



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

~~BITS-Pilani, Hyderabad Campus~~
~~FIRST SEMESTER 20172019-20182020:~~
Course Handout Part II

~~Date: 20 July 2018~~201901-08-2019

In addition to Part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. : INSTR F312
Course Title : TRANSDUCERS AND MEASUREMENT SYSTEMS
Credits : 3
Instructor-in-charge : R. N. Ponnalagu
Schedule : Mon, Wed, Fri 3.00 to 3.50 pm
Tutorial : Mon 8.00 to 8.50 am
Classroom : I 114

COURSE DESCRIPTION:

This course deals with importance and types of transducers used in instrumentation and measurement. Different types of passive and active transducers. Generalized measurement system, functional elements, static & dynamic performance characteristics and error analysis. Measurement techniques for Velocity, Temperature, Pressure, Flow, Motion, Seismic, Level, Humidity, pH, Viscosity etc. Interfacing transducers with instrumentation systems.

SCOPE AND OBJECTIVE OF THE COURSE:

The objective of the course is to impart knowledge on the various types of sensors and transducers, their measurement techniques and applications instrumentation systems. The course also introduces basics of LabVIEW programming.

COURSE OUTCOMES

After learning the course, students will be able to

- Use the concepts in common methods for converting a physical parameter into an electrical quantity
- Select a suitable sensor/transducer for a given application/specification.
- Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers
- Design a real-life instrumentation system.

1. COURSE DESCRIPTION:

Importance and types of transducers used in instrumentation and measurement. Different types of passive and active transducers. Generalized measurement system, functional elements,

static and dynamic performance characteristics and error analysis. Measurement techniques for Temperature, Pressure, Flow, Force, Torque, Level, Motion, Velocity, Humidity, pH, Viscosity etc. Interfacing transducers with instrumentation systems.

[1.] SCOPE AND OBJECTIVE:

To understand the concept and importance of various sensors and transducers in measurement and instrumentation systems. The end result of this course is to make the student capable of select suitable transducer, design and develop instrumentation systems.

[2.] TEXT BOOK (T):

| Title | Author | Edition | Publisher | Library # | ISBN |
|---|---------------------|----------------------------|------------|--|----------------------|
| Introduction to Measurements and Instrumentation | Arun Ghosh N | 4th 2012 | PHI | 620.0028 GHO-A (3rd Edition) | 9788120346253 |

2.[3.] REFERENCE BOOKS:

| Title | Author | Edition | Publisher | Library # | ISBN |
|--|---------------------------|----------------------------|------------------------------|---------------------|----------------------|
| R1: Transducers and Instrumentation | DVS Murthy | 2nd 2013 | PHI | 530.7 MUR-D | 9788120335691 |
| R2: Instrumentation Measurement and Analysis | Nakra and Chaudhry | 4th 2017 | McGraw Hill | | 9789385880629 |
| R3: A Course in Electronic Measurements and Instrumentation | A K Sawhney | 2015 | Dhanpat Rai & Co | 621.37 SAW-A | 9788177001006 |
| R4: Theory and Design for Mechanical Measurements | RS Figliola | 3rd 2005 | John Wiley & Sons | 530.8 FIG-R | 9788126516391 |
| R5: Doebelin's Measurement Systems | E O Doebelin | 6th | Tata McGraw Hill | 681.2 DOE-E | 9780070699687 |

