INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	ELECTRONIC MEASUREMENT AND INSTRUMENTATION				
Course Code	AEC014				
Programme	B.Tech				
Semester	VI	ECE			
Course Type	CORE				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. P Annapurna, Assistant Professor				
Course Faculty	Ms. P Annapurna, Assistant Professor Mr. Mohd Khadir,Assistant Professor Ms. M Saritha, Assistant Professor Ms. M Lavanya, Assistant Professor				

I. COURSE OVERVIEW:

Electronic measurement and instrumentation is used for troubleshooting of electronic equipment, It is an essential requirement of Service sector industry. This course will help to develop skills to become professional technician with capability to measure electrical parameters using various electronic instruments like analog and digital instruments. By learning this course students will able to know basics of various Instruments, transducers and working of electronic circuits used in electronic test and measuring instruments.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEE002	II	Electrical circuits	3
UG	AEC101	III	Electronic Devices and circuits laboratory	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Electronic Measurement and Instrumentation	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modelling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed By
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lectures, Assignments, Exercises
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Design Exercises
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Design Exercises
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	3	Assignments, Exercises

3 = High; 2 = Medium; 1 = Low

VII. H O W PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Lectures and Assignments.
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Acquire a sound understanding theory and performance characteristics of instruments and errors in measurement and apply to DC voltmeters, ammeters, ohmmeters.
II	Provide concepts and operation of different signal generators and wave form analyzers.
III	Compare and contrast different types of oscilloscopes
IV	Select different types of D.C and A.C bridges for measurement of passive components and physical parameters

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the types of voltmeters, ammeters, ohmmeters and Dynamic characteristics of measuring systems .	CLO 1	Analyze Block schematics of measuring systems, performance characteristics like accuracy, precision, resolution and the types of errors.
		CLO 2	Understand the analog measuring instruments its working of analog measuring instruments D' Arsenal movement
		CLO 3	Discuss various types measuring range Meters like DC and AC voltmeters ammeters.
		CLO 4	Understand of basic building of Cathode ray oscilloscopes and cathode ray tubes its

CO 2	Understand the different types of Oscilloscopes and their working principles.	CLO 5	Illustrate the various types of special purpose oscilloscopes and discuss Lissajous figures, frequency measurement, phase measurement, CRO probes
		CLO 6	Understand working principle of signal generators like AF and RF signal generators and Discuss the types of function generators
		CLO 7	Understand the function of various types of signal analyzers and discuss the type like AF
CO 3	Understand the Different types of signal generators and signal analyzers and their working principles	CLO 8	Understand the various wave analyzers heterodyne wave analyzers, harmonic distortion, spectrum analyzers, and power analyzers.
		CLO 9	Discuss various measurements using DC
		CLO 10	Discuss various measurements using A bridges, Maxwell, Hay, Schering, Wien, Anderson bridges, Wagner & ground connection.
CO 4	Explore the different types of A.C. and DC Bridges and their operations	CLO 11	Understand transducers and its classifications and discuss strain gauges.
		CLO 12	Understand Force and displacement transducers,
		CLO 13	Discuss the types of transducers Piezoelectric transducers, variable capacitance transducers;
		CLO 14	Determine measurement of physical parameters Flow measurement, displacement meters, liquid level measurement,
CO 5	Demonstrate the different types of transducers and their principles and operations	CLO 15	Illustrate the following: active and passive, primary and secondary transducers
		CLO 16	Illustrate the measurement of physical parameters of transducer like velocity,
		CLO 17	Illustrate the measurement of vacuum level, temperature measurements

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEC014.01	CLO 1	Analyze Block schematics of measuring systems, performance characteristics like	PO 1	3
AEC014.02	CLO 2	Understand the analog measuring instruments its working of analog measuring	PO 1	3
AEC014.03	CLO 3	Discuss various types measuring range meters like DC and AC voltmeters ammeters.	PO 5	3
AEC014.04	CLO 4	Understand of basic building of Cathode ray oscilloscopes and cathode ray tubes its	PO 5	2

