CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET203	MEASUREMENTS AND INSTRUMENTATION	PCC	3	1	0	4

Preamble : This course introduces principle of operation and construction of basic instruments for measurement of electrical quantities. Measurement of basic circuit parameters, magnetic quantities, and passive parameters by using bridge circuits, sensors and transducers will be discussed.Familiarization of modern digital measurement systems are also included.

Prerequisite :**Nil**

Course Outcomes :After the completion of the course the student will be able to

CO 1	Identify and analysethe factors affecting performance of measuring system
CO 2	Choose appropriate instruments for the measurement of voltage, current in ac and dc measurements
CO 3	Explain the operating principle of power and energy measurement
CO 4	Outline the principles of operation of Magnetic measurement systems
CO 5	Describe the operating principle of DC and AC bridges, transducersbased systems.
CO 6	Understand the operating principles of basic building blocks of digital systems, recording and display units

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	1	-	-	-	-	-	-	2
CO 6	3	-	-	-	2	-	-	-	-	-	-	2

Assessment Pattern

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	20	30
Understand	20	20	50
Apply	15	10	20
Analyse			
Evaluate			
Create			

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Explain static characteristics of measuring systems.
2. Problems related to measurement errors.
3. Concept of calibration of measuring instruments

Course Outcome 2 (CO2):

1. Explain the construction and working indicating Instruments.
2. Problems related to extension of range of meters

Course Outcome 3(CO3):

1. Describe the principle of operation and construction of energy meter
2. Describe the principle of operation and construction of wattmeter
3. Problems related to two and three wattmeter method of power measurement.

Course Outcome 4 (CO4):

1. Explain the principle of operation of ballistic galvanometer.
2. Describe the procedure for plotting the B-H curve of a magnetic specimen.

Course Outcome 5 (CO5):

1. Explain classification of Transducers
2. Measurement of frequency using Wien bridge.
3. Explain the operation of basic ac/dc bridges
4. Illustrate the principle of temperature measurement using thermocouple.

Course Outcome 6 (CO6):

1. Block diagram of DMM, CRO, DSO, PMU
2. Basic ideas on simulation softwares and virtual instrumentation.
3. Explain the operation of basic ac/dc bridges

Model Question paper
QPCODE: PAGES:3

Reg.No:_____

Name :_____

APJABDULKALAMTECHNOLOGICALUNIVERSITY THIRD SEMESTERB.TECHDEGREEEXAMINATION,

MONTH &YEAR

Course Code: EET 203

Course Name: Measurements and Instrumentation

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. What are the different standards of measurement?
2. State and briefly explain the classification of electrical measuring instruments.
3. What are the special features incorporated in low power factor wattmeter?
4. Write short note on three phase energy meter.
5. Describe the working of hall effect sensors.
6. With the help of a diagram indicate the calibration of wattmeter using DC potentiometer.
7. Describe the method of determination of BH curve of a magnetic material.
8. What are the main requirements in magnetic measurements?
9. Explain briefly about digital voltmeter.
10. What is lissajouspattern. Indicate the factors on which shape of these figures depends.

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

1. (a) Explain the essentials of indicating instruments and what are the different methods of producing controlling torque in an analog instrument? **(6)**

(b) Explain with the help of neat sketches, the construction and working of attraction type moving iron instruments. Give the equation for torque of the MI instrument and the merits and demerits. **(8)**

2. (a) Discuss different types of damping. What is the necessity of damping and how damping is provided in PMMC instrument? **(8)**

   (b) A moving coil ammeter has fixed shunt of 0.01Ω. With a coil resistance of 750Ω and a voltage drop of 500mV across it, the full scale deflection is obtained. (1) Calculate current through shunt (2) Calculate resistance of meter to give full scale deflection if shunted current is 60A. **(6)**

Module 2

3. (a) Derive the expression for transformation ratio and phase angle of a current transformer using its equivalent circuit and phasor diagram. **(14)**

4. (a) Explain the construction and operation of dynamometer type wattmeter. **(7)**

   (b) With a neat block diagram, explain the working of electronic energy meter. What are its merits compared to induction type energy meter. **(7)**

Module 3

5. (a) Draw the circuit and phasor diagram of schering bridge for the measurement of capacitance, Derive the expression for the unknown capacitance.**(10)**

   (b) Explain loss of charge method for the measurement of high resistance. **(4)**

6. (a) Explain with the help of neat connection diagram how you would determine the value of low resistance by kelvin's double bridge method. Derive the formula used. **(7)**

   (b) Describe the method of measurement of earth resistance and what are the factors which affect the value of earth resistance? **(7)**

Module 4

7. (a)Explain the method of measurement of permeability. **(5)**

   (b) What is the principle of temperature measurement using thermistors and compare temperature measurement using RTD and thermistor. **(9)**

8. (a) Explain the working of flux meter. **(4)**

   (b) What is a Llyod- Fisher square. Explain the measurement of iron losses in a magnetic material employing Llyod- Fisher square using wattmeter method. **(10)**

Module 5

9. (a) With the help of a neat sketch explain the working of LVDT. Also draw its characteristics. **(6)**

   (b) Explain how CRO can be used to measure the frequency and phase angle. **(8)**

10. (a) How strain is measured using strain gauge. **(4)**

    (b) With a neat diagram, explain the working of a digital storage oscilloscope. **(10)**

(14x5=70)

Syllabus

Module 1

Measurement standards–Errors-Types of Errors- Statistics of errors, Need for calibration.

