Government of Karnataka

Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **Electronic Measurements and Instrumentation**	Course Code : **15EC34T**
Semester : **Third**	Credits : **4**
Teaching Scheme in Hrs (L:T:P) : **4:0:0**	Course Group : **Core**
Type of course : **Lecture + Quiz**	Total Contact Hours : **52**
CIE : **25 Marks**	SEE : **100 Marks**

Prerequisites

Basics of electrical and electronics engineering.

Course Objectives

1. Familiarisation of the basic terms, errors and standards in electronic measurements.
2. Discussion of the working principles, uses of different types of instruments in testing procedures.
3. To understand the working principles of commonly used sensors ,signal conditioners and display systems used in electronic instrumentation
4. Familiarisation of general principles of equipment maintenance and protection.

Course Outcomes

On successful completion of the course, the students will be able to attain the following COs

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand types of measurement, errors, statistical analysis and bridge method of measurement.	***R/U/A***	1,2,3,10	07
CO2	Analyze selection criteria, operation and applications of transducers.	***R/U/A***	1,2,3,10	08
CO3	Understand the operation of PMMC meter, dynamometer, electronic voltmeter and their calibration, conversions.	***U/A***	1,2,3,10	11
CO4	Understand and analyze different types of Oscilloscopes, function generator and spectrum analyzer.	***U/A***	1,2,3,5,10	10
C05	Understand, analyze and working of digital meters, conversion, applications and microprocessor based instruments.	***U/A***	1,2,3,5,10	10
C06	Understand and analyze the prevalent troubleshooting procedures and tools.	***U/A***	1,2,3,5,6,7,10	06
			Total sessions	**52**

Course-PO attainment matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Electronic Instrumentation & Measurements	**3**	**3**	**3**	**--**	**3**	**1**	**1**	**--**	**--**	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course content and pattern of marks for SEE

Unit	Unit Name	Teaching Hours	Questions for SEE			Marks	Weightage (%)
			R	U	A		
1	Basics of measurements	07	05	05	10	20	13
2	Transducers	08	05	05	10	20	16
3	Analog meters	11	10	10	10	30	21
4	Testing instruments	10	10	10	10	30	19
5	Digital meters	10	10	10	10	30	19
6	Instrument maintenance	06	--	05	10	15	12
	Total	**52**	**40**	**45**	**60**	**145**	**100**

Legend: R- Remember, U-Understand A-Application

Course Contents

Unit 1: Basics of measurements 07 Hours

Necessity of measurements-direct and indirect methods, basic terminology, dynamic characteristics of an instrument, generalized electronic measurement system, **Errors**–gross, systematic and random errors, sources of errors. **Statistical analysis**–problems involving arithmetic mean, deviation, average deviation, standard deviation. Limiting errors and probable errors. **Standards**-primary, secondary, working and IEEE standards. Comparison of AC and DC bridges. Principle of Wheatstone bridge and mention its applications.

Unit 2: Transducers 08 Hours

Necessity of electrical transducers, selection of a transducer, active, passive, analog and digital transducers. **Strain gauge**-principle, gauge factor, features of bonded, unbonded, wire and foil type strain gauges, load cell. Principle of working & features of capacitive transducer, Hall effect type, LVDT, thermistor, thermocouple, piezoelectric, proximity sensors, digital optical encoders & PIR sensors.

Unit 3: Analog meters 11 Hours

Principle of PMMC meters, DC ammeters and voltmeters using PMMC. Shunt and series resistors, multi range voltmeters/ammeters, loading effect and voltmeter sensitivity, problems on extending range. Working of electrodynamometer type voltmeter, ammeter and wattmeter.

Electronic voltmeters: Pros and cons**,** working of FET input, chopper type DC amplifier voltmeter, solid-state voltmeter using op-amp, AC voltmeter using full-wave rectifier, Peak responding and true RMS voltmeters. Ohmmeters series and shunt type. Concept of Calibration of meters.

