Far Western University
Faculty of Engineering
Mahendranagar, Kanchanpur
Bachelor's Degree in Computer Engineering
Course of study

Course Title: Computer Instrumentation	**Credit: 3**
Course Code: EX 352	**Number of lecture/week: 3**
Nature of Course: Theory+ Practical	**Tutorial/week: 1**
Year/Semester: III/I	**Total hours: 45**

1. Course Objectives:

The students will be able to understand the method of interfacing instruments to microprocessors. Focus is given to the various protocols for establishing communication between instruments. The concept of programmable peripheral interface and its connection to microprocessors is introduced through examples. The importance of data converters and data acquisitions systems in instrumentation systems is also highlighted. Principles of grounding and shielding during circuit design along with the actual process of creating printed circuit boards is covered. The knowledge of estimating system reliability and designing fault tolerant systems is also touched upon. The students are also provided fundamental knowledge regarding various automation systems used in industry such as PLC and SCADA. Finally, with the help of a case study students are exposed to the equipment and instruments used in industry.

2. Course Outline

Chapter Number	Contents	Duration
1	**Microprocessor Based Instrumentation System** 1.1 Basic Features of Microprocessor Based System 1.2 Open Loop and Closed Loop Microprocessor Based System 1.3 Benefits of Microprocessor Based System 1.4 Interfacing with Microprocessor 1.4.1 Review of Address Decoding 1.4.2 Memory Interfacing 1.4.3 I/O Interfacing 1.5 Programmed I/O, Interrupt Driven I/O and Direct Memory Access	**[3 Hours]**
2	**Programmable Peripheral Devices** 2.1 Importance of Programmable Peripheral Interfaces (PPI) 2.2 8255 PPI 2.2.1 Pin Diagram, Block Diagram 2.2.2 Modes of Operation 2.2.3 Control Word and Status Word 2.2.4 Simple I/O, Strobe I/O, Single and Double Handshake I/O 2.2.5 Interfacing examples of 8255 with 8085 microprocessor 2.2.5.1 Seven-Segment Display Interfacing 2.2.5.2 Stepper Motor Interfacing	**[3 Hours]**

3	**Instrument Interfacing Protocols** 3.1 Serial Protocols: 3.1.1 Recommended Standards (RS 232, RS 422, RS 485), Inter-Integrated Circuit (I^2C), Serial Communications Interface (SCI), Serial Peripheral Interface (SPI), IEEE 1394 (FireWire), Universal Serial Bus (USB), High-Definition Multimedia Interface (HDMI) 3.2 Parallel Protocols: 3.2.1 General Purpose Interface Bus (GPIB, IEEE-488), Versa Modular Eurocard (VME), VME eXtensions for Instrumentation (VXI), Industry Standard Architecture (ISA), Peripheral Component Interconnect (PCI), Peripheral Component Interconnect express (PCIe), PCI eXtensions for Instrumentation (PXI), Advanced Microcontroller Bus Architecture (AMBA) 3.3 Wireless Protocols: 3.3.1 Infrared Data Association (IrDA), Bluetooth, Wi-Fi Direct, IEEE 802.11, Zigbee, Z-Wave, Long Range (LoRa)	**[7 Hours]**
4	**Data Acquisition Systems (DAS) and Data Converters** 4.1 Objective of DAS 4.2 Signal Conditioning of the Inputs 4.3 Single Channel and Multi-Channel DAS 4.4 Computerized DAS 4.5 General Terms involved in A/D and D/A Converters 4.6 Static and Dynamic Errors of Data Converters 4.7 Interfacing examples of A/D and D/A Converters with 8085 microprocessor 4.8 Selection of A/D and D/A Converters based on Design Requirements 4.9 Data Logger and its applications	**[4 Hours]**
5	**Grounding and Shielding** 5.1 Outline for Grounding and Shielding 5.2 Noise, Noise Coupling Mechanism and Prevention 5.3 Single Point Grounding 5.4 Multi-point Grounding and Ground Loop 5.5 Filtering and Smoothing 5.6 Decoupling Capacitors and Ferrite Beads 5.7 Line Filters, Isolators and Transient Suppressors 5.8 Different Kinds of Shielding Mechanisms 5.9 Electrostatic Discharge (ESD) and protection against ESD	**[3 Hours]**
6	**Circuit Board Design** 6.1 Concept of Printed Circuit Board (PCB): 6.1.1 Terminology & Types (Paper, Glass Epoxy, Aluminum Clad, Single Layer, Double Layer, Multi Layered, Flexible) 6.2 PCB Design Considerations: 6.2.1 Voltage Isolation and Current Capacity, Noise Reduction	**[7 Hours]**

