INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**ELECTRONIC MEASUREMENTS AND INSTRUMENTATION**				
Course Code	AECB32				
Program	B.Tech				
Semester	FIVE				
Course Type	Professional Elective				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Course Coordinator	Ms. P Annapurna, 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
B.Tech	AEEB03	II	Electrical circuits
B.Tech	AECB09	III	Electronic Devices and circuits laboratory

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	PPT	✔	Chalk & Talk	✔	Assignments	✗	MOOCs
✔	Open Ended Experiments	✔	Seminars	✗	Mini Project	✔	Videos
✔	Others						

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 expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE

Percentage of Cognitive Level	Blooms Taxonomy Level
10 %	Remember
50 %	Understand
25 %	Apply
15 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (Table 3).

Table 2: 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 center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3**.**

Table 3: Assessment pattern for AAT

5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI. COURSE OBJECTIVES:

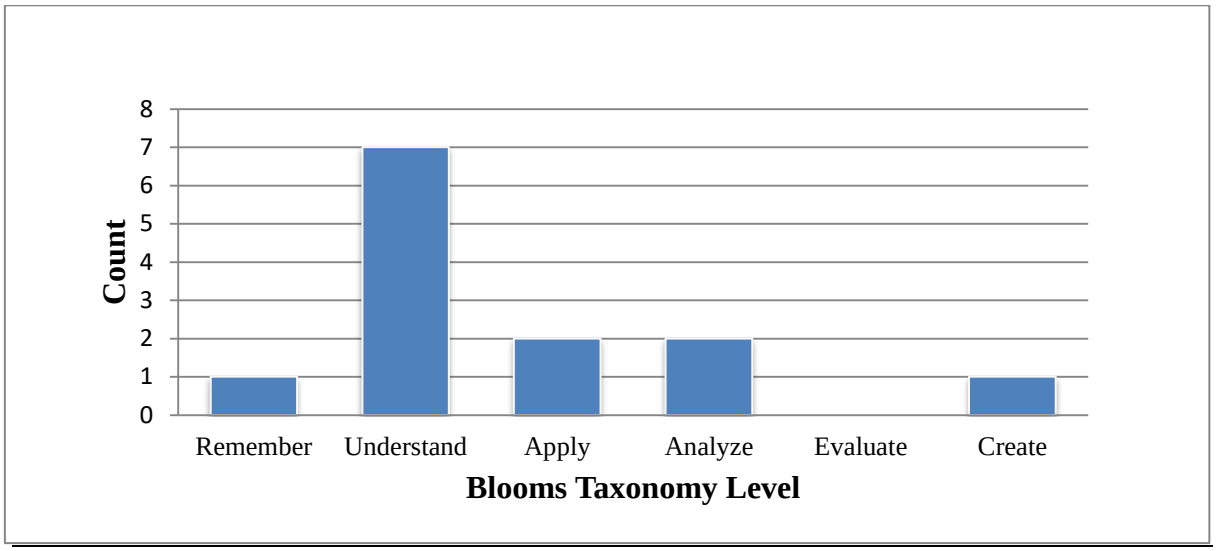
The students will try to learn:	
I	The construction and operation of AC & DC voltmeters and ammeters, Oscilloscopes, signal generators, signal analyzers, transducers and LCR meters.
II	The application of the principles of electronic measurements to monitor high tension power quality and build spectrum analyzers for scientific and industrial applications
III	To explore the applications of measuring instrument in environment monitoring and health monitoring of a smart car.