Unit 4: Testing instruments 10 Hours

Cathode Ray Oscilloscope-block diagram, working of CRT, concept of dual tracing.CRO probes: direct, high impedance, active and current probes. Applications of CRO-simple problems on voltage and frequency measurements. **DSO:** block diagram, advantages and applications. **Sampling oscilloscope:** advantages and applications. **Function generator:** block diagram, features and applications. Features of standard RF signal generator and sweep frequency generator. Features of distortion analyzer, wave analyzers, and spectrum analyzers.

Unit 5: Digital meters 10 Hours

Digital instruments - pros and cons, working of ramp and successive approximation type digital voltmeters. Automatization in digital meters-mechanism of automatic zeroing, polarity indication and auto ranging. **Electronic counters**-decade counters as an electronic counter, totalizing, frequency mode, ratio mode, period mode and time interval mode. **Digital meters**: digital frequency meter, time interval measurement, digital LCR meter, digital multimeter, microprocessor-based instruments, IEEE 488 GPIB instruments.

Unit 6: Instrument maintenance 06 Hours

Concepts and need of electrical grounding and shielding, shielding of cabinets, precautions in instrument usage, precautions for instrument safety. **Interference**–nature, causes, effects and prevention. Generalized trouble shooting.

References

1. *Electronic Measurements and Instrumentation -2nd Revised Edition* , R. K. Rajput, ISBN: 81-219-2917-2
2. *Electronic Measurements and Instrumentation-3rd Edition*, Sanjay Talbar & Akhilesh Upadhayaya, ISBN :81-874-3335-3
3. *Electronic Instrumentation -3rdEdition,* Kalsi H. S., ISBN: 00-707-0206-3
4. *Modern Electronic Instrumentation and Measurement Techniques-2nd Edition,* Albert Helfrick & William Cooper, ISBN:81-203-0752-6

Course Delivery

The course will be delivered through lectures, presentations and support of modern tools. Student activities are off-class.

Course Assessment and Evaluation Scheme

Master Scheme

Assessment Method	What		To Whom	Assessment mode /Frequency /timing	Max. Marks	Evidence Collected	Course Outcomes
Direct assessment	CIE	IA	Students	Three tests+	15	Blue Books	1 to 6
				Quiz@	05	Quiz Sheet	1 to 5
				Activity*	05	Activity report	1 to 6
	SEE	End exam		End of the course	100	Answer Scripts at BTE	1 to 6
				Total	125		
Indirect assessment	Student feedback on course		Students	Middle of the Course	Nil	Feedback Forms	1 to 3 Delivery of course
	End of course survey			End of the Course	Nil	Question-naires	1 to 6 Effectiveness of delivery instructions & assessment methods

Legends: CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation

+ Every I.A. test shall be conducted for 15 marks. Average of three tests, by rounding off any fractional part thereof to next higher integer, shall be considered for IA.

***S**tudents should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must be initiated well in advance so that it can be completed well before the end of the term.

@ Quiz conduction shall be evidenced with quiz sheets and it can be conducted any time before the end of the term

Questions for CIE and SEE will be designed to evaluate the various CLs as per the weightage shown in the following table.

Sl. No.	Cognitive Levels (CL)	Weightage (%)
1	Remembering	30
2	Understanding	30
3	Applying	40
	Total	**100**

Continuous Internal Evaluation (CIE) pattern

(i) Student Activity (5 marks)

The following student activities or similar activities can be assigned for assessing CIE (IA) marks

Sl. No.	Activity
1	(a) Collect the standard specifications of at least ten instruments. OR (b) Suggest cost-quality effective instruments of at least five different instruments by preparing comparative statements containing function, specification, make, market-price, and warranty.
2	(a) Collect service manuals of at least five instruments. OR (b) Prepare a document on calibration types and procedures of at least two instruments.