Classification of instruments, secondary instruments–indicating, integrating and recording-operating forces - essentials of indicating instruments - deflecting, damping, controlling torques.

Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles shunts and multipliers – extension of range.

Module 2

Measurement of power: Dynamometer type wattmeter –Construction and working - 3-phase power measurement-Low Powerfactor wattmeters.

Measurement of energy: Induction type watt-hour meters- Single phase energy meter – construction and working, two element three phase energy meters,

Digital Energymeters -Time of Day(TOD) and Smart metering (description only).

Current transformers and potential transformers – principle of working -ratio and phase angle errors.

Extension of range using instrument transformers, Hall effect multipliers.

Module 3

Classification, measurement of low, medium and high resistance- Ammeter voltmeter method(for low and medium resistance measurements)-Kelvin's double bridge-Wheatstones bridge- loss of charge method, measurement of earth resistance.

Measurement of self inductance-Maxwell's Inductance bridge, Measurement of capacitance –Schering's, Measurement of frequency-Wien's bridge.

Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers.

High voltage and high current in DC measurements- voltmeters, Sphere gaps, DC Hall effect sensors.

Module 4

Magnetic Measurements: Measurement of flux and permeability - flux meter, BH curve and permeability measurement - hysteresis measurement- ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square — measurement of iron losses.

Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells

Temperature sensors-Resistance temperature detectors-negative temperature coefficient Thermistors-thermocouples-silicon temperature sensors.

Module 5

Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.

Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.

Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.

Phasor Measurement Unit (PMU) (description only).

Introduction to Virtual Instrumentation systems- Simulation software's (description only)

Text Books

1. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, DhanpatRai.
2. J. B. Gupta, A course in Electrical & Electronic Measurement & Instrumentation., S K Kataria& Sons
3. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012
4. S Tumanski, Principles of electrical measurement, Taylor & Francis.
5. David A Bell, Electronic Instrumentation and Measurements,3/e, Oxford

Reference Books

1. Golding E.W., Electrical Measurements & Measuring Instruments, Wheeler Pub.
2. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
3. Stout M.B., Basic Electrical Measurements, Prentice Hall
4. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
5. E.O Doebelin and D.N Manik, Doebelin's Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd.
6. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Contents and Lecture Schedule

Module	Topic coverage	No. of Lectures	No of hours
1	**General principles of measurements and classification of meters**		
1.1	Measurement standards–Errors-Types of Errors- Statistics of errors, Need for calibration.	3	**10**
1.2	Classification of instruments, secondary instruments– indicating, integrating and recording- operating forces -	1	
1.3	Essentials of indicating instruments - deflecting, damping, controlling torques.	3	
1.4	Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles shunts and multipliers – extension of range.	3	
2	**Measurement of Resistance, Power and Energy**		
2.1	Measurement of power: Dynamometer type wattmeter – Construction and working - 3-phase power measurement- Low Powerfactorwattmeters.	3	**09**
2.2	Measurement of energy: Induction type watt-hour meters- Single phase energy meter – construction and working, two element three phase energy meters, Digital Energymeters - Time of Day (TOD) and Smart metering (description only).	3	
2.3	Current transformers and potential transformers – principle of working -ratio and phase angle errors. Extension of range using instrument transformers, Hall effect multipliers.	3	
3	**Measurement of circuit parameters using bridges, High voltage and high current measurements**		
3.1	Classification of resistance, low resistance, Ammeter voltmeter method, Kelvin's double bridge Medium resistance- Ammeter voltmeter method - Wheatstones bridge High resistance- loss of charge method- measurement of earth resistance.	3	**09**
3.2	Measurement of self inductance-Maxwell's Inductance bridgeMeasurement of capacitance–Schering's bridge Measurement of frequency-Wien's bridge.	2	
3.3	Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers.	2	
3.4	High voltage and high current in DC measurements- voltmeters, Sphere gaps, DC Hall effect sensors.	2	

4	**Magnetic, Lumen and Temperature Measurements**		
4.1	Measurement of flux and permeability - flux meter, BH curve and permeability measurement - hysteresis measurement	2	**08**
4.2	Ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square - measurement of iron losses.	2	
4.3	Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells	2	
4.4	Temperature sensors-Resistance temperature detectors-negative temperature coefficient Thermistors-thermocouples-silicon temperature sensors.	2	
5	**Transducers and Digital instruments including modern recording and displaying instruments**		
5.1	Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.	2	**09**
5.2	Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.	3	
5.3	Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.	2	
5.4	Phasor Measurement Unit (PMU) (description only). Introduction to Virtual Instrumentation systems-Simulation software's (description only)	2	