LAHORE COLLEGE FOR WOMEN UNIVERSITY

Jail Road, Lahore – Pakistan. Tel: 042-9203072,9203089, 9201950 Fax: 042-9203077

DEPARTMENT OF ELECTRICAL ENGINEERING
Course Descriptive File

1	CourseTitle	Instrumentation and Measurements
2	CourseCode	EE324
3	CreditHours	3+1
4	Pre-requisites/Co-requisites	
5	Semester	VI
6	ResourcePerson	AhlamJameel
7	ContactHours(Theory)	48
8	ContactHours(Lab)	48
9	Office Hours	9am to 4pm.
10	Email	ahlam.khan@hotmail.com

11	Course Outline as per Scheme of Studies (SoS)

a) Electrical/ Electronic Variable Measurement.
b) Non-Electrical Variable Measurement.
c) AC and DC Bridge Circuits
d) Data Acquisition System
e) Transducer

12	Course Objectives as per SoS

This course covers the basic use and application of sensors, transducers and electronic measuring instruments. The theory of analogue DC and AC measuring instruments is first established which is then used to study analog electronic and digital meters. Different types of sensors and transducer are studied with their analog and digital interfacing. The use and application of different measuring instruments are also covered.

13	Books

Text Book:

Electronic Instrumentation and Measurements by David A. Bell (2nd Edition)

Reference Books:

Measurement and Instrumentation Principles by Allen S. Morris (3rd Edition)

14	Course Learning Outcomes (CLOs)

After successful completion, students will be able:

CLO NO.	CLO STATEMENT	PLO	Taxonomy LEVEL
1	Explain the aspects of different instruments/sensors in terms of their use, physical construction, mathematical operation and pros-cons for measuring electrical/physical quantities.	3	C2
2	Compute the electrical parameters with regard to different designing topologies of voltmeter, ammeter, ohmmeter and watt-meter.	3	C3
3	Analyze a variety of transducers, electronic circuits and measuring systems used in different fields.	9	C4

15	Marks Breakup

Theory

Quizzes	10%
Homework/assignments	10%
Midterm exam	30%
Terminal exam(3 hours)	50%
Total (theory)	100%

Lab

Lab Assessments	%
Lab Sessional Exams (xx% Lab performance + xx% Lab Assessments)	%
Lab Terminal Exam (xx% Lab performance + xx% Lab Assessments)	%
Total (lab)	100%

Final marks	Theory marks * 0.75 + Lab marks * 0.25

16						
Week	**Topic**	**CLO**	**Taxonomy Level**	**Specific Outcome**	**Contact Hours**	**Assessment**
1	• **Elements of Measurement System** • **Static Characteristics of Instruments** (Accuracy, Precision, Tolerance, Range of Span, Linearity, Sensitivity, Resolution, Threshold, and Dead Space) • **Practice Problems**	1	**C2**	After completing these contents student will be able to Define the following terms: Fundamental unit, derived unit, accuracy, precision,sensitivity, resolution, error,range and span.	3	Assignment 1 Quiz 1
2	**Construction of Permanent Magnet Moving Coil (PMMC) Instruments** (Coil Assembly, Operating Forces present in the PMMC Instrument, Suspension System used, Damping mechanism used, Torque Equation and Scale of the instrument)	1	C2	After completing these contents student will be able to Sketch the construction of a PMMC instrument and explain its operation.	3	
3	**Electromechanical Instruments** • Galvanometer (Construction, operation and sensitivity of galvanometer) • DC Ammeter (Ammeter Circuit, Scale, Shunt Resistance and	1	C2	After completing these contents student will be able to 1. Show how PMMC instruments are used as galvanometers, dc ammeters.	3	

	Swamping Resistance, Burden Voltage, Multi-range Ammeter)			2. Describe the operation of the Galvanometer 3. Describe the operation of the DC ammeter to include current shunts, multi range ammeters, errors due to loading effects.		
4	**Electromechanical Instruments** • DC Voltmeter (Voltmeter Circuit, Swamping Resistance, Voltmeter Sensitivity, Loading Effect, Multi-range Voltmeter) • Rectifier voltmeter(Full wave rectifier voltmeter, half wave rectifier voltmeter) • Design Problems	1	C2	After completing these contents student will be able to 1. Describe how a DC ammeter is used to form a DC voltmeter and voltmeter ohms-per-volt specifications, errors due to loading effects and precautions in using DC voltmeters. 2. Show how PMMC instruments are used as ac voltmeter using rectification. 3. Describe the operation of half-wave and full-wave rectifier AC voltmeters and how precision rectifier is used to permit a PMMC meter to measure AC voltages.	3	Assignment 1 Quiz 1

