SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OULITNE

COURSE OUTLINE: CONTROL SYSTEMS

CODE NO.: ELN 214 -4

PROGRAM: ELCETRICAL/ELECTRONIC TECHNICIAN

SEMESTER: FOUR

DATE: AUGUST 1987

AUTHOR: ENO LUDAVICIUS

NEW:____ REV.: X

APPROVED: _____ _____

CHAIRPERSON DATE

CALENDER DESCRIPTION

CONTROL SYSTEMS	ELN 214-4
COURSE NAME	COURSE NUMBER

PHILOSOPHY/GOALS:

THE STUDENT WILL BE INTRODUCED TO CLOSED-LOOP FEEDBACK SYSTEMS , INCLUDING ANALOG AND DIGITAL TRANDUCERS, ERROR DETECTPRS, SERVP AMPLIFIRES , ANALOG AND DIGITAL SYNCHRO AND RESOVLVER SYSTEMS AS APPLIED TO SPEED CONTROL AND ROBOTICS, SUPPORTED BY RELATED LABWORK INCLUDING PROGRAMMING ROBOTS AND PROGRAMMABLE CONTROLLERS.

METHOD OF ASSESSMENT (GRADING METHOD):

THE STUDENT WILL BE ASSESSED IN THE FOLLOWING MANNER:

1) THREE WRITTEN TESTS WORTH 20% EACH.

2) PROJECTS WITH INDUSTRIAL CONTROLS AND ROBOTS WORTH 40% IN TOTAL.

TEXTBOOK(S):

1) INDUSTRIAL ROBOTS AND ROBOTICS - E. KAFRISSEN
   - M. STEPHANS

2) IN-PROCESS CONTROL FOR MANUFACTURING CONFERENCE NOTES - IEEE

3) FEEDBACK AND CONTROL SYSTEMS - A.C. McDONALD
   - H. LOWE

4) DC,SYNCRO,& AC BASIC EXPERIMENTS - FEEDBACK

ELN 214 - 4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 1 - INTDUSTRIAL CONTROLS

1.1) CLASSICAL CONTROL THEORY

.1) DESCRIBE WHAT CONTROL SYSTEMS ARE AND THE WAY WE USE THEM.
.2) DEFINE THE TERMINOLOGY NECESSARY TO DESCRIBE CONTROL SYSTEMS. (ie.plant,process,system,feedback,...)
.3) DEFINE THE DIFFERENCE BETWEEN OPEN AND CLOSED LOOP CONTROL SYSTEMS.
.4) DISCUSS THE CONTROL SYSTEM CHARACTERISTICS. (ie.accuracy,stability,sensitivity,noise,cost)
.5) DISCUSS THE CONTROL STRATEGY STAGES FOR MANUFACTURING PROCESSING.
.6) ILLUSTRATE EXAMPLES OF CONTROL SYSTEMS. (ie.pessure,speed,numerical,computer,...)

1.2) MATHEMATICAL MODELING OF A CONTROL SYSTEM

.1) DEFINE THE GENERAL EQUATION FOR A SIMPLE SERVO SYSTEM.
.2) DRAW THE GENERAL BLOCK DIAGRAM OF A SERVO SYSTEM.
.3) DISCUSS THE CONCEPTS OF GAIN,CASCADING BLOCKS, SUMMING JUNCTIONS AND BLOCK REDUCTION.
.4) DISCUSS CONTROL SYSTEM TRANSFER FUNCTION AND FIRST ORDER DIFFERENTICIAL EQUATIONS.
.5) ILLUSTRATE EXAMPLES OF FIRST ORDER DIFF. CONTROL SYSTEMS: - MECHANICAL
- ELECTRICAL

1.3) INDUSTRIAL SERVO CONTROL SYSTEMS

.1) DISCUSS THE MEANING OF A FEEDBACK CONTROL SYSTEM.
.2) DISCUSS THE EVALUATION OF PERFORMANCE OF FEEDBACK SYSTEMS.(ie.error,setpoint,dynamic reponse,...)
.3) DRAW A BLOCK DIAGRAM OF A CLOSED-LOOP FEEDBACK SYSTEM WITH A ROBOT IN THE SYSTEM.
.4) DESCRIBE SIMPLE SPEED CONTROL - PROPORTIONAL
- P + INTEGRAL
- P + I + DERIVATIVE
.5) DISCUSS A SERVOMOTOR CONTROL SYSTEM.

