INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)
Dundigal,Hyderabad-500043

MECHANICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**INSTRUMENTATION AND CONTROL SYSTEMS**			
Course Code	**A70343**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	-	-	4
Course Coordinator	Mr.B D Y Sunil, Assistant Professor, ME			
Team of Instructors	Mr.B D Y Sunil, Assistant Professor, ME Mr. M Prashanth Reddy, Assistant Professor, ME			

I. COURSE OVERVIEW

The Present course concentrates on developing basic understanding about various instruments that are involved in measuring. This course enables the student to understand the working of various measuring instruments. The course focuses on all principles, working, advantages, disadvantages and applications of various measuring instruments.In this course; students also will gain a broad understanding of the control systems. Student can learn in detail about how to measure displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application. A general understanding of measuring characteristics is also included in the beginning of this course. An understanding of the control systems, servomechanisms is also be given to the students at the end of this course.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Physics, Engineering Metrology, Basic Electrical and Electronics Engineering.

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion.	75	100

Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.		

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

I. Understandthebasic principles and performance characteristics of measurement.
II. Understandtheprinciples of various measuring instruments.
III. Applytheworking of various measuring instruments
IV. Visualizethe advantages and limitations of various measuring instruments
V. Comprehendthe applications of various measuring instruments.
VI. Applythe elements of control systems and servo mechanisms.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. Understand the basic principles and performance characteristics of measurement.
2. Apply the basic principles, working, advantages, disadvantages and applications of measuring instruments for displacement, temperature and pressure.
3. Comprehend the basic principles, working, advantages, disadvantages and applications of measuring instruments for level, flow, speed, acceleration and vibration.
4. Visualize the basic principles, working, advantages, disadvantages and applications of measuring instruments for stress strain, humidity, force, torque and power.
5. Understand the basic principles, working, advantages, disadvantages and applications of various control systems.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	H	Assignments and Exams
PO2	An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	H	Assignments and Exams
PO3	Competence to design a system, component or process to meet societal needs within realistic constraints.	S	Assignments and Exams
PO4	To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	N	--
PO5	An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.	H	Assignments and Exams
PO6	To utilize the engineering practices, techniques, skills to meet needs of the	N	--

	health, safety, legal, cultural and societal issues.		
PO7	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	N	--
PO8	An understanding and implementation of professional and Ethical responsibilities.	N	--
PO9	To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.	N	--
PO10	An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.	N	--
PO11	An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.	N	--
PO12	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	S	Assignments and Exams

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	H	Lectures, Assignments
PSO 2	**Design/ Analysis:**An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	S	Projects
PSO 3	**Successful Career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	H	Guest Lectures

N - None **S - Supportive** **H – Highly Related**

IX. SYLLABUS

UNIT-I

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, Classification and elimination of error.

UNIT-II

Measurement of Displacement: Theory and construction of various transducers to measure displacement – Peizo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.

Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators.

Measurement of Pressure: Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.

UNIT-III

Measurement of Level: Direct method – Indirect methods – capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – Bubler level indicators.

Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer

Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle.

UNIT-IV

Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, Strain gauge Rosettes.

Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter.

Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.

UNIT-V

Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems Servomechanisms–Examples with block diagrams–Temperature, speed & position control systems.

TEXT BOOKS:

T1. Measurement Systems: Applications & Design by D.S Kumar, Anuradha Agencies
T2. Instrumentation, Measurement & Analysis by B. C. Nakra & K. K. Choudhary, TMH

REFERENCE BOOKS:

R1. J. B. Jones, R. E. Dugan (2009), Engineering Thermodynamics, 1st edition, Prentice Hall of India Learning, New Delhi, India.
R2. Y. V. C. Rao (2013), An introduction to Thermodynamics, 3rd Edition, Universities Press, Hyderabad, India.
R3. K. Ramakrishna (2011), Engineering Thermodynamics, 2nd edition, Anuradha Publishers, India.

