**ME 321: Mechanical Measurements**

**Second Semester 1434/1435**

## Faculty: Dr. Basharat Salim [2-C-75]: Dr. Zakariya [2-C-81]

**Description:**

Measuring concepts; Data collection and analysis Uncertainty analysis; Instrumentation specifications; Analog and Digital signal analysis;; Applications of measurements for different mechanical properties.

**Text Books**

 (1) Bechwith, T., Marangoni, R. and Lienhard V, J. “Mechanical *Measurements” 5th edition*, Addison Wesley. 1995

(2) Figliola, R. and Beasley, D. “T*heory and Design of Mechanical Measurements”* 3rd edition, J. Wiley, 2000.

**Description of Contents:**

|  |  |  |
| --- | --- | --- |
| LECTURE | CHAPTER | |
| BOOK(1) | BOOK(2) |
| Introduction and fundamental concepts. | 1 | 1 |
| Standard and units, Calibration, Reporting of experiment | 2 | 1 |
| Assessing experimental data and Uncertainty analysis | 3 | 4,5 |
| Characteristics of signals, Frequency spectrum and sampling. | 4 | 2 |
| Measurement system behavior and response, Sensors | 5,6 | 3,12 |
| Signal conditioner, filters, amplifiers and bridge circuits | 7,8 | 6,7 |
| Digital data acquisition systems. | 9 | 7 |
| Measurement of displacement, strain, force, torque. | 11,12,13 | 11,12 |
| Measurement of pressure, flow and temperature | 14,15,16 | 8,9,10 |
| Acoustics measurements. | 18 |  |

**Grading:**

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| --- | --- | --- |
| S.NO | COMPONENT | PERCENTAGE |
| 1 | MID TERM I | 10 |
| 2 | MID TERM II | 15 |
| 3 | MECH. LABORATORY | 10 |
| 4 | DATA ACQUISITION LAB | 10 |
| 5 | SUBJECT ASSIGNMENT | 10=7+3 |
| 6 | TERM PAPER | 5 |
| 7 | FINAL EXAMINATION | 40 |
| TOTAL | | 100 |

**DESCRIPTION OF LABORATORY EXPERIMENTS**

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| **TOPIC OF EXPERIMENT** |
| First Week: Discussion about Laboratory Procedure and Report Writing |
| Second Week: Measurement of Fluid Uncertainty and its propagation. |
| Third Week: Writing of First Report |
| Fourth Week: Calibration  of  Thermocouple |
| Fifth Week: Measurement of Velocity Profile in a Pipe |
| Sixth Week: Flow Measurement by Flow meters |
| Seventh Week: Basics of Data Acquisition- Lab View |
| Eight Week: Analog and Digital Signal (Freq. Spectrum and Sample rate) |
| Ninth Week: Response of First order Measuring System |
| Tenth Week: Pressure Measurement |
| Eleventh Week: Measurement of Strain |
| Twelfth Week: Introduction to NI - ELVIS Applications |
| Thirteenth Week: Acoustic Measurements |

**CONTENTS OF A LABORATORY REPORT**

Objective

Theoretical background

Description of instrument and sensor

Dimensional analysis

Error analysis

Presentation of results using sketches graphs and tables

Discussion of results

Laboratory report should have maximum of five pages without figures and tables.           Laboratory report should have actual copy of note book page of results attached to it.

**DESCRIPTION OF COMMUNICATION PART**

**Laboratory:**

Get the laboratory Note book signed by T. A.

Read over the experiment before laboratory Hour

Understand the procedure clearly

Make good sketches of experimental setup

Obtain experimental data with replications and record observations

Lab. Report grading depends on effective communication and clarity of report.

**Objectives of Mechanical Measurements**

**Measurement of physical variables:**

Force vector (N), Velocity vector (m/sec.), Temperature (oC), Pressure (Pascal), Frequency (Hz=cycle/sec), Strain (μ strains), flow rate (kg/s, m3/s)

**Measurement of Mechanical Parameters**:

Reynolds Number Re=ρvd/μ, Mach No. M = v/c, Dynamic Pressure =0.5 ρV2and other non-dimensional parameters

**Application of Mech. Measurements**

Monitoring of a process

Operation of a process

Control of a process

**Experimentation**

- Testing and performance operation

 - Verification of properties or theory

 - Information needed for analysis

Examples:

Checking or evaluation of:  Oil viscosity variation with temp, Pump performance curve, Piping head loss, Lift and drag of new airfoil shape etc.

**Calibration using Primary or/and Secondary Standards**

Known input signal and find the output.

   - To establish the correct output scale.

   - To find instrument reliability.

   - To eliminate bias error (systematic error)

For linear relation*o/p ∝ I/p* needs single point calibration.

For non-linear relation needs multi-point calibrations.

Static calibration – vs – Dynamic calibration

**Primary Standards For Comparison and Calibration**

*SI System:*  Meter – Kg -- Sec.– Kelvin – volt -  Mole –  Ampere –  Radian

Length (meter): Distance traveled by light in vacuum during *1/299792458* of a sec.

Mass (Kg.): International prototype *(alloy of platinum and iridium)* kept near Paris.

Time (Sec.): Duration of *9192631770* periods of the radiation emitted between two excitation levels of Cesium-133

Temperature (Kelvin):    *K = oC + 273*

**Dimensional Analysis**

Data presented in dimensionless form.

Dimensional analysis helps in experimental planning and similitude

It reduces number of experimental variables.

*No of variables - No of dims.= No of π groups*

Use pi method or by inspection

Basic dimensions: M L T θ (kg, m, sec, K)