AEC014.05	CLO 5	Illustrate the various types of special purpose oscilloscopes and discuss Lissajous figures,	PO 1	3
AEC014.06	CLO 6	Understand working principle of signal generators like AF and RF signal generators	PO 1	2
AEC014.07	CLO 7	Understand the function of various types of signal analyzers and discuss the type like AF	PO 4	2
AEC014.08	CLO 8	Understand the various wave analyzers heterodyne wave analyzers, harmonic	PO 4	1
AEC014.09	CLO 9	Discuss various measurements using DC bridges for Wheat stone bridge, Kelvin bridge.	PO 4	2
AEC014.11	CLO 11	Understand transducers and its classifications and discuss strain gauges.	PO 4	2
AEC014.12	CLO 12	Understand Force and displacement transducers, resistance thermometers, hotwire anemometers, LVDT, thermocouples,	PO 5	3
AEC014.13	CLO 13	Discuss the types of transducers Piezoelectric transducers, variable capacitance transducers; Magneto strictive transducers	PO 5	3
AEC014.14	CLO 14	Determine measurement of physical parameters Flow measurement, displacement meters, liquid level measurement,	PO 5	3
AEC014.15	CLO 15	Illustrate the following: active and passive,	PO 5	2
AEC014.16	CLO 16	Illustrate the measurement of physical parameters of transducer like velocity, force, pressure, high pressure, vacuum level,	PO 1	2
AEC014.17	CLO 17	Illustrate the measurement of vacuum level, temperature measurements	PO 2	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes(COs)	Program Outcomes (POs)				
	PO 1	PO 2	PO 4	PO 5	PSO1
CO 1	3			3	2
CO 2	2		2		
CO 3			2	2	2
CO 4	2				
CO 5		2			

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												3		
CLO 2	3														
CLO 3					3								3		
CLO 4					2										
CLO 5	3														
CLO 6				2									2		
CLO 7				1									2		
CLO 8				1									2		
CLO 9				2											
CLO 10				2											
CLO 11					3										
CLO 12					3								2		
CLO 13					3										
CLO 14					2								2		
CLO 15	2														
CLO 16		2											2		
CLO 17	2														

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO4,PO5,PSO1	SEE Exams	PO1, PO2, PO4, PO5,PSO1	Assignments	-	Seminars	PO1, PO2, PO4, PO5,PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4, PO5,PSO1						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	INTRODUCTION TO MEASURING INSTRUMENTS	Classes: 10
Block schematics of measuring systems, performance characteristics, Static characteristics: Accuracy, resolution, precision, gauss error, types of errors, Dynamic characteristics : Repeatability, reproducibility, fidelity, lag; Analog measuring instruments: D' Arsonval movement, DC voltmeters and ammeter, AC voltmeters and current meters, ohmmeters, multimeters, meter protection, extension of range, digital voltmeters: Ramp type, staircase, dual slope integrating type, successive approximation type, specifications of instruments.		
UNIT-II	**OSCILLOSCOPE**	**Classes: 09**
Oscilloscopes: CRT, block schematic of CRO, time base circuits, delay lines, high frequency CRO considerations, applications, specifications, special purpose oscilloscopes: Dual trace, dual beam CROs, sampling oscilloscopes, storage oscilloscopes, digital storage CROs, Lissajous figures, frequency measurement, phase measurement, CRO probes.		
UNIT-III	**SIGNAL GENERATOR AND SIGNAL ANALYZERS**	**Classes: 08**
Signal Generators: AF and RF signal generators, sine and square wave generators, function generators arbitrary waveform generator, sweep frequency generators, video signal generators, and specifications. Signal Analyzers: AF, HF wave analyzers, heterodyne wave analyzers, harmonic distortion, spectrum analyzers, power analyzers		
UNIT-IV	**AC AND DC BRIDGES**	**Classes: 08**
Measurements using DC and AC bridges: Wheat stone bridge, Kelvin bridge, AC bridges, Maxwell, Hay, Schering, Wien, Anderson bridges, Wagner & ground connection.		
UNIT-V	**TRANSDUCERS**	**Classes: 10**
Transducers: Classification, strain gauges, force and displacement, transducers, resistance thermometers, hotwire anemometers, LVDT, thermocouples, synchros; Piezoelectric transducers, variable capacitance transducers; Magneto strictive transducers, measurement of physical parameters: Flow measurement, displacement meters, liquid level measurement, measurement of humidity and moisture, velocity, force, pressure, high pressure, vacuum level, temperature measurements.		
Text Books:		
1. A.K.Sawhney,"Electrical and electronics measurements and instrumentation", 19th Edition, 2011. 2. H.S.Kalsi, "Electronic Instrumentation", TMH, 2nd Edition, 2004. 3. K. Lal Kishore, "Electronic Measurements and Instrumentation", Pearson Education,2nd Edition, 2010.		

