INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course title	:	**INSTRUMENTATION**			
Course code	:	**57014**			
Course structure		**Lectures**	**Tutorials**	**Practical**	**credits**
		3	**1**	**00**	**3**
Course coordinator	:	**LekhaChandran, Associate. professor**			
Team of instructors	:	**LekhaChandran, Associate. professor**			

I. COURSE OVERVIEW:

This course deals with the essentials in monitoring and analysis of physical systems and its control and introduces different characteristcs of signals , representation of signals, oscilloscope, digital voltmetersa, signal analysers and transducers.

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
UG	4	4	knowledge of the principles of all measuring instruments , basic Mathematics and Science

III. COURSE ASSESSMENT METHODS:

a) Marks distribution:

Session marks	University end exam marks	Total marks
There shall be two mid tem examinations. Each id term exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1to 4 units and the second, after the completion of 5 t 8 units each carrying 5 marks. On the total the internal marks are 25. The average of two internal tests is the final internal marks.	75	100

The external question paper is set by JNTUH consisting of 8 questions, out of which 5 questions to be answered each carrying 15 marks and on the total external marks are 75		

IV. EVALUATION SCHEME:

S.no	Component	Duration	Marks
1	I mid examination	90 minutes	20
2	I assignment	--	05
3	IImid examination	90 minutes	20
4	II assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVE:

i. **Understand** the basic concepts related to the operation of electrical & electronic measuring instruments.
ii. **Understand** how to monitor, analyze and control any physical system
iii. **Understand** the basic concepts of static and dynamic characteristics of instruments
iv. **Analyse** the errors in measurements
v. **Understand** various signals and their representations
vi. **Understand** the operational and application aspects of CRO (normal and storage).
vii. **Understand** the principles of operation and working of DVM
viii. **Understand** different types of signal analysers
ix. **Understand** all the processes and phenomena leading to the development of transducer systems
x. **Analyse** various transducers and their applications in the measurement of various parameters in electrical and non electrical engineering fields.

VI. COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

a. **Understand** the basic concepts of electrical units, measurement errors and accuracy
b. **Knowledge** to measure different physical parameters using different instruments
c. **Determine** the kind of instrument suitable for typical measurement
d. Analyze and design an instrumentation system without losing accuracy and integrity of the measured
e. **Understand** various signals and their representations
f. **Understand** the operational and application aspects of CRO
g. **Understand** the principles of operation and working of DVM
h. **Analysis** of signals using different types of signal analysers
i. **Understand** technical specifications of selecting sensors and transducers for a given application
j. **Evaluate** the type of sensors and transducers for a given application
k. **Design** a system, component or process to meet desired needs in electrical engineering
l. **Apply** the principles and practice for instrument design and develop for real world problems
m. **Apply** the techniques and skills for electrical projects

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
a	An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of	S	Tests and assignments

	Electrical Engineering.(General knowledge)		
b	An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.(Problem Analysis)	H	Tests and assignments
c	To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power.(Design/Development of solutions).	H	Tests and assignments
d	An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving generation, transmission and distribution of electrical energy .(Conduct investigations of complex problems)	S	Tests and assignments
E	An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions. (Modern tool usage**)**	S	Tests and assignments
F	An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs.(The engineer and society)	S	Tests and assignments
G	An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability (Environment and sustainability)	S	Tests and assignments
H	To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.(Ethics)	S	Tests and assignments
I	an Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels.**(**Individual and team work)	H	Tests and assignments
J	an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal ,written for effective technical presentation.**(**Communication)	S	Tests and assignments
K	An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	H	Tests and assignments
l	To be familiar with project management problems and basic financial principles for a multi-disciplinary work.**(**Project management and finance)	S	Tests and assignments

N= None S=Supportive H=Highly related

VIII. SYLLABUS:

UNIT-I **CHARACTERISTICS OF SIGNALS**: Measuring Systems, Performance Characteristics, - Static characteristics, Dynamic Characteristics; Errors in Measurement – Gross Errors, Systematic Errors, Statistical Analysis of Random Errors
UNIT-II **SIGNALS AND THEIR REPRESENTATION**: Signal and their representation: Standard Test, periodic, aperiodic, modulated signal, sampled data, pulse modulation and pulse code modulation

