INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INSTRUMENTATION AND CONTROL SYSTEMS**				
Course Code	AME019				
Programme	B.Tech				
Semester	VII	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	2	1
Chief Coordinator	Mr. M V Aditya Nag, Assistant Professor, ME				
Course Faculty	Dr. Paidi Raghavulu, Professor, ME Mr. M V Aditya Nag, 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.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME010	V	Machine Tools and Metrology	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Instrumentation and Control Systems	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 CIE 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 (CIA), 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	25	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 25 marks of 2 hours duration consisting of two

parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

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	Assignments
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	Seminars
PO 3	**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.	2	Assignments
PO 6	**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.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW 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	Assignments
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	3	Seminars
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	Visualize the concepts of measurement and dynamic performance characteristics of measuring instruments.
II	Understand the measurement of typical physical quantities like displacement, temperature, pressure.
III	Applying techniques for measurement of Level, Flow, Speed, Acceleration and Vibration.
IV	Visualize the measurement of Stress, Strain, Humidity, Force, Torque and Power.
V	Understand the control systems for instrumentation and develop Temperature, Speed and Position control systems.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Ability to describe the static and dynamic characteristics, identify functional elements of generalized measuring system and error control.	CLO 1	Understand the basic principles and measurement system.
		CLO 2	Comprehend generalized configuration and functional description of measuring instruments.
		CLO 3	Visualize static and dynamic performance characteristics.
		CLO 4	Understand the sources of various errors and its elimination.
CO 2	Ability to analyze and design the measuring system for the measurement of displacement, temperature and Pressure	CLO 5	Apply the working principles and identify the measurands for displacement.
		CLO 6	Evaluate temperature measuring methods in various equipments.
		CLO 7	Understand the fluid pressure, its importance and measurement techniques.
CO 3	Ability to analyze and design the measuring system for the measurement of Flow and liquid level.	CLO 8	Comprehend the level measuring devices for ascertaining liquid level.
		CLO 9	Visualize the importance of flow measurement and know various flow measuring devices.
		CLO 10	Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation.

		CLO 11	Comprehend the importance of acceleration and vibration measurement with various techniques.
CO 4	Ability to analyze and design the measuring system for the measurement of stress, strain, humidity, force and torque.	CLO 12	Visualize the stress and strain experienced by various elements and understand the importance of strain measurement with various techniques.
		CLO 13	Understand the concept of humidity in atmosphere as well as the storage applications and maintenance of humidity by measurement.
		CLO 14	Apply the basic principles of instrumentation for force measurement in various fields of engineering.
		CLO 15	Apply the basic principles and characteristics for force and torque measurement.
		CLO 16	Comprehend the instrumentation techniques in solving the engineering measuring applications of torque and power.
CO 5	Ability to analyze & design the control system for control of position, temperature, acceleration & process control.	CLO 17	Understand the control systems for instrumentation in various practical applications.
		CLO 18	Classify the control systems, advantages, limitations and control system terminology.
		CLO 19	Comprehend servo mechanism, regulators for process and position control..
		CLO 20	Apply control system for process control, control of position, temperature and acceleration.

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
AME019.01	CLO 1	Understand the basic principles and measurement system.	PO1,PO2	3
AME019.02	CLO 2	Comprehend generalized configuration and functional description of measuring instruments.	PO1,PO2	2
AME019.03	CLO 3	Visualize static and dynamic performance characteristics.	PO2, PSO3	3
AME019.04	CLO 4	Understand the sources of various errors and its elimination.	PO3	3
AME019.05	CLO 5	Apply the working principles and identify the measurands for displacement.	PO2,PO3	2
AME019.06	CLO 6	Evaluate temperature measuring methods in various equipments.	PO2	2
AME019.07	CLO 7	Understand the fluid pressure, its importance and measurement techniques.	PO3	3
AME019.08	CLO 8	Comprehend the level measuring devices for ascertaining liquid level.	PO1,PO3	2
AME019.09	CLO 9	Visualize the importance of flow measurement and know various flow measuring devices..	PO2	3
AME019.10	CLO 10	Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation.	PO1,PO6	3
AME019.11	CLO 11	Comprehend the importance of acceleration and vibration measurement with various techniques.	PO1, PO2	2
AME019.12	CLO 12	Visualize the stress and strain experienced by various elements and understand the importance of strain measurement with various techniques.	PO1,PO6	3
AME019.13	CLO 13	Understand the concept of humidity in atmosphere as well as the storage applications and maintenance of humidity by measurement.	PO1,PO3	2

