. • Understand the role of AI to enhance community engagement and informing urban development strategies.	• Explain how real-time data from sensors and cameras traffic. • Explain how AI can analysis adaptive traffic signal control systems. • Explain the functionalities of AI algorithms to analyze satellite imagery and weather data. • Explain how machine Learning models to identify high-risk areas.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python/ Octave), AI frameworks for traffic modelling (e.g., TensorFlow/ Scikit-learn), Statistical software for data analysis (e.g., R/ Excel), Data analysis software for predictive modelling (e.g., Octave/ Python), Data visualization software for reporting findings (e.g., Apache Superset).	

Module 7: Utilize AI tools /algorithms in Construction Automation

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to automate project scheduling and resource allocation using AI, ensuring efficient project management and timely completion.
- Overview how to utilize AI-driven robots and drones for construction tasks, improving accuracy, safety, and cost-efficiency.
- Understand how to use AI algorithms to predict equipment failures, enhancing maintenance practices and extending machinery lifespan.
- Overview how to utilize AI for real-time defect detection in construction, ensuring adherence to quality standards.
- Understand how to use AI tools for generating and optimizing design alternatives, leading to innovative and efficient construction solutions.
- Overview to employ AI algorithms to predict and mitigate safety risks on construction sites, enhancing overall safety and reducing accidents.

Duration (in hours): **06:00**	**Duration (in hours)**: **14:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI Understand the role in resource allocation and risk analysis. • Discuss the significance of data-driven decision-making in construction project management. • Overview of robotics and drone technology in construction. • Understand the benefits of automation in reducing labour costs and enhancing safety. • Overview of AI algorithms for data analysis and failure prediction. • Introduction to machine Learning models and their application in anomaly detection. • Understand the role of AI in enhancing creativity and efficiency in engineering designs. • Understand the role of AI in monitoring worker behaviour and compliance.	• Explain how to use AI software to analyze project timelines and resource availability. • Define how to use AI simulations to predict potential project risks and adjust plans accordingly. • Explain how to use robots for material handling and logistics on construction sites. • Explain how sensor systems on construction equipment to collect operational data. • Explain the functionalities of AI algorithms to analyze historical data for predicting maintenance needs. • Explain how to use AI algorithms in visual inspection systems using cameras. • Explain how machine Learning models to recognize defects and anomalies in construction. • Explain how AI monitoring systems to analyze site conditions and worker behaviour.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics tools for timeline and resource analysis (e.g., Excel / R), Data analysis software (e.g., Python/ Octave), High-resolution cameras and visual inspection software, Machine Learning frameworks (e.g., TensorFlow / PyTorch), AI-powered monitoring systems (e.g., camera).	

Module 8: Use AI tools /algorithms for Sustainable Civil Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms to optimize energy efficiency in building designs, contributing to reduced energy consumption and carbon footprints.
- Overview how to use AI to select sustainable building materials, promoting environmental sustainability in construction.
- Understand how to apply AI tools to enhance waste management in construction, leading to reduced landfill contributions and improved recycling processes.
- Overview how to utilize AI algorithms for efficient water management in construction projects, minimizing waste and promoting sustainability.
- Understand to automate lifecycle assessments of civil engineering projects using AI, facilitating informed sustainability decision-making.
- Overview how to use AI tools to analyze climate data for designing resilient infrastructure, ensuring adaptability to changing environmental conditions.

