INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**Electrical and Electronics Instrumentation**			
Course Code	**A60223**			
Regulation	**R15**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	**-**	**-**	**4**
Course Coordinator	**Mr. T Mahesh, Assistant Professor**			
Team of Instructors	**Mr. A Sathish Kumar, Assistant Professor**			

I. COURSE OVERVIEW:

This course deals with measuring instruments mainly indicating instruments and the associated torques, instrument transformers, power factor meter, frequency meter, synchro scopes, wattmeter, energy meter, potentiometer, resistance measuring methods, ac bridges, ballistic galvanometer, flux meter, extension range of indicating instruments.

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
UG	4	4	Engineering Physics, Computational Mathematics and Integral Calculus and Electrical Circuits**.**

III. COURSE ASSESSMENT METHODS:

a) Marks distribution:

Session Marks	University End Exam Marks	Total Marks
There shall be two mid tem examinations. Each midterm 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 1 to 2 1/2 units and the second, after the completion of 2 1/2 to 5 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 part –A and part-B. Where part consists of short answer questions carrying total marks of 25 and part part-B consists of 5 essay type questions consists of internal choice each carrying 10 marks and the total of 50. The total external marks are 75.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	80 minutes	20
2	I Assignment	--	05
3	II Mid Examination	80 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVES:

The course should enable the students to:

I Demonstrate the construction, working and characteristics of electrical measurement instruments.

II Illustrate the principles of energy measurement in electrical loads.

III Outline the use of cathode ray oscilloscope.

IV Evaluate various transducers for electrical measurement

VI. COURSE OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

1 Identify various effects on measuring instruments used to measure electrical quantity.

2 Compare PMMC and MI instruments in view of construction, extension range and various errors.

3 Explain the instruments works on electrostatic effect principle.

4 Construct the potentiometer to measure the small voltages and discuss the importance of standardization in instruments.

5 Use Potentiometer applications in measurement of voltage, current, resistance and power.

6 Distinguish between current transformer and potential transformer.

7 Analysis of ratio error and phase angle error in instrument transformers.

8 Demonstrate the construction and operation of single phase wattmeter and three phase wattmeter.

9 Identify the best method for the measurement of active and reactive powers in balanced, unbalanced system.

10 Generalize the importance of induction effect in the working of energy meter and also describe the energy meter calibration.

11 Compute the unknown resistance using various DC bridges.

12 Predict the unknown inductance and its quality factor using different types of AC bridges.

13 Estimate the capacitance between two conducting surfaces using various AC bridges.

14 Define the transducers and classify the transducers based on measurement of electrical quantities.

15 Design a suitable transducer for the measurement of displacement, pressure, resistances, capacitance, speed and position.

16 Summarize the features, application and various working models of cathode ray oscilloscope.

17 Explain the measurement of phase angle and frequency of various electrical quantities.

18 Apply the concept of electromagnetic and electrostatic fields to solve real time world applications.

19 Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	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.	H	Exercise and Discussion
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.	S	Exercise and Discussion
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.	S	Discussion and seminars
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.	S	Open ended problems
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.	N	------
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	N	------
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	N	------
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	N	---
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	---

Program Outcomes		Level	Proficiency assessed by
PO10	**Communication:** Communicate effectively on complex engineering Activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	N	------
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	N	-----
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	N	------

N= None S= Supportive H = Highly Related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	N	------
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	N	------
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Discussion and seminars

N - None S - Supportive H - Highly Related

V. SYLLABUS:

UNIT I: Introduction to measuring Instruments: Classification-deflecting, damping and control torques-ammeter and voltmeter-PMMC,MI instruments-expression for deflection and control torque-errors and compensation-extension of range using shunts and series resistance, electro-static voltmeter-electro type and standard diac type-extension of range of ES voltmeters.

UNIT II: Potentiometers and Instrument Transformer: Principle and operation of DC Crampton Potentiometer- Standardization –measurement of unknown resistance, current, voltage A.C Potentiometers: Polar and coordinate types Standardization –Applications. CT and PT-ratio and phase angle error.

UNIT III: Measurement of Power and energy; single phase dynamometer type wattmeter-LPF and UPF, double elements and three elements dynamometer wattmeter-expression for deflection and control torque-extension of range of wattmeter-using instrument transformers-measurement of active and reactive power for balanced and unbalanced Systems. Single induction type energy meter-driving and braking torques-errors and compensations-testing by phantom loading using RSS meter-three phase energy meter-tri vector-maximum demand meters

UNIT IV: DC and AC Bridges: Methods of measuring low, medium , high resistance-sensitivity if Wheatstone bridge-carry foster , Kelvin's double bridge for measuring resistance-measurement of high resistance-loss of

charge method. Measurement of inductance, quality factor-Maxwell's, hay's, Anderson's, Owen's bridges-measurement of capacitance and loss angle, desauty's, wein's, Schering bridges.