Reference Books:
1. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press, 1st Edition, 2007. 2. A.D. Helbincs, W.D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI, 56th Edition, 2003.

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Describe Block schematics of measuring systems, performance characteristics, Static and Dynamic characteristics.	CLO 1	T1:2.2, T2:1.2-1.7 T2:2.10
3	Understand Analog measuring instruments: D'Arsonval movement	CLO 2	T1:2.4, T2:1.4
4-6	Discuss DC voltmeters and ammeter, AC voltmeters and current meters.	CLO 3	T2:1.12-1.13
7-9	Discuss ohmmeters, multimeters, meter protection, extension of range.	CLO 3	T1:2.3-2.4 T1:3.2 T2:2.3
10-11	Understand digital voltmeters: Ramp type, staircase, dual slope integrating type, Successive approximation type.	CLO 3	T1:3.3-3.4
12	Remember specifications of instruments.	CLO 3	T1:3.3-3.4
13	Explain the Oscilloscopes, CRT, block schematic of CRO	CLO 4	T1:2.3 T2: 6.10, 3.2
14	Describe the functionalities of time base circuits, delay lines.	CLO 4	T1:11.1-11.5
15	Memorize the high frequency CRO considerations, applications, specifications.	CLO 4	T1:11.1-11.5
16-17	Discuss in detail about special purpose oscilloscopes, Dual trace, and dual beam CROs.	CLO 5	T1:4.8 T1:5.2-5.6
18	Discuss in detail about sampling oscilloscopes, Storage Oscilloscopes.	CLO 5	T1:4.8 T1:5.2 -5.6
19-20	Recognize digital storage CROs, Lissajous figures, and CRO probes.	CLO 5	T1:7.2
21	Understand the frequency measurement, phase measurement.	CLO 5	T1:7.2
22-23	Discuss in detail about the Signal Generators: AF and RF signal generators, sine and square wave generators.	CLO 6	T1:7.2
24	Define function generators, arbitrary waveform generator	CLO 6	T2:10.4
25-26	Describe the functionalities of Sweep frequency generators, Video signal generators and specifications.	CLO 6	T1:8.2 -8.5 T2:10.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
27-28	Describe the functionalities Signal Analyzers: AF, HF wave heterodyne wave analyzers,	CLO 7	T1:9.2-9.7
29-30	Describe the functionalities harmonic distortion, spectrum analyzers, power analyzers.	CLO 8	T1:10.1
31	Illustrate the Measurements using DC and AC bridges.	CLO 8	T1:10.2
32-33	Explain the operation of Wheat stone bridge, Kelvin bridge.	CLO 9	T1:10.2
34-35	Explain the operation of AC bridges, Maxwell, Hay bridges.	CLO 9	T1:10.3
36-37	Discuss Schering, Wien, and Anderson bridges.	CLO 10	T1:10.3
38	Understand Wagner bridge & ground connection.	CLO 10	T1:10.3
39-40	Classify Transducers, strain gauges, force and displacement transducers.	CLO 11	T3:3.12, 5.7, 5.10
41-42	Illustrate resistance thermometers, hotwire anemometers	CLO 11	T3:3.12, 5.7, 5.10
43-44	Explain LVDT, thermocouples, Piezoelectric transducers	CLO 12	T3:7.2
45-46	Understand variable capacitance transducers; Magneto strictive transducers,	CLO 13	T3:8.4
47-48	Understand measurement of physical parameters: Flow measurement, displacement meters, liquid level measurement,	CLO 14	T3:8.5
49-51	Understand Measurement of humidity and moisture, velocity measurements.	CLO 14	T1:2.2 T2:1.2-1.7 T2:2.10
52-53	Illustrate the following: active and passive, primary and secondary transducers	CLO 15	T1:2.2 T2:1.2-1.7 T2:2.10
54-56	Understand force, Pressure, high pressure measurements.	CLO 16	T1:2.2 T2:1.2-1.7 T2:2.10
57-60	Understand Measurement of vacuum level, temperature measurements.	CLO 17	T1:2.4 T2:1.4

XVII. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	To introduce students to monitor, analyze and control any physical system.	Seminars	PO1	PS01
2	To provide a student a knowledge to design and create novel products and solutions for real life problems.	Seminars / NPTEL	PO2	PS01
3	To introduce students a knowledge to use modern tools necessary for electronic projects.	NPTEL	PO1	PS01

Prepared by

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