Duration (in hours): **06:00**	**Duration (in hours)**: **14:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of AI algorithms and their application in energy consumption analysis. • Understand the significance of minimizing the carbon footprint in construction. • Discuss the application of AI in evaluating material performance and cost-effectiveness. • Overview of AI Understand the role in predicting waste generation and optimizing recycling processes. • Understand AI algorithms and their application in modelling water usage. • Overview of AI applications in automating LCA processes. • Overview of AI applications in climate data analysis and modelling.	• Define how AI software can simulate in different energy consumption scenarios for various building designs. • Explain how AI tools to assess various building materials based on sustainability criteria. • Explain how AI evaluations guidelines for selecting eco-friendly materials. • Explain how AI tools to analyze past construction projects and predict future waste generation. • Explain how AI tools to analyze climate data and model and its impact on existing and proposed infrastructure.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics tools for waste generation analysis (e.g., Excel / R)	

Module 9: Advancement in AI for Civil Engineering

Mapped to ICE/N1908, v1.0

Terminal Outcomes:

- Understand how to use AI-driven generative design tools to explore design alternatives, optimize performance, and minimize material waste.
- Overview how to apply advanced machine Learning algorithms for anomaly detection and predictive maintenance, ensuring infrastructure safety and longevity.
- Understand how to utilize NLP applications for efficient navigation and analysis of regulatory documents, improving compliance checks and project approval processes.
- Overview how to apply AI algorithms for environmental impact analysis, leading to the design of sustainable engineering solutions.
- Understand how to deploy and managing AI-powered robotics on construction sites, enhancing productivity and safety.
- Discuss the concept to understand AI technologies for developing smart city solutions, facilitating sustainable urban development and efficient resource management.

Duration (in hours): **06:00**	**Duration (in hours)**: **14:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI in optimizing designs based on predefined parameters. • Overview of machine Learning algorithms and their applications in structural health monitoring. • Discuss the importance of anomaly detection and predictive maintenance in infrastructure longevity. • Understand the sensor technologies and understand the role in data collection. • Understand natural language processing (NLP) and its applications in civil engineering. • Understand the role of AI in enhancing information extraction and analysis. • Overview of AI algorithms can process and analyze large datasets related to environmental factors. • Understand the role of robotics and automation in construction. • Overview of AI applications in robotics for construction tasks. • Overview of smart city concepts and understand the role of AI and IoT in urban development.	• Explain how sensors work in structures to collect real-time data on performance and conditions. • Explain the functionalities of machine learning algorithms to analyze data and identify anomalies. • Explain how NLP tools to analyze regulatory documents and extract relevant sections. • Define how workflows utilize for NLP in ongoing project documentation and compliance checks. • Explain how to use AI algorithms to collect and process environmental data (e.g., air quality, water quality and biodiversity). • Define how AI tools to analyze data from IoT devices for resource management (e.g., water, energy). • Explain how to use AI algorithms in traffic optimization models to improve urban mobility. • Define how AI-powered robotic systems use in specific construction tasks (e.g., bricklaying). • Explain how robotic systems perform and provide efficiency on-site.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics software (e.g., Python/R/ Octave)	

Elective 6: Metallurgical and Materials Engineering

Module 1: Use AI tools/algorithms for Materials Design

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms to analyze datasets for new material discovery, leading to the design of materials with specific characteristics.
- Understand how to use AI tools for optimizing metal alloy compositions, leading to the development of advanced materials with desirable
- Overview of AI algorithms for predicting failure modes and enhancing the durability of materials, contributing to reliable engineering solutions.
- Understand how to develop and validated machine learning models for predicting material properties, enabling tailored material design.

Duration (in hours): 9:00	**Duration (in hours): 18:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI in materials discovery and characterization. • Importance of datasets in predicting material behaviour and identifying candidates. • Understand the machine Learning principles and their applications in material property prediction. • Overview of alloy design principles and the Understand the role of AI in optimizing compositions. • Understand the role of AI in process optimization for material manufacturing. • Understand the relationship between geometry, material properties, and manufacturability. • Explain the significance of AI in optimizing designs for 3D printing. • Overview of AI techniques for analyzing historical testing data.	• Explain the functionalities of AI algorithms to analyze data to identify potential new materials. • Define how to use historical data to make machine learning models for material properties. • Define how Al models to predict the mechanical, thermal and electrical properties based on composition and microstructure. • Explain how AI tools to simulate different metal alloy compositions and predict their performance. • Explain the functionalities of AI algorithms model to control microstructure during material processing. • Explain the functionalities AI algorithms to predict potential failure modes based on loading conditions. • Explain how AI tools to analyze design geometries for 3D printing to identify potential issues.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analytics software (e.g., Python/ R/Octave) , Machine Learning frameworks (e.g., TensorFlow/ Scikit-learn), Data analytics software for historical data analysis (e.g., Python/R),OpenCALPHAD, Quantum ESPRESSO	