UNIT-V: Transducers and Oscilloscopes: Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermocouples, Synchro's, Piezo electric transducers, photovoltaic, photo conductive cells, photo diodes Cathode ray oscilloscope-Cathode ray tube-time base generator-horizontal and vertical amplifiers-CRO probes-applications of CRO-Measurement of phase and frequency-lissajous patterns-Sampling oscilloscope-analog and digital type

TEXT BOOKS:

1 E W Golding and F C Widdis, "Electrical measurements and measuring instruments", Wheeler publishing, 5th Edition, 2006
2 A K Sawhney, "Electrical and Electronic measurement and instruments", Dhanpat Rai and Sons Publications, 2002.

REFERENCES:

1 Buckingham and Price, "Electrical measurements", Prentice Hall.
2 D V S Murthy, "Transducers and Instrumentation", Prentice Hall of India, 2nd Edition, 2009
3 A S Morris, "Principles of measurement of instrumentation", Pearson/Prentice Hall of India 2nd Edition, 1994.
4 H S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill Publications, 1st Edition 1995.

IX. COURSE PLAN:

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

Lecture No.	Learning Objectives	Topics to be covered	Reference
1	To understand classification instrument	Classification instrument	T2:3
2	To determine how indicating instruments work smoothly.	Types of torques associated with secondary instruments	T2:3
3	To understand PMMC instruments	MC instruments	T2:238-249
4	To know mi instruments	MI instruments	T2:257-262
5	To know extension of range of ammeter	Extension of range of ammeter	T2:238-249
6	To derive extension of range of ammeter	Extension of range of ammeter	T2:238-249
7	To determine errors effecting indicating instruments	Types of errors associated with mc and mi instruments	T2:257-262
8	To understand electro-static instruments	Electro-static instruments	T2:282
9	To know types of electro-static instruments	Types of electro-static instruments	T2:282
10	To understand definition of instrument transformer and their uses	Definition of instrument transformer and their uses	T2:313
11	Ability to design Current transformer	Current transformer in detail	T2:316-319

12	Analyze Errors of current transformer	Errors of current transformer	T2:316-319
13	Ability to design potential transformer	Potential transformer in detail	T2:330-335
14	To analyze the errors effecting the potential transformer	Errors of potential transformer	T2:330-335
15	To understand principle of operation of DC Crompton potentiometer	Principle of operation of DC Crompton potentiometer	Internet
16	To determine the error in measurement using potentiometer	Standardization	Internet
17	To understand measurement of resistance using potentiometer	Measurement of resistance using potentiometer	T2:330-335
18	To determine measurement of voltage, current using potentiometer	Measurement of voltage, current using potentiometer	T2:330-335
19	To understand construction and operation of AC potentiometer polar type	AC potentiometer polar type	T2:330-335
20	To understand construction and operation of ac potentiometer co-ordinate type	AC potentiometer co-ordinate type	T2:330-335
21	To determine the error in measurement using potentiometer	Standardization	T2:330-335
22	To determine measurement of power using wattmeter	Measurement of power using wattmeter	T2:363-371
23	To understand construction and operation of single-phase wattmeter	Construction and operation of single-phase wattmeter	T2:363-371
24	To determine measurement of power using single wattmeter method	Measurement of power using single wattmeter method	T2:363-371
25	To determine measurement of power using two-wattmeter method	Measurement of power using two-wattmeter method	T2:363-371
26	To understand measurement of power using three- wattmeter method	Measurement of power using three-wattmeter method	T2:363-371
27	To understand working and importance of double element wattmeter	Double element wattmeter	T2:363-371
28	To apply how to extend the range of wattmeter using instrument transformer	Extension of range of wattmeter using instrument transformer	T2:363-371
29	To determine measurement of reactive power using var—meter	Measurement of reactive power using var—meter	T2:363-371
30	To understand construction and operation of single-phase induction	Single-phase induction type energy meter	T2:383
31	To remember driving and braking torques	Driving and braking torques	T2:383
32	To determine errors effecting energy meter	Errors and compensation	T2:387
33	To determine errors effecting energy meter	Errors and compensation	T2:387
34	To test energy meter using phantom loading for calibration	Testing energy meter using phantom loading	T2:396
35	To understand types of tests for energy meter	Types of tests for energy meter	T2:387