UNIT-III **OSCILLOSCOPE**: Cathode ray oscilloscope-Cathode ray tube-time base generator-horizantal and vertical amplifiers-CRO probes-applications of CRO-Measurement of phase and frequency-lissajous patterns-Sampling oscilloscope-analog and digital type
UNIT-IV **DIGITAL VOLTMETERS**: Digital voltmeters- Successive approximation, ramp, dual-Slope integration continuos balance type-Micro processor based ramp type DVM digital frequency meter-digital phase angle meter
UNIT-V **SIGNAL ANALYZERS**: Wave Analysers- Frequency selective analyzers, Heterodyne, Application of Wave analyzers- Harmonic Analyzers, Total Harmonic distortion, spectrum analyzers, Basic spectrum analyzers, spectral displays, vector impedance meter, Q meter. Peak reading and RMS voltmeters
UNIT-VI **TRANSDUCERS**: Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of resistor, inductor, LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, guage factor, Thermistors, Thermocouples, Synchros, Piezo electric transducers, photovoltaic, photo conductive cells, photo diodes
UNIT-VII: **MEASUREMENT OF NON-ELECTRICAL QUANTITIES-I:** Measurement of strain, Gauge Sensitivity, Displacement, Velocity, Angular Velocity, Acceleration, Force, Torque
UNIT-VIII : **MEASUREMENT OF NON-ELECTRICAL QUANTITIES-II:** Measurement of Temperature, Pressure, Vacuum, Flow, Liquid level.

Text books:

1. Transducers and Instrumentation by D.V.S Murthy, Prentice Hall of India
2. A course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpatrai& Co.

Reference books:

1. Measurements Systems, Applications and Design – by D O Doeblin, TMH publications
2. Modern Electronic Instrumentation and Measurement techniques – by A.D
3. HelfrickAnd W.D.Cooper, Pearson/Prentice Hall of India
4. Principles of Measurement and Instrumentation – by A.S Morris, Pearson /Prentice Hall of India
5. Electronic Instrumentation-by H.S.Kalsi Tata MCGraw-Hill Edition, 1995

Additional Reference

1. **Electrical and Electronics Measurements and Instrumentation byPrithwirajPurkait-**

MCGraw-HillEducation(India)

IX. COURSE PLAN:

The course plan is meant as a guideline. There may be probably being changes.

Lecture no.	**Learning objectives**	**Topics to be covered**	**Reference**
1.	Students will learn electrical, electronics and mechanical instruments and advantages of electrical/electronicsinstruments	Introduction, Classification of instruments	T1,T2,R2
2.	Students will be able to analyse Measuring systems and explain	Measuring systems	T1,T2,R2

	the block diagram of Measuring systems		
3.	Understand static characteristic of instruments	static characteristic	T1,T2,R2
4.	Analyse static errors	Static errors	T1,T2,R2
5.	Tutorial	Tutorial	T1,T2,R2
6.	Students are able to explain Dynamic characteristics	Dynamic characteristics	T1,T2,R2
7.	analyseGross,systematicand randomerrors	Errors in measurements	T1,T2,R2
8.	Analyse Statistical analysis of random errors	Statistical analysis ofrandom errors	T1,T2,R2
9.	Able to explain classification of signals	Standard tests	T1,T2,R2
10.	Tutorial	Tutorial	T1,T2,R2
11.	Diescribe Standard test signals	Standard test signals	T1,T2,R2
12.	Able to apply FT and LT for analysing signals	FT and LT	T1,T2,R2
13.	Able to distinguish between amplitude and frequency and phase modulations	Modulated signals-amplitude and frequency and phase modulations	T1,T2,R2
14.	Able to distinguish PCM, PAM, PDM,PPM techniques	Pulse modulation	T1,T2,R2
15.	Tutorial	Tutorial	T1,T2,R2
16.	Able to explainsampling process	Sampled data, sampling process,Sampling theorem	T1,T2,R2
17.	Able tobexplainCathode ray oscilloscopes	Cathode ray oscilloscopes CRT - block diagram	T2, R2,R4
18.	Able to analyse the parts of a CRO	Horizontal ,vertical amplifier , trigger circuit, Time base generator	T2, R2,R4
19.	Able to explain CRO Screen, probes	Screen, probes	T2, R2,R4
20.	Tutorial	Tutorial	T2, R2,R4
21.	Able to Apply CROfor measurements	Measurements of phase and frequency lissajous pattern	T2, R2,R4
22.	Able to explain Sampling oscilloscopes	Sampling oscilloscopes	T2, R2,R4
23.	Able to explain Analog oscilloscopes	Analog oscilloscopes	T2, R2,R4
24.	Able to explain Digital storage oscilloscopes	Digital storage oscilloscopes	T2, R2,R4
25.	Tutorial	Tutorial	T2, R2,R4
26.	Able to explain Block diagrams and classification of DVM	Comparisons of analog and digital instruments, Block diagrams, classification	T2, R2,R4
27.	Able to explain the different techniques used in DVM	Successive approximations , ramp type DVM	T2, R2,R4
28.	Able to explain the different techniques used in DVM	Dual Slope integration , continuous balance type	T2, R2,R4
29.	Able to explain the different techniques used in DVM	Microprocessor based ramp type DVM ,3-1/2 digits	T2, R2,R4
30.	Tutorial	Tutorial	T2, R2,R4
31.	Able to explain Digital frequency	Digital frequency meter	T2, R2,R4