Module 2: Utilize AI tools/algorithms in Process Optimization and Control in Metallurgy

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to integrate AI algorithms into metallurgical processes to enhance monitoring and improve product quality through real-time adjustments.
- Overview how to utilize machine Learning for predictive maintenance in metallurgical plants, leading to minimized downtime and optimized production levels.
- Understand how to use AI tools to analyze historical process data and optimize operational parameters, leading to improved efficiency and reduced energy consumption.
- Discuss the concept AI-driven simulations to model and optimize metallurgical processes, reducing trial-and-error and enhancing process efficiency.
- Understand of AI algorithms for defect detection and automating quality control processes, ensuring consistent metallurgical output quality.
- Overview how to utilize AI tools to optimize material flow and logistics in metallurgical operations, enhancing efficiency and reducing waste.

Duration (in hours): 9:00	**Duration (in hours): 17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI in real-time data acquisition and processing. • Overview of machine learning techniques used for failure prediction. • Understand the role of AI in automating the optimization process. • Explain the benefits of using AI for process modelling and optimization. • Overview of defect detection techniques using AI and image analysis. • Understand the role AI in optimizing material flow and reducing waste.	• Explain how machine learning models are using in historical equipment data. • Define how AI tools to identify optimal parameter settings from historical process data. • Explain how AI-driven simulations for specific metallurgical processes. • Define how to use AI tools for current material flow and logistics processes. • Explain how AI analysis to optimize material handling and inventory. • Explain the functionalities of AI algorithms for using image datasets or sensor data to identify defects.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI software platforms for data analysis and control (e.g., Octave / Python), Data analytics tools for machine learning model development (e.g., Scikit-learn/ TensorFlow) , Image processing software and tools for training defect detection algorithms (e.g., OpenCV/ TensorFlow)	

Module 3: Use AI tools/algorithms in Computational Techniques for Microstructure Analysis

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms for automated micro structural image analysis, resulting in faster and more accurate identification of critical features.
- Demonstrate to develop AI models for simulating micro structural evolution, enhancing predictive capabilities regarding material properties.
- Understand how to integrate micro structural data with materials property databases using AI, facilitating informed material design decisions.
- Understand how trained machine learning algorithms to predict micro structural outcomes, optimizing manufacturing processes for enhanced material performance.
- Overview how to utilize AI-powered visualization techniques to analyze and interpret complex microstructures, aiding in materials design and development.

Duration (in hours): 9:00	**Duration (in hours): 17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of microscopy techniques (SEM, TEM) and their applications. • Understand the role of AI in enhancing image analysis through automation. • Discuss the applications of AI in predictive modelling of micro structural changes. • Understand the role of AI in uncovering correlations within large datasets. • Overview of machine learning techniques for predictive modelling. • Overview of AI-powered visualization techniques and their applications.	• Explain the functionalities of AI algorithms for automating the analysis of micro structural images. • Define machine Learning and sorts of image processing techniques to quantitatively analyze micro structural features. • Explain how AI models to simulate micro structural evolution. • Define how to use AI tools to find microstructure data from existing materials property databases. • Explain how AI-powered visualization tools to analyze and interpret complex microstructures.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI software for image analysis (e.g., Octave/ Python with OpenCV), AI platforms for data analysis (e.g., Python with pandas/ R), Visualization tools for presenting correlation findings (e.g., Apache Superset), Machine Learning frameworks (e.g., TensorFlow / Scikit-learn), OCTA	