36	To understand construction of three-phase energy meter	Three-phase energy meter	T2:396
37-38	to understand tri-vector meter, maximum demand meter	Tri-vector meter, maximum demand meter	T2:396
39	To understand methods of measuring low, medium and high resistance	Methods of measuring low, medium and high resistance	T2:421-446
40	To understand methods of measuring low, medium and high resistance	Methods of measuring low, medium and high resistance	T2:421-446
41	To analyze sensitivity of Wheatstone bridge	Sensitivity of Wheatstone bridge	T2:424
42	To measure the résistance	Carley's foster bridge	T2:428
43	To measure the resistance	Kelvin's double bridge	T2:428
44	To measure the résistance	Measurement of high resistance-loss of charge method	T2:437
45	To measure the inductance	Measurements of unknown parameters using AC bridges	T2:482-486
46	To measure the inductance	Measurement of unknown inductance. Maxwell's bridge Hay's bridge Anderson's bridge	T2:482-486
47	To measure the Capacitance	Measurement of unknown capacitance. Desauty's bridge Wein's bridge Schering bridge	T2:488-491
48	Problems	Problems	
49	Explain the Working Principles of Various Transducers	Classification of transducers advantage electric transducers, Characteristics and choice of transducers	T2:935-949
50	Explain the Construction of Various Transducers	Principle of Operation of Resistor, Inductor, and Capacitor Transducers	T2:979-986
51	To understand the Measurement of Linear displacement by using LVDT	LVDT, LVDT Applications	T2:1001-1003
52	To understand operation of Strain Gauges	Strain Gauge and its Principle of Operation	T2:964-966
53	Tutorial	Tutorial	T2, R2,R4
54	Compute the Principles and Construction of Various transducers	Thermistors , Thermocouples	T2: 979-986
55	Compute the Principles and Construction of Various transducers	Synchro's ,Piezoelectric transducer	T2: 979-986
56	Compute the Principles and Construction of Various transducers	Photovoltaic ,Photoconductive cells and Photo Diodes	T2:1046-1050
57	Compute the Principles and Construction of Various transducers	Measurement of Strain, Gauge Sensitivity	T2:964
58	To summarize the Cathode ray oscilloscopes	Cathode ray oscilloscopes CRT - block diagram	T2:820-823
59	Analyze the parts of a CRO	Horizontal ,vertical amplifier , trigger circuit, Time base generator	T2:791-795
60	To understand concept of CRO Screen, probes	Screen, probes	T2:796,

61	To understand Sampling oscilloscopes	Sampling oscilloscopes	T2:816-818
62	Compute Analog oscilloscopes	Analog oscilloscopes	T2:819
63	Explain Digital storage oscilloscopes	Digital storage oscilloscopes	T2:820-823

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

Course Objectives	Program Outcomes												Program Specific 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	PSO 1	PSO 2	PSO 3
I	H	-	H	S	-	-	-	-	-	-	-	-	-	-	S
II		S	H	-	-	-	-	-	-	-	-	-	-	-	H
III	H	H	S	H	-	-	-	-	-	-	-	-	-	-	-
IV	H	-	H	-	-	-	-	-	-	-	-	-	-	-	S

S= Supportive **H = Highly Related**

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

Course Outcomes	Program Outcomes												Program Specific 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	PSO 1	PSO 2	PSO 3
1	H	S	S	S	-	-	-	-	-	-	-	-	-	-	S
2	H	-	-	-	-	-	-	-	-	-	-	-	-	-	S
3	S	-	S	-	-	-	-	-	-	-	-	-	-	-	S
4	H	-	_	S	-	-	-	-	-	-	-	-	-	-	S
5	S	-	-	H	-	-	-	-	-	-	-	-	-	-	S
6	S	S	H	-	-	-	-	-	-	-	-	-	-	-	S
7	S	-	-	H	-	-	-	-	-	-	-	-	-	-	S
8	H	H	S	-	-	-	-	-	-	-	-	-	-	-	H
9		H	S	S	-	-	-	-	-	-	-	-	-	-	H
10	S	H	-	-	-	-	-	-	-	-	-	-	-	-	S
11	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	S	H	-	S	-	-	-	-	-	-	-	-	-	-	H
13	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	H	-	-	H	-	-	-	-	-	-	-	-	-	-	H
15	S	H	H	H	-	-	-	-	-	-	-	-	-	-	H

16	S	H	S		-	-	-	-	-	-	-	-	-	-	S
17	S		S		-	-	-	-	-	-	-	-	-	-	S
18	H	H	S	S	-	-	-	-	-	-	-	-	-	-	S
19	H	H	-	-	S	-	-	-	S	H	-	S	-	-	H

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