AME019.14	CLO 14	Apply the basic principles of instrumentation for force measurement in various fields of engineering.	PO6	2
AME019.15	CLO 15	Apply the basic principles and characteristics for torque measurement.	PO1,PO2, PO3	3
AME019.16	CLO 16	Comprehend the instrumentation techniques in solving the engineering measuring applications of torque and power.	PO1,PO2, PO3	2
AME019.17	CLO 17	Understand the control systems for instrumentation in various practical applications.	PO1, PO2, PO6	3
AME019.18	CLO 18	Classify the control systems, advantages, limitations and control system terminology.	PO2,PO6	2
AME019.19	CLO 19	Comprehend servo mechanism, process control and regulators for process and position control.	PO3	2
AME019.20	CLO 20	Apply control system for control of position, temperature and acceleration.	PO3	3

3= High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)					
	PO 1	PO 2	PO 3	PO 6	PSO1	PSO 2
CO 1	3	3	3	-	3	2
CO 2	-	2	3	3	2	2
CO 3	3	3		3	2	3
CO 4	3	2	3	3	2	3
CO 5	3	3	3	3	3	2

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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										2		
CLO 2	3		3										2		
CLO 3		3	3											2	
CLO 4			3										3		
CLO 5		2	2										2		
CLO 6		2											2		
CLO 7			3			3								2	

CLO 8	2		2										2		
CLO 9		3													
CLO 10	3					3								3	
CLO 11	2	2												2	
CLO 12	3					3							2		
CLO 13	2		2											2	
CLO 14						3								2	
CLO 15	3	2	3										2	3	
CLO 16	3	2	3											2	
CLO 17	3	3				3								2	
CLO 18		2				2								2	
CLO 19			2												
CLO 20			3										3		

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3,PO6, PSO1	SEE Exams	PO1, PO2, PO3,PO6, PSO1	Assignments	-	Seminars	PO1, PO2, PO3,PO6, PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO3,PO6, PSO1						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT

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

XV. SYLLABUS

Unit-I	**PRINCIPLES 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.	
Unit -II	**MEASUREMENT OF DISPLACEMENT, TEMPERATURE, PRESSURE**
Measurement of Displacement: Theory and construction of various transducers to measuredisplacement – Piezo 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, FLOW, SPEED, ACCELERATION AND VIBRATION**
Measurement of Level: Direct method – Indirect methods capacitive, ultrasonic, magnetic, cryogenic fuel level indicators – Bubbler 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	**MEASUREMENT OF 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. 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**
Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems Servomechanisms–Examples with block diagrams–Temperature, speed & position control systems.	
Text Books:	
1. K Padma Raju, Y J Reddy, "Instrumentation and Control Systems", McGraw Hill Education1st Edition, 2016. 2. S W. Bolton, "Instrumentation and Control Systems", Newness Publisher, 1st Edition, 2004. 3. K Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd Edition, 2015.E	
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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	Introduction, definition, fundamental measuring process.	CLO 1	T1: 1.1- 1.16
2	Basic principles of measurement, classification, measurement systems.	CLO 1	T1: 1.1- 1.16
3-4	generalized configuration and functional descriptions of measuring instruments – examples	CLO 2	T2:26.7 R2:21.51
5	Static performance characteristics.	CLO 3	T1: 1.16
6-7	Dynamic performance characteristics	CLO 3	T1: 1.16
8	Sources of error, Classification of errors.	CLO 4	T1: 1.16