VII. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
	Course Outcomes	**Knowledge Level (Bloom's Taxonomy)**
CO 1	**Recall** the schematics of measuring systems and performance characteristics of an instrument.	Remember
CO 2	**Explain** the measuring instruments and its working principle by using the instrument D' Arsonval Movement.	Understand
CO 3	**Demonstrates** the various types measuring meters like Digital Voltmeters.	Understand

CO 4	**Describe** the basic building blocks of Cathode ray oscilloscopes and cathode ray tubes	Understand
CO 5	**Compare** various types of special purpose oscilloscopes with its applications.	Analyze
CO 6	**Draw** Lissajous figures or patterns for the given frequencies.	Apply
CO 7	**Illustrate** the working principles of signal generators and signal analysers	Understand
CO 8	**Design** a measuring instrument on requirement basis	Apply
CO 9	**Describe** Transducers and classify them according to their application	Understand
CO 10	**Extend** the concepts of balance bridge to find out the unknown parameter with the given specifications.	Analyze
CO 11	**Illustrate** the working functionality of strain gauges, LVDT	Understand
CO 12	**Compare** wave analyzers and spectrum analyzers based on its working functionality.	Understand
CO 13	**Develop** the appropriate Virtual instrument to solve the real world problem and also to measure different physical parameters.	Create

COURSE KNOWLEDGE COMPETENCY LEVELS



VIII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/ AAT/QUIZ
PO2	**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	3	SEE/CIE/ AAT/QUIZ

Program		Strength	Proficiency Assessed by
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1	SEE/CIE/ AAT/QUIZ
PO4	**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	SEE/CIE/ AAT/QUIZ
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	SEE/CIE/ AAT/QUIZ

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO 1	Formulate and Evaluate the applications in the field of Intelligent Embedded and Semiconductor technologies	--	---
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual Instrumentation and SOC designs	2	SEE, Project
PSO 3	Build the Embedded hardware design and software programming skills for entry level job positions to meet the requirements of employers	1	Project

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	√	√	-	-	-	-	-	-	-	-	-	-	-	√	-
CO 3	√	-	-	√	-	-	-	-	-	-	-	-	-	-	-
CO 4	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	√	-	-	√	-	-	-	-	-	-	-	-	√	-
CO 7	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	-	√	-	√	√	-	-	-	-	-	-	-	-	√	-

CO 9	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	√	-	-	-	√	-	-	-	-	-	-	-	-	√	-
CO 11	√	-	-	√	-	-	-	-	-	-	-	-	-	-	-
CO 12	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 13	-	-	√	-	√	-	-	-	-	-	-	-	-	-	√

XI. JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING - DIRECT

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of Key Competencies
CO1	**PO 1**	**Recall** the schematics of measuring systems and performance characteristics (**knowledge**) of an instrument using the principles of science and mathematics for engineering problems	**2**
CO2	**PO 1**	**Explain** the Different basic building blocks present in measuring instrument and **integrate** combine all the blocks together to find out electrical parameters	**2**
	PO 2	**Explain** the measuring instruments and its working principle by using the instrument D' Arsonval Movement.	**3**
	PSO 2	**Illustrate** the concept DC and AC meters to measure voltage, current and resistance **by using virtual instrumentation.**	**1**
CO3	**PO 1**	**Apply** the **knowledge** of measuring instruments for measuring Digital voltage	**3**
	PO 4	**Analyze** various types measuring meters to measure digital voltage using **design of experiments, analysis and interpretation of data**	**1**
CO4	**PO 1**	**Analyze** different blocks present in oscilloscopes (**knowledge**) and combine all the blocks to get the appropriate output **an engineering specialization to the solution of complex engineering problems**.	**2**
	PO 2	**Describe** the function of Cathode ray oscilloscopes and cathode ray tubes review research literature	**1**
CO 5	**PO 2**	**Analyse** various types of special purpose oscilloscopes and compare them by its applications **Identify, formulate**	**2**
CO 6	**PO 2**	Understand the concept of Lissajous figures or patterns **Identify, formulate**	**2**
	PO 4	**Apply** the concept and draw the patterns for the given frequency **Use research-based knowledge and research methods including design of experiments**	**2**
	PO 5	**Interpret** the concept in modern tools to obtain the pattern at a given frequency.	**3**
	PSO 2	**Draw** Lissajous figures or patterns for the given frequencies.by practical experience of Virtual Instrumentation	**1**
CO 7	**PO 1**	**Understand** concept of multi-function signal generators analyze the different blocks present in generator	**2**
	PO 2	**Describe** the working **of** multi-function signal generators (**complex problem analysis)**.	**3**
CO 8	**PO 2**	**Describe** the function of measuring instrument (**complex problem analysis)**.	**2**