X. COURSE PLAN:

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

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1-15	**Understand** the basic principles and performance characteristics of measurement	Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, Classification and elimination of error.	T1:1.1 -1.16
16-30	**Understand** the basic principles, working, advantages, disadvantages and applications of measuring instruments for displacement, temperature and pressure	**Measurement of Displacement:** Theory and construction of various transducers to measure displacement – Peizo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.	T1: 14.1-14.2
		Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators.	T1: 20.1-20.3
		Measurement of Pressure: Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.	T1: 18.1-18.3
30-45	**Understand** the basic principles, working, advantages, disadvantages and applications of measuring instruments for level, flow, speed, acceleration and vibration.	**Measurement of Level:** Direct method – Indirect methods – capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – Bubler level indicators.	T1: 24.1-24.2
		Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA).	T1: 21.1-21.2
		Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer	T1: 15.1 - 15.3
		Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle.	T1: 16.1-16.2
46-60	**Understand** the basic principles, working, advantages, disadvantages and applications of measuring instruments for stress strain, humidity, force, torque and power.	**Stress Strain Measurements:** Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, Strain gauge Rosettes.	T1: 9.1- 9.5
		Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter.	T1: 10.1-10.6

		Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.	T1: 11.1-11.5
61-75	**Understand** the basic principles, working, advantages, disadvantages and applications of various control systems	**Elements of Control Systems:** Introduction, Importance – Classification – Open and closed systems Servomechanisms–Examples with block diagrams– Temperature, speed & position control systems.	T1: 28.1-28.16

Lecture No.	Course Learning Outcomes	Description	Reference
1	Describe Measurements	Introduction	T1: 1.1-1.16
2-4	Explain principles of measurement	Definition – Basic principles of measurement	T1: 1.1-1.16
5-7	Relate instrument and measurement	Measurement systems	T1: 1.1-1.16
8-10	Discuss generalized configuration	generalized configuration and functional descriptions of measuring instruments – examples	T1: 1.1-1.16
11-12	Explain Dynamic performance characteristics	Dynamic performance characteristics	T1: 1.1-1.16
13	Explain sources of error	sources of error	T1: 1.1-1.16
14	Discuss elimination of error	Classification and elimination of error	T1: 1.1-1.16
15	Describe Measurement of Displacement	Measurement of Displacement: Theory and construction of various transducers to measure displacement, Peizo electric	T1: 14.1-14.2
16	Analyze Inductive	Measurement of Displacement: Theory and construction of various transducers to measure displacement, Inductive	T1: 14.1-14.2
17	Enumerate Measurement of Displacement	Measurement of Displacement: Theory and construction of various transducers to measure displacement, capacitance	T1: 14.1-14.2
18	Describe various transducers	Measurement of Displacement: Theory and construction of various transducers to measure displacement, resistance	T1: 14.1-14.2
19	Discussionization	ionization and Photo electric transducers	T1: 14.1-14.2
20	DescribeCalibration procedures	Calibration procedures	T1: 14.1-14.2
21	Discuss Range, drift	Measurement of Temperature: Classification – Ranges	T1: 20.1-20.3
22	DiscussElectrical Resistance	Various principles of measurement – Expansion, Electrical Resistance	T1: 20.1-20.3
23	Explain Thermistor	Thermistor – Thermocouple	T1: 20.1-20.3