Execution Mode:

1. Above two activities or two similar activities can be assigned by the teacher per batch; each batch can have at most 2 students.
2. Activities shall be carried out batch-wise throughout the semester and submit the report before the end of the semester.
3. Report shall be qualitative and as concise as possible.
4. Each of the activity can be carried out off-class; however, demonstration/presentation if necessary, shall be done in the class room.
5. Teacher is expected to observe and record the progress of students' activities
6. Assessment shall be made based on quality of activity, presentation/demonstration and report in accordance with the following **rubrics** table

(ii) Model of rubrics for assessing student activity

Dimension	Scale					Marks (Example)
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	
1. Research and gathering information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3
2. Full-fills team roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2
3. Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5
4. Listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3

		speak				
					Total marks	ceil(13/4)= 4

(iii) CIE/IA Tests (15 Marks)

Three tests have to be conducted, during specified schedule, in accordance with the test pattern given below and their average-marks shall be considered for CIE/IA.

(iv) Format of CIE/IA test question paper

CIE Question Paper							
Institution Name and Code							
Course Co-ordinator/Teacher							
Program Name		***Test No.***		*Units*			
Class/Sem		*Date*		*CL*			
Course Name		*Time*		*COs*			
Course Code		*Max. Marks*	15	*POs*			
Note to students: Answer all questions							
Question No.	**Question**			Marks	**CL**	**CO**	**PO**
1							
2							
3							
4							

Legends: PO-Program Outcome, CO-Course outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Note: Internal choice may be given in each CO at the same cognitive level (CL).

(v) Model question paper for CIE

CIE Question Paper					
Institution Name and Code					
Course Co-ordinator/Teacher					
Program Name	Electronics and Communication	***Test No.***	1	*Units*	1 & 2
Class/Sem	3rd Sem	*Date*	1/1/2017	*CL*	R/U/A
Course Name	**Electronic measurement and instrumentation**	*Time*	10-11AM	*COs*	1 & 2
Course Code	15EC34T	*Max. Marks*	15	*POs*	1, 2 & 3

Note to students: Answer all questions

No.	**Question**	Marks	**CL**	**CO**	**PO**
1	A circuit was tuned for resonance by eight different students and the values of resonance frequency in KHz were recorded as 532,548,543,535,546,531,543 and 536. Calculate the arithmetic mean, average deviation and variance.	05	A	1	1,2,3
2	Sketch the schematic of wheat-stone bridge. Identify its limitations	05	U/A	1	1,2
3	Illustrate how load cell can be used for measuring force OR Explain the principle of piezoelectric transducers. List its	05	A/R	2	1,2

	applications				

(iv) Quiz for CIE (5 marks)

The teacher is expected to conduct the quiz and collect the quiz sheets as evidence. Quiz may be conducted for higher marks and be scaled down to 5 and fractional part shall be rounded off to the next higher integer. The questions shall cover all CLs.

Semester end-exam evaluation (SEE)

(i) End-exam question-paper pattern

Unit	Unit Name	Study Duration (Hrs.)	No. Questions for end-exam	
			PART – A 5 Marks	PART – B 10 Marks
1	Basics of measurements	07	01	1.5
2	Transducers	08	01	1.5
3	Analog meters	11	02	02
4	Testing instruments	10	02	02
5	Digital meters	10	02	02
6	Instrument maintenance	06	01	01
	Total	**52**	**09 (45 Marks)**	**10 (100 Marks)**

(ii) Model Question Paper

Course Title : **ELECTRONIC MEASUREMENTS AND INSTRUMENTATION**
Course Code : **15EC34T** Time : **3 Hrs**
Semester : **THIRD** Max. Marks : **100**

Instructions : *1. Answer any **SIX** question from **Part A** (5x6=30 Marks)*
*2. Answer any **SEVEN** full questions from **Part B** (7x10=70 Marks)*

Part A

1. Following are the set of readings taken by two meters for a true value of 5v.
   Meter A: 4.81v, 4.81v, 4.79v, 4.78V
   Meter B:4.92V, 5.09V, 4.83V, 5.16V
   Decide the meter with better precision. Justify your answer after defining precision
2. Identify a transducer with excellent dynamic response and list its disadvantages and applications.
3. Compare the features of electromechanical instruments with electronic meters
4. Explain the working of a Ohmmeter whose scale has zero marking on right side.
5. Differentiate between alternate and chop methods of obtaining dual trace in a CRO
6. Justify the use of delay lines inside a CRO
7. List the advantages and disadvantages of digital meters
8. Sketch the block diagram of a digital LCR meter
9. State the significance of having functional block diagram in a service manual. Draw an example functional block diagram.