	PO 4	Identify (**knowledge**) to solve **complex engineering problems** in measurements by using the principles of **engineering fundamentals**	**1**
	PO 5	**Apply (Modern tool) to Design** a measuring instrument on requirement basis.	**2**
	PSO 2	**Develop an instrument using** practical experience of Virtual Instrumentation	**2**
CO 9	**PO 1**	**Apply** (understand) the **knowledge** of engineering fundamentals to define transducer	**2**
	PO 2	**Illustrate** Transducers and classify them according to their application.) (complex engineering problems)	**2**
CO 10	**PO 1**	(**understand**) the concept of bridges in electronic measuring instruments	**2**
	PO 4	Design a bridge on requirement basis using and find out the unknown parameter with the given specifications (**analysis and interpretation of data)**	**2**
	PSO 2	**Understand** the performance of a bridge using practical experience of Virtual Instrumentation	**3**
CO 11	**PO 1**	Understand the concepts of different types of transducers **(Engineering knowledge)**	**2**
	PO 4	**Illustrate** the working functionality of (**Conduct investigations of complex problems)** strain gauges, LVDT	**1**
CO 12	**PO 1**	**Understand** (**knowledge**) the concepts of analyzers such spectrum and wave analyzers	**2**
	PO 2	**Compare** the working functionality of two analysers by **formulate, review research literature**	**1**
CO 13	**PO 3**	**Develop** (**Design/development of solutions)** an instrument to solve the real world problem and also to measure different physical parameters.	**2**
	PO 5	**Apply** appropriate modern engineering tools including prediction and modeling to measure different physical parameters.	**2**
	PSO 3	**Understand** the concepts of measuring instrument systems to measure different physical parameters. Using **embedded hardware design**	**2**

XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

Course Outcomes	Program Outcomes / No. of Key Competencies Matched												PSOs / No. of key competencies		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	2	2	2
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-

CO 6	-	2	-	2	3	-	-	-	-	-	-	-	-	1	-
CO 7	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	-	2	-	1	2	-	-	-	-	-	-	-	-	2	-
CO 9	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	2	-	-	2	-	-	-	-	-	-	-	-	-	3	-
CO 11	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 12	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 13	-	-	2	-	2	-	-	-	-	-	-	-	-	-	2

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

Course Outcomes	**Program Outcomes / No. of key competencies**												**PSOs / No. of key competencies**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**1**	**2**
CO 1	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	66.7	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0
CO 3	100	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 4	66.7	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 5	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 6	0.0	20.0	0.0	18.2	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0
CO 7	66.7	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 8	0.0	20.0	0.0	9.1	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0
CO 9	66.7	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 10	66.7	0.0	0.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0
CO 11	66.7	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 12	66.7	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 13	0.0	0.0	20.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100

XIV. COURSE ARTICULATION MATRIX (PO – PSO MAPPING)

COs and POs and COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – **0**≤ ***C***≤ 5% – No correlation
2 – 40 % <***C***< 60% –Moderate
1 – 5 <***C***≤ 40% – Low/ Slight
3 – 60% ≤ ***C***< 100% – Substantial /High

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	2	-	2	3	-	-	-	-	-	-	-	-	1	-
CO 7	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	-	2	-	1	2	-	-	-	-	-	-	-	-	2	-
CO 9	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	2	-	-	2	-	-	-	-	-	-	-	-	-	3	-
CO 11	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 12	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 13	-	-	2	-	2	-	-	-	-	-	-	-	-	-	2
TOTAL	19	16	2	7	7	0	0	0	0	0	0	0	0	7	2
AVERAGE	**2.11**	**2.00**	**2.00**	**1.40**	**2.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.75**	**2.00**