24	Discuss Pyrometers	Pyrometers – Temperature Indicators	T1: 20.1-20.3
25	Discuss Measurement of Pressure	Measurement of Pressure: Units – classification – different principles used	T1: 18.1-18.3
26	Differentiate Manometers, Piston	Manometers, Piston	T1: 18.1-18.3
27	Enumerate Diaphragm gauges	Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement	T1: 18.1-18.3
28	Explain Thermal conductivity	Thermal conductivity gauges	T1: 18.1-18.3
29	Discuss ionization pressure	ionization pressure gauges, Mcleod pressure gauge	T1: 18.1-18.3
30	Enumerate Direct Indirect methods	Measurement of Level: Direct method – Indirect methods	T1: 24.1-24.2
31	Explain capacitative	capacitative, ultrasonic	T1: 24.1-24.2
32	Enumerate magnetic	magnetic, cryogenic fuel level indicators	T1: 24.1-24.2
33	Explain Bubler level indicators	Bubler level indicators	T1: 24.1-24.2
34	Explain Rotameter	Flow Measurement: Rotameter, magnetic flow meter	T1: 21.1-21.2
35	Enumerate Ultrasonic	Ultrasonic, Turbine flow meter	T1: 21.1-21.2
36	ExplainHot – wire anemometer	Hot – wire anemometer	T1: 21.1-21.2
37	Enumerate(LDA)	Laser Doppler Anemometer (LDA)	T1: 21.1-21.2
38	Enumerate Mechanical Tachometers	Measurement of Speed: Mechanical Tachometers	T1: 15.1 - 15.3
39	Explain Electrical tachometers	Electrical tachometers	T1: 15.1 - 15.3
40	Discuss Stroboscope	Stroboscope	T1: 15.1 - 15.3
41	Enumerate Noncontact tachometer	Noncontact type of tachometer	T1: 15.1 - 15.3
42	Enumerate Acceleration	Measurement of Acceleration and Vibration: Different simple instruments	T1: 16.1-16.2
43	Discuss Seismic instruments	Principles of Seismic instruments	T1: 16.1-16.2
44-45	Discuss Vibrometer	Vibrometer and accelerometer using this principle	T1: 16.1-16.2
46-47	Explain Stress Strain Measurements	Stress Strain Measurements: Various types of stress and strain measurements	T1: 9.1-9.5
48	Explain electrical strain gauge	electrical strain gauge	T1: 9.1-9.5
49	Explain gauge factor	gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains	T1: 9.1-9.5
50	Explain Strain gauge	usage for measuring torque, Strain gauge Rosettes	T1: 9.1-9.5
51	Explain Humidity	Measurement of Humidity: Moisture content of	T1: 10.1-

		gases	10.6
52	Discuss psychrometer	sling psychrometer	T1: 10.1-10.6
53	Enumerate Absorption psychrometer	Absorption psychrometer	T1: 10.1-10.6
54	Explain Dew point meter	Dew point meter	T1: 10.1-10.6
55	Explain Torque and Power	Measurement of Force, Torque and Power: Elastic force meters	T1: 11.1-11.5
56	Explain Elastic force meters	Measurement of Force, Torque and Power: Elastic force meters	T1: 11.1-11.5
57	Discuss load cells	load cells	T1: 11.1-11.5
58	Enumerate Torsion meters	Torsion meters	T1: 11.1-11.5
59-60	Enumerate Dynamometers	Dynamometers	T1: 11.1-11.5
61	Enumerate Control Systems	Elements of Control Systems: Introduction, Importance	T1: 28.1-28.16
62	Discuss Classification of Control Systems	Elements of Control Systems: Classification	T1: 28.1-28.16
63	Explain Open and closed systems	Open and closed systems	T1: 28.1-28.16
64-66	Discuss Servomechanisms	Servomechanisms–Examples with block diagrams	T1: 28.1-28.16
67	Discuss Temperature control systems	Temperature control systems	T1: 28.1-28.16
68	Enumeratespeed control systems	speed control systems	T1: 28.1-28.16
69	Enumerateposition control systems	position control systems	T1: 28.1-28.16

MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H											H		H
II	H	H	S		H							S	H		H
III	H	H	S		H							S	H		H
IV	H	H	S		H							S	H		H
V	H	H	S		H							S	H		H
VI	H	H										S		S	S

N=None **S=Supportive** **H=Highly related**

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

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	H											H		H
2	H	H	S		H							S	H		H
3	H	H	S		H							S	H		H
4	H	H	S		H							S	H		H
5	H	H										S		S	S

N=None **S=Supportive** **H=Highly related**

Prepared by: Mr.B D Y Sunil, Assistant Professor, ME

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