Virginia Western Community College
IND 251
Automated Manufacturing Systems I

Prerequisites
Divisional Approval

Course Description
Presents basic principles used in the design and implementation in manufacturing work cells. Includes selection of the robot system, worksite, application cell sensors, development of cycle times, and economic analysis.

Semester Credits: 4 **Lecture Hours: 2** **Lab/Recitation Hours: 4**

Required Materials

Textbook:
Instructor developed

Automation Systems

Course Description

The Automation Systems course in the Level 2 certification program is divided into two main branches; Manufacturing Technologies, including CNC, CAD and CAM; and Microcontrollers and Programming, which constitute essential tools in modern manufacturing particularly mechatronic systems.

VIRGINIA WESTERN COMMUNITY COLLEGE
School of Science, Technology, Engineering and Mathematics
(540)-857-7273

3080 Colonial Ave. SW
Roanoke, VA 24015

When breaking down this system into its modules, it is likely to find a microcontroller as the intelligent core of the entire structure. The microcontroller section begins to explain the theory behind microcontroller and microprocessor architecture, and focuses later on its features and ways of interaction with other electronic elements understanding its particular function, and its role as part of a whole. This theory is complemented with practical exercises that reflect the importance of microcontrollers in a mechatronic system. The use of component data sheets for reference, calculations and design is also explained. The course culminates with the instruction of Assembly Language programming, which is applied when operating microcontrollers and designing and constructing devices that include this type of element. Basic programming skills can be taught parallel to the instruction of the Assembly syntax at the earlier stages as needed. This section makes up for approximately 60% of the total material for Manufacturing Automation.

For the remainder of the class, the emphasis turns to manufacturing automation. In this section the main concepts to be covered include Metal Cutting, Modal Analysis, CNC, CAM and CAD. These tools provide students with part of the skill set necessary to maintain and improve mechatronic systems. The class can concentrate on one or more of these topics as needed in each particular case and depending the students' background. The metal cutting section includes references on material properties, tool geometry and mechanics for manufacturing processes. The section on CNC is one of the main focuses of this part of the course and it includes different types of commands, an introduction to CNC design and general algorithms. The CAM section explains the use of NC, APT, parametric definitions as well as tool geometry. The course ends with general CAD instruction that can be deepened as needed.

Course Philosophy

The main goal of Course 3 is to give a clear view to students about the different tools that they can use to maintain and improve mechatronic systems used in manufacturing environments. A Level 2 Siemens Mechatronics associate is expected to have a solid background concerning manufacturing methods and devices. Within this goal, the knowledge and familiarity with common concepts in manufacturing such as CNC, CAM and CAD is essential to form a highly skilled technician with " Handlungskompetenz" who will be able to interact with the environment, incorporate improvements, and remain flexible when changes are required.

In addition to this knowledge this course emphasizes in microcontroller technology and computer programming, which are of great importance in modern manufacturing as the main bridges between classical manufacturing and rapidly evolving technology.

Microcontrollers are covered to the extent where students are able to construct, program and operate such devices to control one or several modules within a mechatronic system.

Course Goals

1. Be able to apply knowledge about automation manufacturing to maintain and improve mechatronic systems.
2. Realize the importance of microcontrollers and automated tools as essential components on a mechatronic system.
3. Understand the relationship of these elements as part of a whole and how they interact with others in a way that allows for successful operation and continuous improvement.

Course Objectives

Upon completion of the course, students should be able to:

1. Operate, assemble and interconnect microcontrollers.
2. Make use of microcontrollers in a mechatronic system taking advantage of its features to expedite automation systems.
3. Program mechatronic modules and systems.
4. Recognize metal cutting methods, tool geometries and general material properties.
5. Use CAD, CAM and CNC general concepts to maintain and improvemechatronic systems.
6. Understand CNC fundamentals and basic notions on CNC programming.
7. Identify general aspects about CAM, its applications and advantages in aautomated manufacturing environment.
8. Represent models for mechatronic components by using CAD tools.

Microcontrollers Fundamentals

- **Microcontroller, Microprocessor and Microcomputer**
  - **Applications**
  - **Interconnection setups**
- **Components of Microcontroller**
  - **CPU Overview**
  - **ALU Overview**
  - **RAM Overview**
  - **ROM Overview**
  - **Ports**

Microcontroller Systems

- **Visual representation**

- Numbering systems
  - Binary System and binary-decimal conversions
  - Hexadecimal system and conversion
- LSB and MSB
- Busses overview and classification
  - Biderectional and uniderectional busses
  - Adress busses
  - Control busses
  - Data busses

Components of a Microcontroller

- ALU
  - Logical Operations
- Components
  - Registers
  - Flags
- RAM
  - RAM Princeples
  - Timing - Waveform diagrams
  - Store - Read capabilities
  - Data sheet interpretation
  - RAM classification
  - Interconnections for RAM
  - Memory maps
- ROM
- Introduction 8085
  - Historical overview
  - Data sheet and diagram interpretation
  - Pin configuration
  - Latches
  - Timing diagrams
- Multiplexed address data bus
  - Use of latches for multiplex address busses
  - Visual representation
- Clocks and Clock Signals
  - Mechanical vibrations principle
  - Study of frequency, FCPU and FPeripherial
- I/O Port
  - Output port
  - Address decoder
  - I/O Port structure
  - Input port

    - IOM signal
    - One signal line pin
- Assembly (withs parallel training)
    - Syntax
    - Introduction to simulator program
    - MVI, ADD
    - JMP, JNZ, JM commands
    - 16-Bit numbers into 8-bit systems
    - JP comparing
    - Checking bits (AN1)
    - Setting bits (OR1)
    - Resetting bits (AN1)
    - Ports (In/Out)
    - Applied Project
    - External Memory
    - Execution timing with 8085
    - Functions

Manufacturing Automation
Introduction to a Flexible Manufacturing System

The main elements of a FMS

- Computer Aided Design (CAD) / Computer Aided Manufacturing (CAM)
- Computer Numerical Control and Distributed / Direct Numerical Control
    - Fundamentals of Computer Numerical Control (CNC)
    - CNC Design
    - Degree Of Freedom and DNC
    - Standard CNC Commands
    - Motion Commands
    - Miscellaneous Commands
    - Work Holding Device
- Modular Conveyor as Material Handing and Storage
    - The use of conveyors in the FMS
    - Different Modules of a modular conveyer system
- Computer Control System
    - PLC applications in manufacturing automation context
    - Computer Aided Quality Assurence (CAQ)
    - Communication in and of FMS
        - Industrial Communication
        - Supervisory Control And Data Acquisition (SCADA)

Notes to Instructors

1. Fluid CIM, Automation Studio and CIROS (software packages for simulation) are required.

2. The final exam/project is worth 15-20% of the final grade.