Course Title: Advanced Pneumatic Systems Engineering

Course Code: 2017-MECH

Course Duration: 60 Hours (30 Hours Theory + 30 Hours Practical)
Target Audience: Engineers, Technicians, and Individuals with a background in mechanical or electrical engineering, as well as professionals interested in advancing their knowledge of pneumatic systems.

Course Overview

This comprehensive course is designed for individuals seeking an in-depth understanding of pneumatic systems, including their components, design principles, and applications in industrial automation. The course covers advanced concepts in pneumatics, with practical applications and hands-on training.

Course Format

- **Mode**: In-person or online (virtual labs and simulations).
- **Learning Style**: Interactive lessons, real-world case studies, practical projects, and group discussions.
- **Evaluation**: Tests (theoretical and practical), assignments, and a final project.
- **Materials Included**: Lecture slides, simulation software, case study handouts, practical guides, and access to PLC programming platforms.

Course Objectives

By the end of this course, participants will:

- Understand advanced pneumatic principles, laws, and calculations.
- Be able to design and analyze pneumatic systems and circuits.
- Gain proficiency in programming and controlling pneumatic systems using PLCs.
- Implement safety protocols and preventative maintenance procedures in pneumatic systems.
- Complete real-world projects, applying learned skills to solve industrial challenges.

Detailed Course Outline

Unit 1: Introduction to Pneumatics (8 Hours)

- **1.1 What is Pneumatics?**
  - Definition and overview of pneumatic systems.
  - Difference between pneumatic and hydraulic systems, with examples of applications.
- **1.2 History and Evolution of Pneumatic Systems**
  - A historical perspective on the development of compressed air technologies.
  - Technological advancements and modern uses of pneumatics in industry.
- **1.3 Applications of Pneumatics**
  - Industrial applications: Packaging, automation, and material handling.
  - Medical applications: Pneumatic-powered medical devices.
  - Other uses: Automotive and robotic systems.

Unit 2: Pneumatic System Components (10 Hours)

- **2.1 Compressors**
  - Types of compressors: Piston, rotary, and screw compressors.
  - How to choose the right compressor for your application.
  - Preventative maintenance techniques for compressors.
- **2.2 Air Treatment**
  - Air Filters: Types, functions, and roles in system efficiency.
  - Dryers: Types of air dryers and their importance in moisture removal.
  - Lubricators: Maintaining lubrication for system longevity.
- **2.3 Actuators**

- Pneumatic cylinders: Single-acting and double-acting cylinders.
- Air motors: Principles of operation and applications.
- Basic calculations for force and velocity of actuators.

- **2.4 Valves**
  - Types of valves: Directional, flow control, and pressure relief.
  - Actuation types: Manual, electrical, and pneumatic actuation.
  - Symbol recognition and interpretation in pneumatic schematics.

Unit 3: Basic Pneumatic Principles (8 Hours)

- **3.1 Gas Laws and Their Applications**
  - Boyle's Law, Charles' Law, and the Ideal Gas Law in pneumatic applications.
- **3.2 Pneumatic Circuit Design and Analysis**
  - Elements required for circuit design.
  - Simple and advanced pneumatic circuit examples.
  - Use of FluidSIM software for simulations and analysis.
- **3.3 Reading Pneumatic Schematics**
  - Understanding and interpreting pneumatic diagrams and system layouts.
  - Case studies for performance evaluation.

Unit 4: Control Systems in Pneumatics (12 Hours)

- **4.1 Manual vs. Automatic Control**
  - Advantages and disadvantages of manual control.

- Introduction to automatic control systems in pneumatics.

- **4.2 Electrical and Mechanical Control**
  - Limit switches, sensors, and relays in controlling pneumatic circuits.
  - Operation of contactors and their role in circuit design.
- **4.3 PLC Integration in Pneumatics**
  - Introduction to PLC (Programmable Logic Controllers).
  - Programming PLCs to control pneumatic systems (using Siemens, Allen-Bradley).
  - Hands-on programming exercises.
- **4.4 Advanced Control Systems**
  - Proportional control and its benefits in pneumatic systems.
  - Intelligent control systems using sensors and PLCs.
  - SCADA system integration with pneumatic control systems.

Unit 5: Maintenance and Safety in Pneumatic Systems (10 Hours)

- **5.1 Preventive and Periodic Maintenance**
  - Systematic checks and component replacement.
  - Scheduling maintenance tasks to avoid system failure.
- **5.2 Safety Standards**
  - Compressed air safety protocols.
  - Emergency procedures and standard operating procedures for pneumatic systems.
  - International safety standards (ISO 4414).

- **5.3 Troubleshooting and Fault Diagnosis**
  - Common issues in pneumatic systems and their solutions.
  - Diagnostic tools and techniques for identifying faults.
  - Repair and recovery procedures.

Unit 6: Applied Projects (10 Hours)

- **6.1 Pneumatic Circuit Design Projects**
  - Practical projects on designing simple and complex pneumatic control circuits.
- **6.2 PLC-Based Control Projects**
  - Programming and configuring PLCs to control pneumatic systems.
  - Analyzing and optimizing system performance.
- **6.3 Case Studies**
  - Real-world applications of pneumatic systems in industry.
  - Problem-solving and evaluation of system performance in case studies.

Unit 7: Tests and Certifications (2 Hours)

- **7.1 Performance Evaluation**
  - Written theoretical exams.
  - Practical assessments of pneumatic system design and PLC programming.
- **7.2 Course Certification**
  - Issuance of completion certificates for successful candidates.
  - Recognition of acquired skills for professional growth.

Required Prerequisites

- Basic background in engineering (mechanical/electrical) or a related field.
- Understanding of basic physics concepts like pressure, flow, and force.

Tools and Software Used

- Simulation software: FluidSIM or Automation Studio for pneumatic system design and analysis.
- PLC programming software: TIA Portal or RSLogix for programming and control exercises.
- Real-world pneumatic components: Compressors, cylinders, valves, actuators, and PLCs.

Expected Outcomes

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

- Design and optimize pneumatic systems for various industrial applications.
- Program and control pneumatic systems using PLCs.
- Implement safety and maintenance protocols in pneumatic installations.
- Analyze and troubleshoot advanced pneumatic circuits effectively.

Certification

Upon successful completion of all course components, participants will receive:

- A **Certified Pneumatic Systems Engineer** certificate.
- Skills recognition for designing, controlling, and maintaining advanced pneumatic systems.