Part B

1. (a) Define Error. Indicate the ways of reducing systematic and random errors.
   (b) Explain IEEE standards
2. (a) Compare AC and DC bridges
   (b) List the benefits of using electrical transducer
3. (a) A strain gauge has an unstrained length of 10cm and a resistance of 100KΩ.When its length reduces to 9.9 cm, the resistance decreases to 98 KΩ. Estimate its gauge factor.
   (b) Write a note on proximity sensors
4. In a particular application, it is necessary to accurately measure RMS value of sinusoidal, non sinusoidal and complex waveforms. Identify a suitable type of voltmeter and explain its operation.
5. (a) A milli Ammeter of 2.5Ω resistance reads upto 100mA. Estimate the resistance required to transform into a voltmeter of 0-10v. Sketch the relevant circuit.
   (b) List the features of electrodynamometer type instruments.
6. (a) Describe the working of DSO
   (b) List the applications of sweep frequency generator.
7. Describe with a block diagram how function generator produces different types of wave forms. List its applications
8. Describe the working of a digital voltmeter which works on the principle of voltage to time conversion.
9. (a) Illustrate how an electronic counter can be used in ratio mode
   (b) List the features of IEEE488 GPIB
10. (a) List the precautions to be taken to achieve personnel safety during servicing
    (b) Outline the major benefits of grounding and shielding

Institutional activities (No marks)

The following are suggested institutional activities, to be carried out at least one during the semester. The course teacher/coordinator is expected to maintain the relevant record (Containing, Activity name, Resource persons and their details, duration, venue, student feedback, etc) pertaining to Institutional activities.

Sl. No.	Activity
1	Organize Seminar, workshop or Lecture from experts on the modern trends/developments in instrumentation and measurements.
2	Organize hands-on practice for use of DSO/ECG/Any other modern measuring instrument.
3	Motivate students to take case study on instrumentation/measurements-based mini projects (small applications) to inculcate self and continuous learning.

Model Question Bank

Note: The questions in the question bank are indicative but not exhaustive. Sub-questions on different CLs may be combined to frame 10-marks questions or 10-marks questions given here can be splitted into 5-marks questions if necessary keeping weightage of CLs approximately intact and adhering to SEE end-exam pattern.

UNIT-1: Basics of measurements

5-mark questions

UNDERSTAND

1. Explain the necessity of measurements.
2. Compare the features of AC and DC bridges.

APPLICATION

3. A circuit was tuned for resonance by eight different students and the values of resonance frequency in KHz was recorded as 532, 548, 543, 535, 546, 531, 543 and 536. Calculate the arithmetic mean, average deviation and variance.
4. Sketch the schematic of Wheatstone bridge. Mention its relevance in measurements?
5. Following are the set of readings taken by two meters for a true value of 5v.
   Meter A: 4.81V, 4.81V, 4.79V, 4.78V
   Meter B: 4.92V, 5.09V, 4.83V, 5.16V
   Choose the meter with better precision. Justify your answer after defining precision.

10-mark Questions

REMEMBER

1. Define speed of response, dynamic error, accuracy, fidelity and resolution w.r.t measurements
2. Define precision, error log, instrument and sensitivity w.r.t measurements.

