CMP4102 Instrumentation and Control Engineering

Period per Week			Contact Hour per Semester	Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WE	WCM	CU
45	30	00	60	100	60	40	4

Rationale

The computer is an electronic device whose design and manufacture utilizes a great deal of instrumentation and control engineering concepts. A student of computer engineering has to be exposed to the relevance of these fundamental concepts in the design of computer circuitry.

Objectives

This course aims at:

- Enabling student understand that control systems are a daily phenomena, that virtually everything needs feedback, that electronic or electromechanical systems most times include a feedback loop, either explicitly or implicitly.

- Giving the student knowledge of analog and digital control engineering concepts.

This course aims to help the student with:

- Knowledge of procedures for measuring and improving the reliability of digital components within measuring systems.
- Knowledge of the formal standards governing instrument calibration procedures and measurement system performance.
- An introduction on the topic of sensors and their use within instrumentation systems.
- Knowledge of the principles and theory of measurement

Course Content

1. ***Review of Measurement Specification***
   - Standards, units- instrument types
   - performance characteristics: static and dynamic characteristic
2. ***Measuring system***
3. ***Analogue Instruments***
   - Moving coil,
   - iron instruments
4. ***Digital Instruments***
   - Multimeters
   - data analysers
   - signal synthesisers.
5. ***Counters and timers***
6. ***Measuring Errors***
   - Random errors
   - Systematic errors
7. ***Transducers***
   - Measurement of displacement
   - velocity and acceleration
   - time and frequency
   - light,
   - temperature, volume, pressure, flow and force
8. ***Analogue Data Processing***
   - The operational amplifier
   - Characteristics
   - Configurations
9. ***Simulation of differential equations and transfer function***
10. ***Data Acquisition and Conversion***
    - Sampling theorem
    - Quantisation
    - Multiplexing
    - filtering sample and hold
    - Bridge Circuits
11. ***Introduction to design of feedback systems***
    - Properties and advantages of feedback systems
12. ***Time-Domain And Frequency-Domain Performance Measures***
13. ***Stability And Degree Of Stability***
14. ***Complex Plane Analysis***
    - Algebra
    - Applications to Control Engineering
15. ***Stability Criteria***

- Routh's Criterion
- Root locus method
- Nyquist criterion

16. Bode Plots

- Introduction
- Frequency response analysis

17. Unit Circle

- PID Compensator
- time response

18. State Space Analysis

- Observability
- Controllability and the corresponding vectors

19. Digital Control System

- z transforms
- Jury Test

Learning Outcomes

The student will:

- Be able to comfortably check for stability of any system using any criteria.
- Understand the concept of control system engineering, why it is carried out and will appreciate its application in digital control.
- Acquire knowledge of the type of measuring instruments and be able to appreciate why certain instruments are m ore favourable in a particular environment and requirement (accuracy or precision among others);
- Understand the types of errors that occur during measurement and how best they can be minimised during experimental setup.
- Acquire concepts on sensors and their use in design of automated systems.

Recommended Books and References

[1] William L. Brogan, *Modern Control Theory,* 2nd ed., Prentice-Hall, 1985

[2] Nise, N. S, *Control Systems Engineering,* 3rd ed., New York, NY: Wiley, 2000.

[3] Allan S. Morris, *Measurement and Instrumentation Principles,* 3rd ed., Butterworth Heinemann, 2001

[4] K. Ogata, *Discrete- Time Control Systems*