Syllabus

Course Description:

This short course provides a foundational understanding of Artificial Intelligence (AI) principles and their potential applications within the welding engineering field. Participants will gain insights into key AI concepts, learn basic Python programming, explore linear regression techniques, and delve into fundamental AI algorithms. The course emphasizes practical applications, focusing on how AI can enhance welding processes, improve quality control, and optimize production efficiency.

Learning Objectives:

Upon successful completion of this course, participants will be able to:

- Define AI and understand its key concepts and subfields.
- Write basic Python code for data manipulation and analysis.
- Apply linear regression models to analyze welding data and make predictions.
- Understand the principles of common AI algorithms relevant to welding, such as:
    - **Supervised Learning:**
        - Support Vector Machines (SVM) for weld defect classification
        - Decision Trees for predicting weld quality based on process parameters
    - **Unsupervised Learning:**
        - K-means clustering for grouping welds with similar characteristics
    - **Reinforcement Learning:**
        - Developing AI agents for optimizing welding parameters in real-time
- Identify potential applications of AI in welding engineering, including:
    - Predictive maintenance of welding equipment
    - Quality control and defect detection
    - Process optimization and parameter tuning
    - Robotic welding and automation

Modules:

1. **Introduction to Artificial Intelligence**
    - What is AI?
    - History and Evolution of AI
    - Types of AI (Narrow, General, Super)
    - AI Applications in Manufacturing
2. **Python Fundamentals for Welding Engineers**
    - Introduction to Python Programming
    - Data Types and Variables
    - Control Flow (if-else, loops)
    - Functions and Modules
    - Data Structures (Lists, Dictionaries)
    - Working with Data (Importing and Exporting Data, Data Cleaning)
    - Libraries for Data Science (NumPy, Pandas, Matplotlib)
3. **Linear Regression for Welding Data Analysis**
    - Introduction to Regression Analysis
    - Simple Linear Regression
    - Multiple Linear Regression
    - Model Evaluation Metrics (R-squared, Mean Squared Error)
    - Application of Linear Regression to Welding Data (e.g., predicting weld strength based on process parameters)
4. **Basic AI Algorithms for Welding Engineers**
    - Supervised Learning:
        - Support Vector Machines (SVM): Theory and Applications in Weld Defect Classification
        - Decision Trees: Understanding and Implementing Decision Trees for Weld Quality Prediction
    - Unsupervised Learning:
        - K-means Clustering: Identifying Weld Groups with Similar Characteristics
    - Reinforcement Learning: Introduction to Reinforcement Learning Concepts and Potential Applications in Welding (e.g., optimizing welding parameters in real-time)

Assessment:

- **In-class assignments/exercises:** Practical coding exercises and data analysis tasks related to each module.
- **Project:** A small project where students apply AI techniques to a specific welding engineering problem (e.g., developing a simple AI model for predicting weld defects).
- **Quizzes/Exams:** Short quizzes to assess understanding of key concepts.

Prerequisites:

- Basic understanding of welding engineering principles.
- Some familiarity with mathematics and statistics.

Software/Tools:

- Python (with necessary libraries: NumPy, Pandas, Scikit-learn, Matplotlib)
- Jupyter Notebook (Google Colab: https://colab.research.google.com/)