UNDERSTAND

1. (a)Define error. Indicate the ways of reducing systematic and random errors.
   (b) Explain IEEE standards

UNIT-2: Transducers

5-mark questions

REMEMBER

1. List the factors which decide the selection of a transducer
2. List the features of PIR sensors

UNDERSTAND

1. Discuss the necessity of transducers
2. Compare strain gauges with capacitive transducers
3. Compare the features of wire type and foil type strain gauges

APPLICATION

4. Write a note on PIR sensors
5. Explain the principle of piezoelectric transducers. list its applications

10-mark Questions

UNDERSTAND

1. Explain active, passive, analog and digital transducers. Give an example for each

APPLICATION

2. (a) Illustrate how load cell can be used for measuring force

(b) List the benefits of using electrical transducer

3. (a) A strain gauge has an unstrained length of 10cm and a resistance of 100KΩ.when its length reduces to 9.9 cm, the resistance decreases to 98 KΩ. Calculate its gauge factor.
   (b) Write a note on proximity sensors

UNIT-3: Analog Meters

5-mark Questions

REMEMBER

1. Define calibration and summarize the calibration process of any instrument of your choice.

UNDERSTAND

1. Compare the features of electromechanical instruments with electronic meters
2. Explain the working of Ohmmeter whose scale has zero marking on right side.

10-mark Questions

APPLICATION

1. In a particular application, it is necessary to accurately measure RMS value of sinusoidal, non sinusoidal and complex waveforms. Choose a suitable type of voltmeter and explain its operation.
2. (a) A milli ammeter of 2.5Ω resistance reads up to 100mAs. Calculate the resistance required to transform into a voltmeter of 0-10v. Sketch the relevant circuit
   (b) List the features of electrodynamometer type instruments

UNIT-4: Testing instruments

5-mark Questions

REMEMBER

1. List the applications of CRO
2. List the applications of DSO
3. List the applications of spectrum analyzer

UNDERSTAND

4. Explain the working of a standard RF signal generator
5. Differentiate between alternate and chop methods of obtaining dual trace in a CRO

APPLICATION

6. Choose a suitable oscilloscope for VHF operations. List its advantages and disadvantages
7. Justify the use of delay lines inside a CRO
8. Choose suitable CRO probe for (i) small signal operations
   (ii) Current measurement. List their features
9. Choose suitable CRO probe (i) used for HF and high impedance operations
   (ii)which utilizes a FET. List their features

10-mark Questions

REMEMBER

1. List the applications of sweep frequency generator, distortion analyses and wave analyzer.

UNDERSTAND

1. Explain the working of CRT with a neat sketch
2. (a) Describe the working of DSO
   (b) List the applications of sweep frequency generator.

APPLICATION

3. Explain with a block diagram how function generator produces different types of wave forms. List its applications
4. Explain the working of a CRO with a block diagram

UNIT-5: Digital Meters

5-mark Questions

REMEMBER

1. List the advantages and disadvantages of digital meters

UNDERSTAND

2. Compare analog meters with digital meters

APPLICATION

3. Sketch the block diagram of a digital LCR meter
4. Sketch the block diagram of a digital frequency meter. list its advantages.
5. Show how time gap between two events can be measured digitally.

10-mark Questions

REMEMBER

1. (a) Illustrate how an electronic counter can be used in ratio mode
   (c) List the features of IEEE488 GPIB

UNDERSTAND

2. Explain the working of a successive approximation type digital voltmeter
3. Explain the working of a digital LCR meter

APPLICATION

4. Explain the working of a digital voltmeter which works on the principle of voltage to time conversion.
5. (a) Sketch the block diagram of a digital multimeter
   (b) Write a brief note on microprocessor based instruments

UNIT-6: Instrument Maintenance

5-mark Questions

REMEMBER

1. List the precautions to be taken to achieve personnel safety during servicing
2. List the causes of interference

UNDERSTAND

1. Describe the role of functional block diagram in servicing.
2. Explain how shielding reduces interference.
3. Explain how grounding reduces interference

APPLICATION

1. Write the significance of having functional block diagram in a service manual. Draw an example functional block diagram

10-mark Questions

REMEMBER

1. List the precautions to be taken to prevent instrument damage during servicing.

UNDERSTAND

1. Explain the procedure of generalized trouble shooting with a flow chart.

APPLICATION

2. List the methods of preventing interference
3. (a) List the precautions to be taken to achieve personnel safety during servicing
   (b) Outline the major benefits of grounding and shielding

End