5	**Electromechanical Instruments** • Rectifier ammeter • Ohmmeter (Ohmmeter Accuracy) • Series Ohmmeter • Shunt ohmmeter	1	C2	After completing these contents student will be able to 1. Calculate appropriate shunt and series resistance values for given ammeter and voltmeter ranges, and determine instrument accuracy. 2. Show how PMMC instruments are used as ac ammeter using rectification. 3. Describe the operation of half-wave and full-wave rectifier AC ammeters and how precision rectifier is used to permit a PMMC meter to measure AC currents.	3	
6	**Electromechanical Instruments** • Electrodynamic Wattmeter (Construction and operation) • Design problems related to Voltmeter,	2	C3	After completing these contents student will be able to 1. Describe the operation of wattmeter and how precisely an electrodynamic instrument can	3	

	ammeter and electrodynamometer)			measure AC and DC power.		
7	• **Analog Electronic Instruments** (Operational Amplifier Voltmeter, Voltage-to-Current Converter, Op- amp Voltage follower voltmeter, Series and Shunt Electronic Ohmmeter, Linear Ohmmeter)	2	C3	After completing these contents student will be able to 1.Draw the circuit diagrams of various op-amp analog voltmeters and explain the operation of each circuit. 2. Draw series, shunt and linear ohmmeter circuits as used in electronic instrument. 3. Sketch a circuit to show how current is measured by electronic voltmeter. 4. Describe how an AC electronic voltmeter is constructed and how it can operate.	3	Assignment 2 Quiz 2
8	• **AC electronic voltmeters** • Current measurement with electronic instruments. • Analog electronic multi-meters **(** Lab type multi-meter,Multi-meter probes)	2	C3	After completing these contents student will be able to 1. Use analog electronic multi-meters for resistance, current and voltage measurements.	3	

	• Design problems					
9	**Transducers (**Introduction, Resistance changing transducers i-e: RTD, Thermistors, Strain gages, photoconductive transducers , self-generating transducers i-e: Thermocouples, piezoelectric, magnetic-induction, photovoltaic transducers, Electromagnetic Flow meter, Inductive transducer, capacitive transducers, phototransistors and photodiodes).	3	C4	After completing these contents student will be able to 1. Explain how resistance-changing transducers work and how the electric changes can be measured. 2. Explain how the self-generating transducers work and how electrical changes can be measured. 1. Draw the basic block diagram of digital frequency meter, sketch the system waveforms and explain the system operation. 2. Discuss the errors that occur in digital frequency meters and method used for specifying measurement accuracy. 3. Describe the construction and explain the principle of the electromagnetic flow meter. 4. Explain how the inductive and capacitive	3	Assignment 3

				transducers work and how electrical changes can be measured. 5. Describe the operation of phototransistors and photodiodes and describe suitable circuits for their use.		
10	**Digital Instrument Basics** • Basic Logic gates • Flip Flops • Digital Displays(LED, LCD) • Digital Counting(Scale of 16 counter, Decade counter, scale of 2000 counter, Digital Frequency division) • Analog to Digital Converter(Ramp type A/D converter, Quantization error) • D/A converter(R/2R network, resolution) • Practice Problems	2	C3	After completing these contents student will be able to: 1. Sketch the circuits of various gates. Explain the operation of each gate and sketch its logic symbols. 2. Sketch a basic transistor flip flop circuit and explain its operation. 3. Explain the operation of LCDs and LEDs and how they are used in seven segment numerical displays. 4. Logic diagrams and operations of counter scales 5. Show how decade counters may be used for frequency division. 6. Draw circuit diagrams of A/D and D/A converters and show how	3	Assignment 4

				conversion is achieved and discuss conversion accuracy and resolution.		
11	**Digital Voltmeters and Frequency Meters** • Digital Voltmeter Systems(Ramp type digital voltmeter, Dual slope Integrator DVM) • Digital Frequency Meter System(Basic Frequency meter)	2	C3	After completing these contents student will be able to 1. Sketch the block diagram of DVM using an A/D converter. 2. Show the system waveforms and explain how a DVM operates. 3. Sketch the block diagram of DVM using Dual slope integrator and explain how a DVM operates. 4. Draw the block diagram of digital frequency meter, and explain the system operation.	3	Assignment 5
12	**Low, high and precise Resistance Measurements** • Voltmeter/Ammeter method and error analysis • Substitution Method • Wheatstone Bridge(Accuracy, sensitivity) • Kelvin Bridge • Practice Problems	3	C4	After completing these contents student will be able to 1. Explain the V/A methods and the substation method of resistance measurement. 2. Sketch the circuit diagram of Wheatstone bridge, explain its operation and derive its balance equation.	3	

				3. Determine the accuracy and sensitivity of the Wheatstone bridge. 4. draw the circuit diagram of Kelvin bridge for low resistance measurement, and derive its balance equation.		
13	**Low, high and precise Resistance Measurements** • Loss of charge method • Megaohm method • AC bridge • General balance AC bridge • Maxwell inductance bridge for measurement of inductance	3	C4	After completing these contents student will be able to 1. Explain loss change method and mega ohm method. 2. Sketch ac bridge circuit diagrams, Maxwell inductance bridge and their operation.	3	
14	**Inductance Measurement** • Maxwell inductance capacitance bridge • Hay bridge • Owen's bridge	3	C4	After completing these contents student will be able to 1. Explain Maxwell inductance capacitance bridge 2. Explain Hay bridge 3. Explain Owen's bridge.	3	

15	**Capacitance measurement** • Series resistance bridge • Parallel resistance bridge • Wein Bridge(Measurement of Frequency) • Q-meter • Data Acquisition System	3	C4	After completing these contents student will be able to 1. Explain series/parallel resistance bridges 2. Sketch ac bridge circuit diagrams and derive expressions for capacitance measurement 3. Compare the Series resistance bridge, Parallel resistance bridge, Wein Bridge	3	Assignment 6
16	**CRO** • Introduction • Components • Digital storage oscilloscope • Construction **Signal Generator**	3	C4	After completing these contents student will be able to 1. Explain the construction and working of Oscilloscope 2. Explain the construction and working of signal generator		