XV. ASSESSMENT METHODOLOGY - DIRECT

CIE Exams	PO 1,PO 2 PO 4	SEE Exams	PO 1,PO 2 PO 4,PSO 1	Assignments	-	Seminars	PO 1,PO 2 PO 4,PSO 1
Laboratory Practices	-	Student Viva	-	Mini Project	PSO 1,PSO 2	Certification	-
Term Paper	-	5 Minutes Video	PO 4	Tech talk	PO 4	Open Ended Experiments	-

XVI. ASSESSMENT METHODOLOGY - INDIRECT

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

XVII. SYLLABUS

MODULE-I	INTRODUCTION TO MEASURING INSTRUMENTS
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.	
MODULE-II	**OSCILLOSCOPE**
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.	
MODULE-III	**SIGNAL GENERATOR AND SIGNAL ANALYZERS**
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	
MODULE-IV	**AC AND DC BRIDGES**
Measurements using DC and AC bridges: Wheat stone bridge, Kelvin bridge, AC bridges, Maxwell, Hay, Schering, Wien, Anderson bridges, Wagner & ground connection.	
MODULE-V	**CONTROL AND STABILITY**
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.	
Textbooks:	
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.	

XVIII. COURSE PLAN:

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

Lecture No	Topics to be Covered	CO	Reference
1-2	Describe Block schematics of measuring systems, performance characteristics, Static and Dynamic characteristics.	CO 1	T1:2.2, T2:1.2-1.7 R2:2.10
3-4	Understand Analog measuring instruments: D'Arsonval movement.	CO 2	T1:2.4, T2:1.4
5-6	Discuss DC voltmeters and ammeter, AC voltmeters and current meters.	CO 2	T2:1.12- 1.13 R2:2.16
7-9	Understand digital voltmeters: Ramp type, staircase, dual slope integrating type, Successive approximation type.	CO 3	T1:2.3-2.4 T1:3.2 R2:2.3
10-11	Explain the Oscilloscopes, CRT, block schematic of CRO	CO 4	T1:3.3-3.4
12-14	Analyze the high frequency CRO considerations, applications, specifications	CO 4	T1:3.3-3.4
14-16	Describe the functionalities of time base circuits, delay lines.	CO 4	T1:2.3 T2: 6.10,3.2
15-18	Discuss in detail about special purpose oscilloscopes, Dual trace, and dual beam CROs	CO 5	T1:11.1- 11.5
19-20	Discuss in detail about sampling oscilloscopes, Storage Oscilloscopes	CO 6	T1:11.1- 11.5
21-22	Understand the frequency measurement, phase measurement.	CO 6	T1:4.8 R1:5.2-5.6
23-25	Discuss in detail about the Signal Generators: AF and RF signal generators, sine and square wave generators.	CO 7	T1:4.8 T1:5.2 -5.6 R2:5.3
26-27	Define function generators, arbitrary waveform generator	CO 7	T1:7.2 R2:5.7
28-39	Describe the functionalities Signal Analyzers: AF, HF wave heterodyne wave analyzers,	CO 8	T1:7.2 R2:5.7
30-31	Describe the functionalities harmonic distortion, spectrum analyzers, power analyzers	CO 8	T1:7.3 R2:5.8
32-33	Illustrate the Measurements using DC and AC bridges	CO 9	T1:8.2 -8.5 R2:10.4
34-35	Classify Transducers, strain gauges, force and displacement transducers.	CO 9	T1:8.2 -8.5 T2:10.4
36-37	Illustrate resistance thermometers, hotwire anemometers	CO 9	T1:9.2-9.7
38-39	Explain LVDT, thermocouples, Piezoelectric transducers	CO 10	T1:10.1 R2:10.7
40-41	Understand variable capacitance transducers; Magneto strictive transducers,	CO 10	T1:10.2
42-43	Understand measurement of physical parameters: Flow measurement, displacement meters, liquid level measurement,	CO 11	T1:10.2
44-45	Understand Measurement of humidity and moisture, velocity measurements.	CO 12	T1:10.3

Lecture No	Topics to be Covered	CO	Reference
44-45	Understand Measurement of vacuum level, temperature measurements.	CO1 3	T1:10.3

Prepared by:
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