

MSE2107: MEASUREMENT THEORY AND APPLICATION

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Measurement Theory and Application

Subject Code

MSE - Materials Science and Engineering

Course Number

2107

Academic Unit

Materials Science and Engineering (MSE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

MA1200/ MA1300

Calculus and Basic Linear Algebra I/Enhanced Calculus and Linear Algebra I

MA1201/ MA1301

Calculus and Basic Linear Algebra II/Enhanced Calculus and Linear Algebra II

PHY1201 General Physics I

PHY1202 General Physics II

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course will provide students with basic understanding of measurement theories, knowledge of signal processing techniques and data analysis. Several essential opto-electrical measurement techniques relevant to material characterizations will be introduced. The course will also introduce fundamental electronic circuit components and systems, knowledge of DC and AC circuit analysis, and working principles of various essential transducers. Students will acquire knowledge to develop skills to design measurement protocols with computer-aided methods.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Principle of measurement, including signal, noise and errors analysis. Signal modulation and system performance analysis.	20		x	
2	Understand instrumentation techniques and be familiar with commonly used electrical instruments	20	x		
3	Master basic DC and AC circuit analysis. Introduction of filter, transient circuits and corresponding frequency responses circuit. Understand the working principle and implementation approach of transducers in electronic circuits.	20	x		
4	Understand the principle of computer-aided measurement.	20		x	
5	Be able to apply knowledge and develop skills for computer-aided measurement and analysis. Be able to develop instrumentation algorithms for specific measurements, e.g. temperature and analog to digital signal etc.	20		x	x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Present basic theories, concepts and examples	1, 2, 3, 4, 5	3 hours/week

2	Tutorial	Provide additional explanations and help the students to apply the knowledge in lectures	1, 2, 3, 4, 5	1 hours/week
3	Laboratory	Provide laboratory exercises on the related topics	1, 2, 3, 4, 5	8 hours/ 13week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("- " for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3	20	3-4 assignments will be given.	No
2	Mid-term	1, 2, 3	15	Quizzes will be given mainly on the physical theories, signal processing techniques and data analysis theories.	No
3	Laboratory Reports	4, 5	15	Students will be asked to develop three measurement protocols to characterize particular material properties, including signal processing and data analysis.	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)**Assessment Task**

1. Assignments

Criterion

The student completes all assessment tasks/activities and the work demonstrates an excellent understanding of the scientific principles and the working mechanisms

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

2. Laboratory reports

Criterion

The student completes all assessment tasks/activities and the work demonstrates systematic investigation of the assigned project. The report meets the requirement of a scientific report with excellent writing style.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

3. Midterm

Criterion

The student can thoroughly identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

4. Examination

Criterion

The student can thoroughly identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Part III Other Information

Keyword Syllabus

- Introduction to instrumentation
- Measurement system: Signal sensing, conditioning, data processing, Fourier analysis. Input-output configuration: Signal modulation, AM, FM, PTM, deflection and null instruments, active and passive components, analog and digital instruments, Decibel notation, bandwidth, -3dB point. Static and dynamic measurements: Sensitivity, resolution, precision, threshold, hysteresis, drift, zero-order system, input impedance and output impedance, loading effect, noise, measurement errors.
- Measurement principles and basic instruments
- Case studies of measurements (hardness, conductivity, optical absorption, and morphology etc.)
- Circuit analysis techniques: Kirchoff's circuital laws, DC and ac circuits, circuit models, LCR circuits. Common electronic circuits: Diode circuits, regulated power supplies, filters, operational amplifiers. Components in measurement systems: Power supplies, galvanometer, multimeter, oscilloscope, electrodynamic instrument, power meter, energy meter, potentiometer, counters, X-Y plotter, Wheastone bridge, Kelvin bridge.
- Case studies of instrumentation.
 - Those areas will be focused on solving several prototypical material-related problems, such as material degradation mechanism, thin film formation, material crystallization, and developing data analysis protocol etc.
- Computer-aided instrumentation method.

- Control of instrument with computer-aided method.
- Measurement algorithm for automation.
- Advanced data analysis with computer methods
- Hardware and software development using computer-aided control for a specific project.

Reading List

Compulsory Readings

Title	
1	Measurement and Instrumentation: Theory and Application, Alan S Morris, Reza Langari, Saint Louis: Elsevier Science & Technology, 2011, ISBN: 0123819601

Additional Readings

Title	
1	Basic Theory and Laboratory Experiments in Measurement and Instrumentation, Andrea CataldoNicola GiaquintoEgidio De BenedettoAntonio MasciulloGiuseppe Cannazzallaria LorenzoJacopo NicolazzoMaria Teresa MeoAlessando De MonteGianluca ParisiFederico Gaetani, Springer, Cham, ISBN: 978-3-030-46740-1, (Available Online via CityU Library)