University of Sistan and Baluchestan

Department of Mechanical Engineering-Mechatronics

Course Title: Advanced Measurement Techniques

Instructors: Tahereh Fanaei Sheikholeslami

Credits: 3

Description and Importance of the Course

Education for engineers and researchers to acquire knowledge of recently developed technologies in electronic-mechanical engineering is needed due to the recent developments in micro-electronics technology and computer science, which influences mechanical engineering to produce new intelligent machines with advanced technologies.

A mechatronic engineers is expected to design, measure and produce value-add products using integrated knowledge of electronics and information engineering as well as conventional mechanical engineering. Advanced measurement course concentrate on methods of sensing, physical principles of sensors operations, practical designs, and interface electronic circuits.

Course covers design and selection of best suited sensors for a specified problem, regarding range, accuracy, dynamic behavior, environment requirements, etc.

+ General Electrical measurement techniques: Resistance, IV and CV measurements

+ General Physical measurement techniques: SEM, AFM, FTIR, UV-Visible, ….

References

- **Main Reference:** Handbook of Modern Sensors: Physics, Designs, and Applications, By: Jacob Fraden, Springer, 2010.
- **Second Reference:** Measurement Instrumentation and Sensors Handbook, by: John G. Webster, 2000.

Some Useful Textbooks:

- Fundamentals of Electronic Circuit Design, By: Hongshen Ma, 2005.
- How to Design and Build Working Electronic Circuits, By: Hongshen Ma, 2005.

Course Details

Week	Contents	
1	Data Acquisition: Sensors, Signals, and Systems, Sensor's place in a device, Sensor Classification, Units of Measurements.	Four Point Probe Resistivity Measurement
2	Characteristics of Instrumentation: Passive and Active Sensors, Calibration, Modifying and Interfering Inputs, Accuracy and Error, Sensor Fusion, Estimation Lab section	
3	Operational Modes of Instrumentation: Null Instrument, Deflection Instrument, Analog and Digital Sensors, Analog and Digital Readout Instruments, Input Impedance	IV Curve and related parameters
4	Physical Principles of Sensing: Electric Charges, Fields	
5	Physical Principles of Sensing: Capacitance	Hall Effect Measurement
6	Physical Principles of Sensing: Magnetism and Induction	
7	Physical Principles of Sensing: Piezoelectric Effect	**Midterm Exam** (subjects of weeks 1 to 6)
8	Physical Principles of Sensing: Thermoelectric Effect	Capacitance-Voltage Measurement
9	Physical Principles of Sensing: Light	Scanning Electron Microscopy (SEM)
10	Interface Electronic Circuits: Input C/Cs of Interface Circuits, Amplifiers, Light-to-Voltage Converters, Excitation Circuits, ADC.	
11	Interface Electronic Circuits: ADC, Bridge Circuits, Noise in Sensors and Circuits.	Uv-Visible Spectroscopy
12	Motion Detectors, Position, Displacement, and Level: Potentiometric Sensors, Capacitive Sensors	Atomic Force Microscopy (AFM)
13	Pressure Sensors, Humidity and Moisture Sensors	**Seminars**
14	Force, Strain, and Tactile Sensors, Flow Sensors	**Seminars**
15	DOE 1	
16	DOE 2	

Evaluation

- Seminar: 15%

Each student chooses one type of the sensors **based on the main reference book** and prepare a presentation for 30 to 40 minutes.

- DOE Project: 20%

A DOE procedure should be define for an optional sensor based on a virtual set of measured data, simulate the performance of the sensor and optimized its output.

- Midterm exam: 30%
- Final exam: 35%