Module 4: Utilize AI tools/algorithms for Predictive Modelling of Material Behaviour

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to utilize AI tools to develop predictive models that accurately forecast material behaviour based on comprehensive datasets.
- Overview machine learning algorithms to accurately predict mechanical properties, fatigue life, and failure modes of materials, enhancing material design and application.
- Understand how to use predictive modelling to optimize processing parameters for improved material characteristics, enhancing application performance.
- Discuss the concept of AI-driven models for predicting material failure, enhancing safety measures and maintenance strategies in engineering applications.
- Understand how to integrate AI with FEA to simulate complex material behaviour, providing accurate predictions for design optimization and structural integrity assessments.
- Overview how to develop adaptable AI algorithms that refine predictive models with new data, ensuring continuous improvement in materials science and engineering applications.

Duration (in hours): 9:00	**Duration (in hours): 17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the role of AI to enhance the accuracy of predictions regarding material behaviour. • Overview of various machine learning algorithms applicable to material property prediction. • Overview of predictive modelling techniques for optimizing processing conditions. • Overview of stress-strain behaviour and its relevance to material failure. • Understand the role of predictive models in enhancing safety and maintenance planning. • Understand the principles of finite element analysis (FEA) and its applications in material behaviour simulation. • Overview of AI's Understand the role in enhancing FEA predictions and accuracy.	• Define how AI-based predictive models to use in relevant datasets to forecast material behaviour under varying conditions. • Explain various machine learning algorithms to develop predictive models for mechanical properties and failure modes. • Explain how different sorts of methods for continuously refining predictive models based on incoming data. • Explain how different AI techniques with FEA to simulate complex material behaviours. • Explain how AI-driven predictive models to analyze stress-strain data to predict material failure.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Data analysis software (e.g., Python / R) for data manipulation and model development, AI modelling frameworks (e.g., TensorFlow / Keras), Machine Learning software and libraries (e.g., Scikit-learn), Optimization software for process parameters (e.g., Octave), Machine Learning platforms (e.g., TensorFlow / PyTorch), Lammps.	

Module 5: Use AI tools/algorithms in Smart Manufacturing and Industry 4.0

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to use AI algorithms for real-time monitoring of manufacturing processes, leading to optimized conditions and reduced waste.
- Overview of AI tools for predictive maintenance, enhancing equipment reliability and productivity in metallurgical processes.
- Understand how to use AI algorithms to analyze datasets and optimize metallurgical processes, leading to improved product quality and reduced operational costs.
- Overview of AI tools to optimize supply chain operations, enhancing responsiveness and reducing excess inventory in metallurgical companies.
- Understand how to implement AI-driven digital twin technology to simulate and analyze material behaviour, leading to improved decision-making and process optimization.
- Overview of AI algorithms to enhance quality control processes, ensuring adherence to specifications and reducing defects in metallurgical products.

Duration (in hours): **9:00**	**Duration (in hours)**: **17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Overview of sensors and IoT devices in data collection for metallurgical processes. • Understand the role of AI algorithms in analyzing sensor data to make timely adjustments. • Understand machine Learning models can analyze operational data to predict equipment failures. • Understand the role of AI tools in optimizing metallurgical processes. • Overview how AI can predict demand and optimize inventory levels. • Understand the concept of digital twins and their applications in manufacturing. • Understand the role of AI in enhancing the accuracy and efficiency of digital twin technology. • Understand how AI-powered image recognition and anomaly detection can improve quality assurance.	• Explain how to use IoT devices and sensors to gather data during metallurgical processes. • Explain how to use machine learning models for analyzing operational data to predict equipment failures. • Explain the functionalities of AI algorithms to analyze datasets related to casting, welding and heat treatment. • Explain how AI tools to analyze historical data for demand forecasting. • Explain the functionalities of AI algorithms for image recognition to inspect materials and components. • Explain how to impact AI-enhanced quality control on product specifications and defect rates.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
AI and machine Learning software (e.g., Python/ R), Data analytics software for operational data analysis (e.g., Octave), Machine Learning platforms (e.g., TensorFlow/ Scikit-learn), Data analysis and visualization tools for process optimization (e.g., Apache Superset), Computer vision software (e.g., OpenCV/ TensorFlow), GMSH, Elmer.	

