PHY2213: ADVANCED MEASUREMENT AND INSTRUMENTATION

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Advanced Measurement and Instrumentation

Subject Code
PHY - Physics
Course Number
2213

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
AP2212/PHY2212 Measurement and Instrumentation

Precursors
Nil

Equivalent Courses
AP2213 Advanced Measurement and Instrumentation

Exclusive Courses
Nil

Part II Course Details

Abstract

To introduce basic understanding of electronic circuit components and system, knowledge of DC and AC circuit analysis, and working principle of various essential transducers. Student will acquire knowledge to develop skills to design electronic measurement systems with computer aided method.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand the AC signal representation and use the complex representation and phasor diagram in the analysis of AC circuits.	15	x	x	
2	Determine the transient responses of basic electronic circuits involving resistors, capacitors and inductors.	15	x		
3	Design functional electronic circuits with diode and operational amplifiers.	15	x		
4	Understanding of Fourier series and transform, sampling theory and A/D conversion.	15		x	
5	Use computer aided method to control and acquire data from instrument and the development of instrumentation algorithm for specific measurement, e.g. temperature and analogy to digital signal etc.	40		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 self-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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Lectures on (1) Introduction of AC signal and it' s representations in the complex and phasor diagram forms; (2) Compute the frequency responses of of the RC, RL and RLC circuits; (3)Introduction of filter representation, Bode and phasor diagram and the calculation of filter transfer functions; (4) Introduction of basics op-amp circuits and the effects of feedback on op-amp circuits; (5) Introduction of Fourier series and transform, sampling and A/D conversion.	1, 2, 3, 4, 5	2 hours/week
2	Tutorials	Provide additional explanations and assists the students in the analysis of the various electronic circuits.	1, 2, 3, 4, 5	1 hour/week
3	Laboratory Exercise	Allows the students to have hands-on exercises in hardware communication with the electronic instruments using LabView.	1, 2, 3, 4, 5	8 hours/13 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks
1	Assignments Students will be assessed on their ability to solve the circuit analysis problems and the concepts presented in the lectures.	1, 2, 3	10	
2	Mid-term Students' general understanding of the materials taught in the first half of the course. For instance the ability to solve the AC circuit problems.	1, 2, 3	15	

3	Laboratory Reports Students' understanding of the operational principles of the various electronic circuits and their abilities to apply virtual instrumentation techniques in the measurement process.	4, 5	25	
4	Examination Students will be assessed via the examination on their understanding of concepts learned in class, textbooks, reading materials and their ability to apply subject-related knowledge.	1, 2, 3, 4, 5		

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

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

Capable to solve and analyse electronic circuit problems and demonstrate their understanding of the working principles of the instruments of measurement systems.

Excellent (A+, A, A-)

High
Able to correctly answer nearly all assignment questions.

Good (B+, B, B-)

Significant
Able to correctly answer most assignment questions.

Fair (C+, C, C-)

Moderate
Able to correctly answer most assignment questions.

Marginal (D)

Basic
Able to correctly answer a few assignment questions.

Failure (F)

Not reaching marginal level
Unable to correctly answer even a few assignment questions.

Assessment Task

2. Laboratory reports

Criterion

Demonstrate the ability to build the measurement instrument circuit and controlling the lab instruments with the computer software.

Excellent (A+, A, A-)

High
Active participation in all lab sessions and able to demonstrate excellent understanding of the principles and control of the instrument circuit.

Good (B+, B, B-)

Significant
Active participation in all lab sessions and able to demonstrate understanding of most of the principles and control of the instrument circuit.

Fair (C+, C, C-)

Moderate
Active participation in all lab sessions and able to demonstrate understanding of a majority of the principles and control of the instrument circuit.

Marginal (D)

Basic
Active participation in all lab sessions and able to demonstrate understanding of the key principles and control of the instrument circuit.

Failure (F)

Not reaching marginal level
Fail to participate in all lab sessions and unable to demonstrate the understanding of the purpose and operation of the instrument circuit.

Assessment Task

3. Midterm

Criterion

The student can thoroughly identify and explain principles of measurement system and analyse electronic circuits.

Excellent (A+, A, A-)

High
Able to correctly answer nearly all midterm questions.

Good (B+, B, B-)

Significant
Able to correctly answer most midterm questions.

Fair (C+, C, C-)

Moderate
Able to correctly answer some midterm questions.

Marginal (D)

Basic
Able to correctly answer a few midterm questions.

Failure (F)

Not reaching marginal level
Unable to correctly answer even a few assignment questions

Assessment Task

4. Examination

Criterion

Explain the concept of measurement systems with ability to design and analyse electronic measurement circuits.

Excellent (A+, A, A-)

High
Able to correctly answer nearly all examination questions.

Good (B+, B, B-)

Significant
Able to correctly answer most examination questions.

Fair (C+, C, C-)

Moderate
Able to correctly answer some examination questions.

Marginal (D)

Basic
Able to correctly answer a few examination questions.

Failure (F)

Not reaching marginal level
Unable to correctly answer even a few examination questions.

Part III Other Information

Keyword Syllabus

- 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 physical problems, such as optical interference effect, heat transfer, material degradation mechanism, 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 method
- Hardware and software development using computer aided control for a specific project.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	B C Nakra and K K Chaudhry, “Instrumentation Measurement and Analysis”, 2nd edition, Tata McGraw-Hill (2004).
2	A S Morris, “Measurement and Instrumentation Principles”, 3rd edition, Butterworth-Heinemann (2001).
3	D E Johnson, J R Johnson and J L Hilburn, “Electric Circuit Analysis”, 3rd edition, Upper Saddle River, N J: Prentice Hall (1997).
4	J J Brophy, “Basic Electronics for Scientists”, 5th edition, McGraw- Hill (1990).
5	E O Doebelin, “Measurement Systems: Application and Design”, 4th edition, McGraw- Hill (1998).
6	B A Gregory, “An Introduction to Electrical Instrumentation and Measurement Systems”, 2nd edition, Macmillan (1996).
7	J A Haslam, G R Summers and D Williams, “Engineering Instrumentation and Control”, Edward Arnold (1995).
8	A F P van Putten, “Electronic Measurement Systems”, Prentice Hall (1988).
9	R E Simpson, “Introductory Electronics for Scientists and Engineers”, 2nd edition, Prentice-Hall (1987).
10	Robert H. King, “Introduction to data acquisition with LabVIEW”, 2nd edition, (2013)
11	Robert H. Bishop, “Learning with LabVIEW 2009” (2010)