COURSE PLAN

| Lecture # | Topics to be covered | Brief Learning Objectives | Chapter in the Text Book Reference |
|------------------|--|---|--|
| 1-32 | Introduction to Transducers and measurement system | Definition, classification of transducers and generalized measurement system | T1 (5.1, 5.3, 1.2) Class notes |
| 43-6 | Study of performance characteristics and error analysis. | Calibration, Precision, Accuracy, Threshold, Resolution, Hysteresis, Linearity, Sensitivity, Drift, Span, Range, Mean, Deviation, Normal distribution curve, Probable errors. | Class notes |
| 7-810 | Resistance type Transducers | Use of resistance type transducers for temperature, pressure, displacement, moisture and other measurements. | T1 (6.2, 10.3) R1 (6.1.1-6.1.6) |
| 911-1012 | Inductive type Transducers | Different types of inductive type transducers and their use in thickness and displacement measurements. | T1 (6.2) R1 (6.2) Class notes |
| 113-152 | Capacitive type Transducers | Use of capacitive type transducers for displacement, thickness and moisture measurements. | T1 (6.2) R1 (6.3) |
| 163-1418 | Thermoelectric and piezo electric transducers | Thermocouple for temperature measurement and Piezo electric transducers for mechanical measurements :- | T1 (10.14) R1 (7.1, 7.2), R2 (12.5.2, 4.5) |
| 15-16 | Piezoelectric transducers | Use of Piezoelectric transducers for mechanical measurements. | R1 (7.2) R2 (4.5) |
| 1719-1821 | Magentostrictive and hall effect transducers | Use of Magentostrictive transducers for force and torque measurements and applications of hall effect transducers | T1 (6.5) R1 (7.3, 7.4) |
| 19-20 | Hall effect transducers | Use of Hall effect transducers for voltage and current measurements. | R1 (7.4) |
| 21-222 | Electro-mechanical transducers | Study of various types of Electro-mechanical transducers and their use. | T1 (9.5) R1 (7.5.1, - 7.5.2) |
| 23-254 | Photoelectric transducers | Study of various types of Photoelectric transducers and their use. | R1 (7.6) |
| 2526-2627 | Digital transducers and Proximity sensors | Study of encoders and proximity sensors and their use. | T1 (6.6- 6.7) R1 (7.8) R2 (4.9) |
| 287-2928 | Motion Acceleration measurement | Study of absolute and relative displacement, velocity and acceleration. | R1 (6.1.3, 6.2.2, 6.3.2) R2 (7) |
| 2930-3031 | Force and torque and measurement shaft power | Elastic elements (Bourdon tube, Bellows, Diaphragm), Strain gages, load cell, Torsion bar, Dynamometer and s. Inverse transducers, Force, | T1 (9) R1 (5.3, 5.4) |

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|--------------------------------------|-------|--|--|---|
| | | measurement | Torque, Current, Temperature balance systems. | |
| 31-32 | 32-34 | Pressure measurement | Fundamentals of pressure measurement and calibration. To learn techniques of high and low pressure measurement. Elastic elements (Bourdon tube, Bellows, Diaphragm), Dead weight gages, manometers, elastic elements. Bridgman, McLeod, Thermal conductivity, Ionization Gauge. | T1 (8) R1 (5.2) |
| 33-34 | 35-36 | Flow measurement | Obstruction meters, Rota meters, Pitot static tube meters, Turbine meters, electromagnetic flow meters, ultrasonic flow meters, vortex shedding, laser Doppler velocity meter. Hot wire anemometer, mass flow meter, positive displacement meter. | T1 (11) R1 (5.8) |
| 35 | 36 | Temperature measurement | Temperature measurement using conventional, Radiation methods, Thermal expansion methods. | T1 (10.1, 10.2, 10.5, 10.6, 10.8) R1 (5.1) |
| 37 | 38 | Level measurement | Direct and indirect methods, ultrasonic, radar, microwave | T1 (12) R1 (5.6) |
| 39 | 40 | Viscosity, density, pH, humidity measurement | Hydrometer, air bubbler, weighing system, electrode element hygrometers, wet and dry psychrometers. | T1 (13.1, 13.2, 13.5, 13.7) R1 (5.5, 5.7, 6.1.6, 6.3.3, 7.9.4) |
| 41 | 42 | Interfacing transducers with instrumentation systems. | Discussing various methods with examples. | Class notes |
| Basics of LabVIEW programming | | | | |

3.[4.] EVALUATION SCHEME:

| Component | Duration | Weightage | | Date & Time | Nature of Component Remarks |
|----------------------------|----------|------------|------------|---|--------------------------------|
| | | % | Marks | | |
| Midsem | 1h 30m | 25 | 75 | 28/9, 11.00 -- 12.30 PM To be announced 10.10.2018 3.30 to 5.00 pm | CB |
| Comprehensive Exam | 3 hours | 40 | 120 | 07/12.2018 to 20/12.2019 AN 2.00 to 5.00 pm | CB |
| Quiz (Announced/ surprise) | - | 15 | 45 | During Lecture / Tutorial | CB |
| Project | - | 20 | 60 | To be announced | OB |
| Total | | 100 | 300 | | |

CB → Close book; OB → Open book

- 4.[5.] **CHAMBER CONSULTATION HOUR:** To be announced in class Wednesday, 4 - 5 pm
- 5.[6.] **Makeup Policy:** Make-up only to those who apply before start of test Make-up will be given on **genuine** grounds only. Prior application should be made for seeking the make- up examination. No make-up will be given for the surprise quiz.
- 6.[7.] **NOTICES & OTHER INFORMATION:** Please refer course CMS page regularly.
- 7.[8.] **Academic Honesty and Integrity Policy:**
Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

R. N. Ponnalagu
Instructor-in-charge- INSTR F312