Module 6: Utilize AI in Materials Recycling and Circular Economy

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to enhance sorting efficiency of recyclable materials.
- Overview how to apply AI to optimize recycling processes, enhancing overall efficiency and material recovery rates.
- Overview of AI-driven predictive modelling to forecast recycling yields, enhancing operations and contributing to resource recovery.
- Understand how to use AI tools to conduct lifecycle assessments of materials.
- Understand how to use AI tools to assist in the design and development of sustainable materials.
- Overview how to utilize AI algorithms to support circular economy strategies.

Duration (in hours): 8:00	**Duration (in hours): 17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the principles of computer vision and machine learning in material sorting. • Understand how AI can analyze operational data to optimize these processes. • Understand the role of AI in improving the accuracy and efficiency of lifecycle assessments. • Overview of AI simulations can evaluate material behaviours and properties. • Understand the role of AI tools in informing recycling programs and sustainable practices.	• Explain the functionalities of computer vision algorithms to identify various metals and materials. • Explain the functionalities of AI algorithms to monitor and analyze data from recycling processes. • Explain how to use AI tools to gather and analyze data for conducting lifecycle assessments of materials. • Define how to use AI algorithms data for resource flows and usage patterns. • Explain how to use AI for sustainable practices across supply chains.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Computer vision software (e.g., OpenCV / TensorFlow), High-resolution cameras, Machine Learning platforms (e.g., Scikit-learn / Keras), Predictive modelling software (e.g., Octave/ Python), Data analytics tools (e.g., Apache Superset).	

Module 7: Advancement in AI for Metallurgy and Materials Engineering

Mapped to ICE/N1909, v1.0

Terminal Outcomes:

- Understand how to utilize AI algorithms to accelerate the discovery of new materials, enabling efficient identification of candidates for specific applications.
- Overview of advanced AI tools to optimize metallurgical processes, leading to improved yield, reduced waste, and enhanced product quality.
- Understand how to utilize AI-powered monitoring systems to ensure consistent quality in metallurgical processes and reduce defects.
- Overview of machine learning for predictive maintenance in metallurgical facilities, leading to minimized downtime and extended machinery lifespan.
- Understand how to utilize AI tools for complex simulations of metallurgical processes, leading to informed design decisions and enhanced process improvements.
- Overview how to integrate AI tools within the framework of Industry 4.0, fostering smarter manufacturing environments and promoting sustainability in materials engineering.

Duration (in hours): **07:00**	**Duration (in hours)**:**17:00**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Understand the principles of AI algorithms in material property prediction. • Overview of AI analyzes large datasets to optimize production parameters. • Overview of how AI systems detect deviations from optimal conditions. • Overview of machine Learning algorithms and their applications in equipment performance analysis. • Overview of how AI tools enhance the modelling of metallurgical processes. • Understand of AI-driven insights contribute to smarter manufacturing.	• Explain the functionalities of AI algorithms to existing datasets to predict properties of new materials. • Explain how AI tools to analyze data from metallurgical processes for optimization. • Define how AI-powered monitoring systems work in metallurgical operations. • Explain how AI tools aligned with Industry 4.0 initiatives in metallurgical operations. • Explain how machine learning algorithms use to analyze equipment performance data. • Define how AI simulation tools to use for making model of metallurgical processes and utilize for predicting outcomes.
Classroom Aids	
Whiteboard, Marker, Computer, Peripherals (keyboard, mouse, monitor), Projection Equipment, PowerPoint Presentation and software	
Tools, Equipment and Other Requirements	
Machine Learning platforms (e.g., TensorFlow / Scikit-learn)	

