

Aerospace Instrumentation

Code AE-341	Credit Hours 2-1
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COURSE DESCRIPTION:

This course will give understanding of various elements of instrumentation system and their performance characteristics. It will enable the students to select appropriate elements/ hardware for desired areas of measurement applications. Topics like measurement process, standards and dimensional units of measurement, sensors/ transducers, data acquisition system, static & dynamic performance characteristics, importance of time dependent characteristics of the measurands are included to enhance the capability of engineering students. A brief overview of concepts pertaining to significant numbers, measurement errors and uncertainty has been introduced to evaluate the goodness of experimental/ measurement data.

Lab portion includes development of measurement systems through selecting appropriate hardware like sensors, signal conditioners and utilizing Arduino/ PC based data acquisition systems. Apart from practical lab work, a number of Virtual Instrumentation exercises in LabView software have been incorporated in the Lab portion. Lab work also includes demonstration of automated dimensional measurement quality control equipment like Coordinate Measuring Machine (CMM) etc.

TEXT AND MATERIAL

Text Book:	<ol style="list-style-type: none">1. Measurement & Instrumentation Principles by Alan S. Morris, Latest Available Edition2. Electrical Fundamentals by Aviation Maintenance Technician Certification Series, Latest Available Edition3. Measurement and Instrumentation: Theory and Application (Latest Available Edition), by Alan S. Morris and Reza Langari
Reference Book:	<ol style="list-style-type: none">1. Fundamentals of Instrumentation & Measurement by Dominique Placko Mechanical Measurements by Thomas G. Beckwith, Roy D. Marangoni, Lienhard V, John H., 6th Edition

PREREQUISITE:

NIL

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

ASSESSMENT SYSTEM FOR LAB:

Quizzes	10%-15%
Assignments	5% - 10%
Lab Work and Report	70-80%
Lab ESE/Viva	20-30%

Teaching Plan

Week No	Topics	Learning Outcomes	Delivery Method
1	Introduction to Measurement & Instrumentation	Course Outline, objectives, teaching plan, assessment method	Lecture
2	Principles of Measurement	<ul style="list-style-type: none"> • Measurement Units • Measurement System Applications • Elements of a Measurement System • Choosing Appropriate Measuring Instruments • Potentiometers • Wheatstone Bridge • Examples 	Lecture and discussion
3	Instrument Type & Performance Characteristics	<ul style="list-style-type: none"> • Categorization of Sensors • Active & Passive Instruments • Static Characteristics of Instruments • Precision • Accuracy & Inaccuracy • Repeatability & Reproducibility • Range or Span • Examples 	Lecture and discussion

4	Static Characteristics of Instruments	<ul style="list-style-type: none"> • Sensitivity of Measurement • Linearity • Threshold • Resolution • Zero Drift or Bias • Examples • Solve related problems 	Lecture and discussion
5	Static Characteristics of Instruments Cont.... Operational Modes of Instruments	<ul style="list-style-type: none"> • Sensitivity to Disturbance • Sensitivity Drift • Hysteresis • Dead Space • Examples • Solve Related Problems • Null Instrument • Deflection Instruments • Analog & Digital Instruments 	Lecture and discussion
6	Dynamic Characteristics of Instruments	<ul style="list-style-type: none"> • Zero Order Instruments • First Order Instruments • Capacitive Circuits • Inductive Circuits • Examples • Solve Related Problems 	Lecture and discussion
7	Sensor Technologies	<ul style="list-style-type: none"> • Strain Gauges • Strain Gauge Quarter Bridge Circuits • Strain Gauge Half Bridge Circuits • Strain Gauge Full Bridge Circuits 	Lecture and discussion
8	Sensor Technologies Cont....	<ul style="list-style-type: none"> • Examples on Strain Gauges • Problems on Strain Gauges • Encoders • Incremental Encoders • Absolute Encoders 	Lecture and discussion
9	MID TERM EXAM		
10	Temperature Measurement	<ul style="list-style-type: none"> • Principles of Temperature Measurement • The International Practical Temperature Scale • Thermocouples • Working Principle of Thermocouples • Types of Thermocouples • Examples on Thermocouples 	Lecture and discussion
11	Temperature Measurement Cont....	<ul style="list-style-type: none"> • Problems on Thermocouples • Varying Resistance Devices • Resistance Temperature Devices 	Lecture and discussion

		<ul style="list-style-type: none"> • Thermistors • Examples 	
12	Introduction to LabVIEW	<ul style="list-style-type: none"> • Virtual Instruments • Parts of a VI • Starting a VI • Front Panel • Block Diagram • Searching for Controls, Vis and Functions • Selecting a Tool • Data Flow • Building a VI 	Lecture and Hands-On practice on LabVIEW
13-14	Developing a VI in LabVIEW	<ul style="list-style-type: none"> • Numeric Functions • Comparison Functions • Boolean Functions • Practice Exercises on Designing a Front Panel and Wiring Practices On the Block Diagram of a VI • Practice Exercises on Developing VIs and Implementing Code in LabVIEW 	Lecture and Hands-On practice on LabVIEW
15	Loops, Shift Registers & Case Structures in LabVIEW	<ul style="list-style-type: none"> • For Loops In LabVIEW • While Loops in LabVIEW • Shift Registers in LabVIEW • Case Structures in LabVIEW • Examples and Exercises of all 	Lecture and Hands-On practice on LabVIEW
16	Timing in LabVIEW, Local Variables in LabVIEW, Sequential Programming in LabVIEW & Introduction to Data Acquisition	<ul style="list-style-type: none"> • Timing Functions and Timing VIs in LabVIEW • Local Variables in LabVIEW • Sequential Programming • Introduction to Data Acquisition 	Lecture and Hands-On practice on LabVIEW
17	Pressure	<ul style="list-style-type: none"> • Basics of Pressure Measurement • Manometers • Barometers • Bourdon Tubes • Diaphragms • LVDT • Capacitive Pressure Sensors • Fiber-Optic Pressure Sensors • Examples & Problems 	Lecture and discussion
17	Project Viva	Viva on Instrumented Hardware of Projects	Individual Viva
18	End semester exam (ESE)		

Instrumentation Lab LIST OF EXPERIMENTS

Sr. No.	List of Experiment	Equipment Used
1	Basic Control Systems Equipment and Terms Used	DIGIAC 1750 Trainer
2	Positional Resistance Transducers	DIGIAC 1750 Trainer
3	Wheatstone Bridge Measurements	DIGIAC 1750 Trainer
4	Temperature Measurement	DIGIAC 1750 Trainer
5	Light Measurement	DIGIAC 1750 Trainer
6	Linear Position or Force Applications	DIGIAC 1750 Trainer
7	Sound Measurement	DIGIAC 1750 Trainer
8	Sound Output	DIGIAC 1750 Trainer
9	Display Devices	DIGIAC 1750 Trainer
10	Dynamometer and DC Motor	DIGIAC 1750 Trainer
11	Getting started with Arduino and Arduino IDE	Arduino Kit
12	Arduino and LCD interfacing	Arduino Kit
13	Arduino and Ultrasonic Sensor Interfacing	Arduino Kit
14	Arduino and IR Sensor Interfacing	Arduino Kit