SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: AUTOMATED CONTROL DESIGN

Code No.: ELR 315-6

Program: ELECTRICAL TECHNOLOGY

Semester: SIX

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New: ______ Revision: X

APPROVED: L.P. Orazietto
Chairperson

Date

AUTOMATED CONTROL DESIGN
Course Name

ELR 315-6
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PHILOSOPHY/GOALS:

To provide a sound understanding of the basics of control system analysis and performance standards as applied to linear control systems.

METHOD OF ASSESSMENT (GRADING METHOD):

Written tests at regular intervals.

A -- 80 - 100%
B -- 66 - 79%
C -- 55 - 65%
R -- LESS THAN 50%

Distribution of marks is 70% theory and 30% laboratory.

TEXTBOOKS:

FEEDBACK AND CONTROL SYSTEMS by McDonald and Lowe

COURSE OBJECTIVES

LECTURE	LAB	TOPIC
12	6	*Mathematical Modeling*
		Methods of writing differential equations of electrical, mechanical, thermal and hydraulic systems
		Laplace transforms and inverse Laplace transforms
		Transfer functions
		Block diagrams
3	3	*Time Domain Analysis*
		Test signals
		Steady-state error constants
		System types
		Time response of first and second order systems
		Time response specifications
3	3	*Stability Analysis*
		Introduction
		Stability in the s-domain
		Routh-Hurwitz criteria
3	3	*Root Locus Method*
		Introduction
		Properties of the Root Locus
		Root Locus for systems with time delay
		Transient response from Root Locus
3	3	*Frequency Response Methods*
		Introduction
		Frequency response
		Bode logarithmic plots
		Stability margins
6	12	*System Performance Improvement*
		Introduction
		Elementary Cascade compensating networks
		Phase-lead network
		Bode pilot phase-lead cascade compensation
		Root locus phase-lead cascade compensation
		Phase-lag compensation
		Bode plot lag compensation
		Root locus lag compensation
		Lag-lead compensation
		Root locus lag-lead compensation
		Bode plot lag-lead compensation

15	15	*Introduction to Robotics* *Basic concepts* *Classification and structure of robotics systems* *Drives and control systems* *End-of-arm tooling* *Robot and controller operation* *Sensors and interfacing* *Robot programming*

SPECIFIC OBJECTIVES

The student shall be able to:

1. *Mathematical Modeling*

   1. *Write differential equations describing the operation of*
      a) electrical circuits and components
      b) mechanical translation systems
      c) analogous circuits
      d) mechanical rotation systems
      e) thermal systems
      f) hydraulic systems
      g) dc servomotors
      h) ac servomotors

   2. *Use Laplace transforms and inverse Laplace transforms to solve differential equations.*

   3. *Develop transfer functions and apply block diagram algebra.*

2. *Time Domain Analysis*

   1. *Describe mathematically and graphically, step input, ramp input and parabolic input test signals.*

   2. *Describe steady-state errors of a control system in terms of the following input functions*
      a) step
      b) ramp
      c) parabolic

   3. *Describe and compare the characteristic of type 0, 1 and 2 systems*

   4. *Describe the time response of first and second order systems.*

3. *Stability Analysis*

   1. *Use the Routh-Hurwitz criterion to determine the stability of a system.*

4. *Root Locus*

   1. *Use the root locus method to determine the stability and transient response of a control system.*

5. *Frequency Response*

   1. *Use Bode plots to determine the stability of a system.*

6. *System Performance Improvement*

1. *Use phase-lead networks to reduce phase lag and improve the phase margin of a control system by using Bode plots and root-locus methods.*

2. *Use phase-lag compensation to achieve high gain at low frequencies and reduce the steady-state error by using Bode plots and root-locus methods.*

3. *Use lag-lead compensation to achieve improvements in both transient and steady-state performance using Bode plots and root-locus methods.*

7. *Introduction to Robotics*

1. *Recall the advantages of industrial robots and typical industrial and non-industrial applications.*

2. *Recall that industrial robot is a reprogrammable multi-functional manipulator designed to move material, parts, tools or specialized devices through variable programmed motors for the performance of a variety of tasks.*

3. *Recall and explain the terms accuracy, resolution and repeatability.*

4. *Recall that robotic systems are classified as*
   a) according to type of system: point-to-point (PTP) versus continuous path (CP)
   b) according to the type of control loops: open-loop versus closed-loop or
   c) according to the structure of the manipulator: cartesian, cylindrical, spherical or articulated

   and be able to describe with the aid of block diagrams and sketches the advantages and limitations of each classification.

5. *Explain with the aid of sketches and schematics hydraulic* and dc *servomotor systems and their control and application to robots.*

6. *Recall and explain the characteristics of end-of-arm tooling and discuss the types and applications of end-of-arm tooling such as standard grippers, special purpose grippers and special purpose tools.*

7. *Recall and explain that the potential relationship between the robot, the gripper, the tool-center-point, the workpiece and the universe in which all of these exist are defined by reference frames defined by Cartesian co-ordinates.*

8. *Recall and explain the advantages of using open-loop (non-servo) control of a robot, and be able to discuss the methods of material and external control that are in common use.*

9. *Recall and explain the advantages of using closed-loop (servo) control of a robot and be able to discuss the methods of internal and external control that are in common use.*

10. *Recall and explain with the aid of block diagrams the controller block diagram of*
    a) a non-servo system and
    b) a servo system

11. *Recall and explain the requirements for sensors in a work cell and be able to describe typical contact, non-contact and process monitoring devices and their interfacing requirements.*

12. *Program a robot by either teach pendant or microcomputer.*