On- the- Job-Training

Mapped to A.I for Technocrat

Mandatory Duration (in hours): 120:00	Recommended Duration (in hours): 00:00
Location: On-Site/ Off-Site	

Terminal Outcomes :

- Understand how to apply linear regression, decision trees, SVM and neural networks in real-world predictive analytics projects.
- Building and deploying CI/CD pipelines for automating software delivery.
- Explore containerization techniques use Docker and Kubernetes for efficient deployment automation.
- How to integrate AI tools for predicting deployment outcomes and optimizing system performance.
- Work with AI-based frameworks such as Kubernetes, Jenkins and Ansible to streamline deployment processes.
- Develop skills in automating rollback procedures based on AI-driven insights and predictions.
- Apply predictive models to solve complex business problems and optimize decision-making processes.
- Implement AI algorithms to forecast deployment success and reduce system downtime.
- Collaborate on real-time AI-enhanced resource allocation during software deployment.
- Understand the principles of orchestrating containerized applications in distributed environments.
- Explore AI tools for optimizing the performance of large-scale deployment systems.
- Understand to integrate machine learning models into continuous deployment pipelines.
- Analyze case studies of AI-driven deployment automation to improve system efficiency.
- Gain knowledge of decision-making models in predictive maintenance scenarios.
- Understand best practices for managing and deploying AI-based applications in complex environments.

Annexure

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialisation**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
Post-graduation in CS &IT	In relevant field	1	In relevant field	0	-	
Graduation in CS & IT	In relevant field	3	In relevant field	0	-	

Trainer Certification	
Domain Certification	**Platform Certification**
Certified for Job Understand the role "A.I - Technocrat", mapped to QP: "ICE/TT/32/Q1009, v1.0", Minimum accepted score is 80%	Recommended that the Trainer is certified for the Job Understand the role: "Trainer (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2601, v2.0". The minimum accepted score as per MEPSC guidelines is 80%.

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training/Assessment Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
Post-graduation in CS&IT	In relevant field	1	In relevant field	0	-	-
Graduation in CS& IT	In relevant field	3	In relevant field	0	-	-

Assessor Certification	
Domain Certification	**Platform Certification**
Certified for Job Understand the role "A.I - Technocrat", mapped to QP: "ICE/TT/32/Q1009, v1.0", Minimum accepted score is 80%	Certified for the Job Understand the role: "Assessor (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2701, v2.0", with a minimum score of 80%.

Assessment Strategy

This section includes the processes involved in identifying, gathering and interpreting information to evaluate the Candidate on the required competencies of the program.

1. Assessment System Overview:

- Batches assigned to the assessment agencies for conducting the assessment on SIP
- The batch allocation Matrix prepared for each month based on previous months' performance of AAs, which determines the quantum of Assessment which can be allocated to each AA for a month
- Post allocation of assessment, Assessment agencies send the assessment confirmation to AWARDING BODY
- Assessment agency deploys the ToA certified Assessor for executing the assessment
- AWARDING BODY monitors the assessment process.

2. Testing Environment:

- A combination of Theory and practical/demonstration test is deployed to assess knowledge and Skill respectively of Learners.
- Assessment is conducted at Training center in in-person/offline mode
- For Skill assessment, environment is simulated to create a realistic Working Environment that should replicate the key features of the workplace. In job Understand the roles, where it is difficult to replicate the same, the OJT assessment is implemented.
- During the practical task, trainees are assessed on their workmanship, quality of finished product, time management, etc., based on the performance criteria (PC), knowledge and Understand and their professional and soft skills as specified in the qualification pack.
- Knowledge assessment is done through closed ended questions up to level 4 and from level 5 onwards, it is mixture of open ended and closed ended questions

