Virginia Western Community College
IND 243
Principles and Applications of Mechatronics

Prerequisites
MEC 140

Course Description
Introduces terminology and principles related to Mechatronic system design and application. Integrates concepts of electrical/electronic, mechanical and computer technologies in the development, setup, operation and trouble shooting of automated products and systems. Covers the breakdown of various automated manufacturing operations with emphasis on system planning, development and trouble shooting processes.

Semester Credits: 3 **Lecture Hours: 2** **Lab/Recitation Hours: 2**

Required Materials

Textbook:

TOOLING UNIVERSITY

Other Required Materials:

CIM cell, PLCs, Sensors

VIRGINIA WESTERN COMMUNITY COLLEGE
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Course Outcomes

1. **Provide a basic knowledge of CIM cells**
2. **Interpret technical information and familiarization of CIM components of basic systems.**
3. **Provide selection, implementation and testing of various CIM components.**
4. **Install, maintain and repair CIM systems**
5. **Troubleshoot CIM systems**
6. **Determine the sequence of operations of an automated production system.**
7. **Identify major components of an automated production system.**
8. **Understand and operate manual overrides.**
9. **Understand the principles of flow control valves and set actuator speed.**
10. **Perform output mapping.**
11. **Perform input mapping.**
12. **Understand pneumatic diagrams.**
13. **Understand electrical schematics.**
14. **Disassemble automated production stations.**
15. **Disconnect electrical components and wiring.**
16. **Remove mechanical components from a station.**
17. **Understand the operation and function of sensors and limit switches.**
18. **Write simple PLC (programmable logic controller) programs.**
19. **Build an automated production station.**

Topical Description

(Outline chapters, sections and timeline to be covered in the book)

Section	Topics	Suggested Timeline

1. Digital Fundamentals
   - 1.1. Introduction
   - 1.2. Signals
     - 1.2.1. Signals
     - 1.2.2. Binary Digits
     - 1.2.3. Logic Levels
     - 1.2.4. Equivalent Binary Digits
     - 1.2.5. Analog Measurement in Control Systems
     - 1.2.6. Conversion

- 1.3. Basic Logic Operations
  - 1.3.1. Introduction
  - 1.3.2. NOT Operation
  - 1.3.3. AND Operation
  - 1.3.4. OR Operation
  - 1.3.5. NAND Operation
  - 1.3.6. NOR Operation
  - 1.3.7. X-OR Operation
  - 1.3.8. X-NOR Operation
  - 1.3.9. Basic Logic Functions
- 1.4. Number Systems
  - 1.4.1. Introduction
  - 1.4.2. Decimal Number System
  - 1.4.3. Binary Number System
  - 1.4.4. Hexadecimal Number System
  - 1.4.5. Number System Conversion
  - 1.4.6. Signed Numbers
  - 1.4.7. Floating Point Numbers
  - 1.4.8. Digital Number Applications
- 1.5. Combining Logic in Mechatronic Systems
  - 1.5.1. Combined Logic Control
  - 1.5.2. Combined Logic Circuits
  - 1.5.3. Boolean Algebra

2. PLCs in Mechatronic Systems
- 2.1. Introduction
- 2.2. Basics
  - 2.2.1. Advantages to PCs
  - 2.2.2. Process Control
  - 2.2.3. In- and Outputs
- 2.3. Siemens PLCs
  - 2.3.1. Overview
  - 2.3.2. Compact PLCs
  - 2.3.3. Modular Systems
- 2.4. Programming
  - 2.4.1. Introduction
  - 2.4.2. Programming Languages
  - 2.4.3. PLC Scan
  - 2.4.4. Programming Devices
  - 2.4.5. In- and Output Numbering
  - 2.4.6. Programming Software
- 2.5. Basic PLC Operations

2.5.1. Bit Logic

Course Philosophy:
This course is the fourth in a series of four courses which prepare students for certification as a Siemens Certified Mechatronic Systems Assistant. The job profile for which the Level 1 certification prepares students is that of a machine operator, who has a well-rounded understanding of the complex inter-relationships and inter-workings of a mechatronic system.
This course, as all courses within the Certification Program, is based upon a systems-oriented approach. Students learn about individual components and system characteristics within the context of an actual mechatronic system. At the beginning of this course, students should first be presented with a complex system. Ideally, this system is physically available at the educational institution and within the first class meetings should be visited by the students. By focusing on an actual system, students understand clearly why they are learning the subject material. This increases significantly the learning effect and promotes a fuller understanding of the material being learned. By viewing the system as a whole, learning retention is also increased, as the student experiences the components as part of a whole, rather than in isolation. Of great importance is that the student is able to transfer the knowledge learned to a new system and is able to quickly familiarize himself in a new context.
This understanding leads to a better informed employee who has sufficient knowledge to make well-informed decisions about the running of the system upon which he or she is working.

Course Goals:
Upon completion of the course, students should:
1. Understand the role of programmable logic controllers in complex mechatronic systems, modules and subsystems.
2. Understand the flow of information in the system.
3. Understand and apply troubleshooting, maintenance and safety rules.

Course Objectives:
At the conclusion of this course, students will be able to:
1. Explain the role of programmable logic controllers within a given system or module.
2. Trace and describe the flow of information in a given mechatronic system or subsystem with a focus on the control function of PLCs in the system.
3. Describe the basic functions of PLCs.
4. Read, analyze and utilize the technical documents such as data sheets, timing diagrams, operation manuals, schematics.
5. Correctly localize, identify and document system malfunctions in or caused by PLC hardware, based upon the technical documentation.

6. Apply safety rules while working on the system.
7. Transfer the knowledge learned from one system to another system.

Notes to Instructors

The exam/project is worth 20% of the final grade.