	Through PCB Layout, High and Low Power Circuit on Single PCB, Component & I/O Placement – PCB Design for Mixed Signal (Analog and Digital) Circuits 6.3 Schematics: 6.3.1 Schematic drawing from circuit, Placing, editing, and connecting parts and electrical symbols, Libraries and parts, Netlist creation, Exporting and importing schematic data 6.4 Layout Design: 6.4.1 PCB Workflow, Footprint generation for Surface Mount and Through hole components, Importing, Components placing, Details of layers, Routing guidelines, Copper Pour, Design Rule Check, Adding reference texts, Gerber file generation	
7	**Instrumentation Reliability** 7.1 Basic Concepts of Reliability: 7.1.1 Reliability Principles and Terminology, Definition of Reliability, Meaning of failure, statistical nature of failure, repairable and non-repairable failures, component failure versus system failure 7.2 System Reliability: 7.2.1 Systems with components in series, systems with components in parallel, series-parallel systems, fault tree techniques, K-out-of-M Systems 7.3 Reliability Data Analysis: 7.3.1 The reliability function, bathtub curve, linear hazard model, exponential hazard model, mean time between failures (MTBF), Mean time to failure (MTTF), Mean time to repair (MTTR), a-priori and a-posteriori concept 7.4 High Reliability Systems: 7.4.1 Reliability budgets, Redundancy with majority voting, Level of redundancy 7.5 Fault Tolerant Hardware and Software	**[5 Hours]**
8	**Instrumentation for Automation** 8.1 Need for Automation in Industry 8.2 Benefits of Automation 8.3 Programmable Logic Controller (PLC) 8.3.1 PLC Architecture: Block Diagram and Working Principle 8.3.2 PLC Classification based on Type and Size 8.3.3 PLC Hardware: Addressing of PLC Input/Output, PLC Wiring 8.3.4 PLC Programming: Ladder, Instruction List, Structured Text, GRAFCET 8.3.5 PLC Instructions: Data Transfer, Arithmetic, Data Comparison, Data Manipulation, Timer Instructions, Counter Instructions, Program Control Instructions, Pulse Instruction, PID Instruction 8.4 Supervisory Control & Data Acquisition (SCADA)	**[7 Hours]**

	8.4.1 Functional Block Diagram 8.4.2 Functions of SCADA 8.4.3 Communication between PLC and SCADA 8.4.4 SCADA Applications	
9	**Case Study** Examples chosen from industrial situations with particular attention paid to the basic measurement requirements, accuracy, and specific hardware and software employed. **Examples:** ➢ Instrumentation for a power station including all electrical and nonelectrical parameters. ➢ Instrumentation for a wire and cable manufacturing and bottling plant. ➢ Instrumentation for a beverage manufacturing and bottling plant. ➢ Instrumentation for a complete textile plant; for example, a cotton mill from raw cotton through to finished dyed fabric. ➢ Instrumentation for a process; for example, an oil seed processing plant from raw seeds through to packaged edible oil product. ➢ Instruments required for a biomedical application such as a medical clinic or hospital. ➢ Other industries can be selected with the consent of the Subject teacher.	**[6 Hours]**

3. List of Practical / Experiments

S.N.	Experiment Name
1	Data transfer using 8255 PPI and 8085 processor
2	Interfacing 7-segment and stepper motor using 8255 PPI & 8085 processor
3	ADC 0816 interfacing with 8085 processor using 8255 PPI
4	DAC 0808 interfacing with 8085 processor using 8255 PPI
5	Ladder diagram implementation of basic logic gates Ladder diagram for various discrete state systems
6	PLC Programming Experiments: - Speed control of AC Servo Motor - Water Level Control
7	Single-sided PCB Design - Layout & Hardware
8	Developing and implementing any control loop using SCADA system

4. Field Visit

Two days field visit should be carried out by the students to explore about computer instrumentation. After the field visit, students should (i) submit a field report individually; and (ii) prepare for the group presentation at the end.

References

1. Ramesh Gaonkar, "*Microprocessor* Architecture Programming and Applications with the 8085", 4th edition, Prentice-Hall, Inc. Upper Saddle River, NJ, USA

2. Douglas V. Hall, "*Microprocessors and interfacing programming and Hardware*", 2nd Edition.
3. Barry B. Brey, "*The intel microprocessors, architecture, Programming and interfacing*", 8th Edition.
4. M.M.S. Anand, "*Electronic Instruments and Instrumentation technology*", Prentice hall of India, New Delhi.
5. Colin Simpson, "*Programmable Logic Controllers, Prentice Hall*", 1st Edition.
6. Gary Dunning, "*Introduction to Programmable Logic Controllers*", 3rd Edition.
7. Walter C Boschart, "*PCB design and technology*" Tata McGraw-Hill publishing company Ltd., New Delhi.
8. Sanjay Gupta, "*P.C. Interfacing for data Acquisition & Process Control*", 2nd Edition.
9. Stuart A. Boyer, "*SCADA: Supervisory Control And Data Acquisition*" 4th Edition.
10. Kim R Fowler, "*Electronic Instrument Design*", Oxford University- 1996.

Evaluation Scheme:

Chapter	Hours	Marks Distribution*
1	3	4
2	3	6
3	7	8
4	4	6
5	3	6
6	7	8
7	5	6
8	7	10
9	6	6

* There may be minor variation in marks distribution

Internal Evaluation (Marks Weightage)		Final Exam (Marks Weightage)	Total	Remarks
Assessment/Class Performance/Attendance/Quizzes/ Tutorials/Presentation	Practical			
40		60	100	Internal marks will be of 40 if there are no practical works in the course
20	20	60	100	Internal marks will be of 20 if there are practicals in the course (20 marks will be allocated for Practicals)