3. Assessment Quality Assurance levels/Framework

- Assessment criteria is developed ed for each QP which acts as a guide for developed ing question set /banks
- Sample questions aligned with Assessment criteria for each QP are developed ed by AWARDING BODY and validated by industry
- Taking reference of Assessment criteria and Sample Questions, AAs create the question bank which is further validated by AWARDING BODY
- Questions are mapped to the specified assessment criteria
- It is mandatory that Assessor and Trainer must be ToA certified & ToT Certified respectively
- Continuous Monitoring through virtual and In-person mode are conducted to ensure the assessment is conducted as per stipulated process
- Process and Technical audit of assessment batches by quality team are conducted to avoid the errors in assessment process
- A well -defined comprehensive framework of NON-COMPLIANCE MATRIX is defined and implemented to identify the non-compliance made by assessor and AA and punitive actions are taken correspondingly.
- The capacity building sessions are conducted regularly for assessors and assessment agencies to update them about best practices in assessment

4. Types of evidence or evidence-gathering protocol:

- Post Assessment, the evidences are uploaded by Assessor to assessment agency and further assessment agency to AWARDING BODY as per stipulated TAT
- Evidences are broadly the photographic and video graphic in nature
- Assessment agencies upload the evidence on SIP and detailed evidence on AWARDING BODY digital platform (ZoHO)
- Evidences are; NOS wise-Geotagged photographs and videos of Theory Test &Practical Tasks, Attendance sheet, result summary sheet, group photographs.

5. Method of verification or validation:

- The process and technical audit of assessment batches are done by AWARDING BODY
- Attendance of each candidate is verified and it is ensured that only those candidates are assessed by assessors who are meeting the stipulated minimum percentage of attendance
- The result of each candidate is verified, it is verified that that result on SIP are matching with respect to summary sheet submitted by AAs
- Under detailed technical audit for sample of batches, the knowledge and skill assessment results for each candidate are checked in technical aspect.
- All the evidences of batches are preserved on server of AWARDING BODY digital platform

On the Job:

- On job training (OJT), candidates undergo training and leaning at actual workplace for a fixed period of time and a certain weightage of assessment is allocated out of total skill weightage of Qualification Pack for undergoing OJT as stipulated by ICE. This OJT score and assessors' end point score are combined to arrive at final Marking/grading of trainees' skill test. The OJT score is determined by Supervisor of company under which candidates undergo on job training.

References

Glossary

Term	Description
Declarative Knowledge	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood in order to accomplish a task or to solve a problem.
Key Learning Outcome	Key learning outcome is the statement of what a learner needs to know, understand and be able to do in order to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, Understand (theory) and skills (practical application).
OJT (M)	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on site
OJT (R)	On-the-job training (Recommended); trainees are recommended the specified hours of training on site
Procedural Knowledge	Procedural knowledge addresses how to do something, or how to perform a task. It is the Overview to work, or produce a tangible work output by applying cognitive, affective or psychomotor skills.
Training Outcome	Training outcome is a statement of what a learner will know, understand and be able to do it upon the completion of the training.
Terminal Outcome	Terminal outcome is a statement of what a learner will know, understand and be able to do upon the completion of a module. A set of terminal outcomes help to achieve the training outcome.

Acronyms and Abbreviations

Term	Description
QP	Qualification Pack
NSQF	National Skills Qualification Framework
NSQC	National Skills Qualification Committee
NOS	National Occupational Standards
ICE	The Institution of Civil Engineers
MCQ	Multiple Choice Question
A.I	Artificial Intelligence
CNN	Convolutional Neural Network
IoT	Internet of Things
CV	Computer Vision
YOLO	You Only Look Once
GDPR	General Data Protection Regulation
OSHA	Occupational Safety and Health Administration
NLP	Natural Language Processing
GPS	Global Positioning System
GPR	Global Positioning Radar
RFID	Radio Frequency Identification
RNN	Recurrent Neural Networks