9	Classification of errors, elimination of error and calibration.	CLO 4	T1: 1.16
10	Zero order, 1st order 2nd order systems.	CLO 4	T1: 1.12-1.16
11-12	Classification of transducers, Theory and construction of LVDT, Resistance, Inductive transducer for measurement of displacement.	CLO 5	T1: 14.1-14.2
13	Theory and construction of capacitance transducer for measurement of displacement.	CLO 5	T1: 14.1-14.2
14	Theory and construction of Piezo electric and photo electric transducer transducers for measurement of displacement.	CLO 5	T1: 14.1-14.2
15	Theory and construction of Ionization and Photo electric transducer for measurement of displacement.	CLO 5	T1: 14.1-14.2
16	Hall effect Transducer, LDR	CLO 5	T1: 14.1-14.2
17	Measurement of Temperature: Classification – Ranges	CLO 6	T1: 20.1-20.3
18	Various principles of measurement – Expansion, Electrical Resistance	CLO 6	T1: 20.1-20.3
19	Resistance Temperature Detyector (RTD)	CLO 6	T1: 20.1-20.3
20	Thermistor for temperature measurement.	CLO 6	T1: 20.1-20.3
21	Thermocouple for temperature measurement	CLO 6	T1: 20.1-20.3
22	Pyrometers – Temperature Indicators	CLO 6	T1: 20.1-20.3
23	Measurement of Pressure: Units – classification – different principles used	CLO 7	T1: 18.1-18.3
24	Piston gauge, Manometers,	CLO 7	T1: 18.1-18.3
25-26	Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement	CLO 7	T1: 18.1-18.3
27	Thermal conductivity gauges	CLO 7	T1: 18.1-18.3
28	Ionization pressure gauges, Mcleod pressure gauge	CLO 7	T1: 18.1-18.3
29	Measurement of Level: Direct method – Indirect methods	CLO 8	T1: 24.1-24.2
30	Capacitive, ultrasonic level measurement	CLO 8	T1: 24.1-24.2
31	Magnetic, cryogenic fuel level indicators	CLO 8	T1: 24.1-24.2
32	Bubbler level indicators	CLO 8	T1: 24.1-24.2
33	Flow Measurement: Rotameter, magnetic flow meter	CLO 9	T1: 21.1-21.2
34	Ultrasonic, Turbine flow meter	CLO 9	T1: 21.1-21.2
35	Hot – wire anemometer, Laser Doppler Anemometer (LDA)	CLO 9	T1: 21.1-21.2
36	Measurement of Speed: Mechanical Tachometers	CLO 10	T1: 15.1 - 15.3
37	Electrical tachometers	CLO 10	T1: 15..3
38	Noncontact type of tachometer , Stroboscope	CLO 10	T1: 15.1 - 15.3

39	Measurement of Acceleration and Vibration: Different simple instruments	CLO 11	T1: 16.1-16.2
40	Principles of Seismic instruments	CLO 11	T1: 16.1-16.2
41-42	Vibrometer and accelerometer using this principle	CLO 11	T1: 16.1-16.2
43-44	Stress Strain Measurements: Various types of stress and strain measurements	CLO 12	T1: 9.1- 9.5
45	Electrical strain gauge	CLO 12	T1: 9.1- 9.5
46	gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains	CLO 12	T1: 9.1- 9.5
47	usage for measuring torque, Strain gauge Rosettes	CLO 12	T1: 9.1- 9.5
48	Measurement of Humidity: Moisture content of gases, sling psychrometer	CLO 13	T1: 10.1-10.6
49	Absorption psychrometer, Dew point meter	CLO 13	T1: 10.1-10.6
50	Measurement of Force , and Elastic force meters	CLO 14	T1: 10.1-10.6
51	Measurement of Torque r	CLO 15	T1: 11.1-11.5
52	load cells, Torsion meters	CLO 16	T1: 11.1-11.5
53-54	Measurement of Power, Dynamometers	CLO 16	T1: 11.1-11.5
55	Elements of Control Systems: Introduction, Importance, Classification	CLO 17	T1: 11.1-11.5
56	Open and Closed systems	CLO 18	T1: 28.1-16
57-58	Servomechanisms–Examples with block diagrams	CLO 19	T1: 28.1-28.16
59	Temperature control systems, Speed control system	CLO 20	T1: 28.1-28.16
60	Position control systems	CLO20	T1: 28.1-28.16

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

S No	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Advances in Designing processes	Seminars and Laboratory Practice	PO2	PSO1
2	Advanced topics	Guest Lectures and Laboratory Practice	PO3	PSO2
3	Recommended practices in design and analysis using software's.	Seminars and Laboratory Practice	PO3	PSO1

Prepared by:
Dr. Paidi Raghavulu, Professor, ME
Mr. M V Aditya Nag, Assistant Professor, ME

HOD, ME