	meter		
32.	Able to explainDigital phase angle meter	Digital phase angle meter	T2, R2,R4
33.	Able to explain signal analysers	Wave analyser frequency nalyser,Heterodyne	T2, R2,R4
34.	Able to explain signal analysers	Application of wave analyzerHarmonicnalyzers, Total harmonic distortion	T2, R2,R4
35.	Tutorial	Tutorial	T2, R2,R4
36.	Able to explain the working of different types of signal analysers	Spectrum analyzer, Spectral displays,	T2, R2,R4
37.	,,	Vector impedance meter	T2, R2,R4
38.	,,	Q meter	T2, R2,R4
39.	Will be able to distinguish between Peak reading and RMS voltmeters	Peak reading and RMS voltmeters	T2, R2,R4
40.	Tutorial	Tutorial	T2, R2,R4
41.	Will be able to explain the working principles of various transducers	classsification of transducers advantageelectricransducers, Characteristics and choice of transducers	T2, R2,R4
42.	Will be able to explain theconstruction of various transducers	Principle of operation of resistor, inductor, and capacitor transducers	T2, R2,R4
43.	Will be able to explain LVDT and apply LVDT for the measurement of linear displacement	LVDT, LVDT applications	T2, R2,R4
44.	Will be able to explainstraingauges	strain gauge and its principle of operation	T2, R2,R4
45.	Tutorial	Tutorial	T2, R2,R4
46.	Will be able to explain the principles and construction of various transducers	Thermistors , Thermocouples	T2, R2,R4
47.	Will be able to explain the principles and construction of various transducers	Synchros ,Peizoelectrictransducer	T2, R2,R4
48.	Will be able to explain the principles and construction of various transducers	Photovoltaic,Photocconductive cells and photo diodes	T2, R2,R4
49.	Will be able to explain principles and construction of various transducers	Measurement of straln, Guage sensitivity	T2, R2,R4
50.	Tutorial	Tutorial	T2, R2,R4
51.	Application of the transducers for measuring non electricalquantities	Displacement Transducer	T2, R2,R4
52.	,,	Velocity, Angular velocity transducer	T2, R2,R4
53.	,,	Accelaration transducers	T2, R2,R4
54.	,,	Force transducers, Torque transducers	T2, R2,R4
55.	,,	Torque transducers	T2, R2,R4
56.	Tutorial	Tutorial	T2, R2,R4
57.	,,	Measurement of temperature	T2, R2,R4

58.	,,	Pressure sensors	T2, R2,R4
59.	,,	Flow measurements	T2, R2,R4
60.	,,	Vaccum measurements	T2, R2,R4
61.	,,	Tutorial	T2, R2,R4
62.	,,	Ultrasonic detectors	T2, R2,R4
63.	,,	Level transducers	T2, R2,R4
64.	Discussing previous question papers	Discussing previous question papers	T2, R2,R4
Total: 64			

X. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course objectives	Program outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	H	S	S	S	S	S	S	S	H	S	H	S
2	H	S	S	S	S	S	S	S	H	S	H	S
3	S	S	S	S	S	S	S	S	S	H	S	S
4	H	S	S	S	S	S	S	S	H	S	H	S
5	H	S	S	S	S	S	S	S	H	S	H	S
6	H	S	S	S	S	S	S	S	H	S	H	S
7	H	S	S	S	S	S	S	S	H	S	H	S

S=Supportive H=highly related

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

Course objectives	Program outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	H	S	S	S	S	S	S	S	H	S	H	S
2	H	S	S	S	S	S	S	S	H	S	H	S
3	H	S	S	S	S	S	S	S	H	S	H	S
4	H	H	S	S	S	S	S	S	H	S	H	S
5	H	S	S	S	S	S	S	S	H	S	H	S
6	H	H	S	S	S	S	S	S	H	S	H	S
7	H	S	S	S	S	S	S	S	H	S	H	S
8	H	S	S	S	S	S	S	S	H	S	H	S
9	H	S	S	S	S	S	S	S	H	S	H	S
10	H	S	S	S	S	S	S	S	H	S	H	S

S=Supportive H=highly related

Prepared by: Lekha Chandran, Associate Professor

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