ELN 214 - 4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 1 - INDUSTRIAL CONTROLS

1.4) THE ACTUATORS OF A INDUSTRIAL CONTROLS

.1) DESCRIBE THE ADVANTAGES & DISADVANTAGES OF THE THREE TYPES OF ACTUATORS USED IN INDUSTRY.
.2) DESCRIBE THE FACTORS WHICH INFLUENCE THE CHOICE OF A AN ACTUATOR FOR GIVEN APPLICATION.
.3) DISCUSS ELECTRICAL ACTUATION
- SOLENOIDS
- RELAYS
- AC SERVOMOTOR
- STEPPER MOTORS

.4) DISCUSS HYDRAULIC ACTUATION
- LINEAR
- ROTORY

.5) DISCUSS PNEUMATIC ACTUATION
- LINEAR
- ROTORY

1.5) INDUSTRIAL SENSORS & TRANSDUCERS

.1) DEFINE THE MAJOR DIFFERENCE BETWEEN THE TERMS SENSOR AND TRANSDUCER.
.2) DESCRIBE THE CATEGORIZATION OF SENSORS:
- MECHANICAL
- FLUID
- THERMAL
- OPTICAL

.3) DISCUSS THE DIFFERENT TYPES OF MECHANICAL TRANSDUCERS:
- DISPLACEMENT
- STRAIN
- MOTION

.4) DISCUSS THE DIFFERENT TYPES OF FLUID TRANSDUCERS:
- PRESSURE
- FLOW

.5) DISCUSS THE DIFFERENT TYPES OF TEMPERATURE TRANSDUCERS:
- RTD
- THERMOCOUPLES
- THERMISTORS
- IC SENSORS

.6) DISCUSS THE DIFFERENT TYPES OF OPTICAL TRANSDUCERS:
- OPTICAL ENCODERS
- VISION SYSTEMS
  - CAMERAS
  - LASER SCANNERS
  - X-RAYS
  - INFRARED CAMERAS
  - 3D CAMERAS

ELN 214 - 4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 1 - INDUSTRIAL CONTROLS

1.6) GENERALIZED DATA ACQUISITION AND CONVERSION SYSTEMS

.1) DISCUSS THE DATA ACQUISITION AND CONVERSION SYSTEMS USED FOR ROBOTIC TRANSDUCERS.
.2) DISCUSS THE METHODS USED IN ANALOG-TO-DIGITAL CONVERSION.
.3) DISCUSS THE METHODS USED IN DIGITAL-TO-ANALOG CONVERSION.
.4) DISCUSS THE RS-232-C AND IEEE-488 BUS INTERFACE.

ELN 214 =4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 2 - INTRODUCTION TO INDUSTRIAL ROBOTICS

2.1)ROBOT TERMS & DEFINITIONS

.1)DEFINE THE TERM "ROBOTICS"
.2)DISCUSS THE HISTORY OF ROBOTS
.3)ROBOTIC TERMINOLOGY
.4)VIDEO: THE ROBOT REVOLUTION
.5)VIDEO: ROBOTS IN INDUSTRY
.6)THE ROBOT SYSTEM & SUBSYSTEMS
.7)VIDEO:ROBOT SUBSYSTEMS

2.2)ROBOT CLASSIFICATION

.1)ROBOT ARM GEOMETRY CLASSIFICATION - RECTANGULAR
- CYLINDRICAL
- SPHERICAL

.2)ROBOT INTELLIGENCE CLASSIFICATION - LOW TECHNOLOGY
- MEDIUM TECHNOLOGY
- HIGH TECHNOLOGY

.3)POWER SOURCES CLASSIFICATION
.4)APPLICATIONS CLASSIFICATION
.5)CONTROL TECHNIQUE CLASSIFICATION
.6)PATH CONTROL CLASSIFICATION

2.3)ROBOT HANDS:END-OF-ARM-TOOLING (END EFFECTORS)

.1)DESCRIBE THE TWO CATEGORIES OF MECHANINCAL HANDS : 1)INDUSTRIAL
2)PROSTHETIC
.2)DESCRIBE THE END-OF-ARM TOOLING CHARACTERISTICS & CLASSIFICATIONS.
.3)DESCRIBE THE TYPES OF END EFFECTORS CATEGORIZED AS GRIPPERS : 1)STANDARD
2)VACUUM
3)MAGNETIC
4)SPECIAL PURPOSE
.4)DESCRIBE THE TYPES OF END EFFECTORS CATEGORIZED AS TOOLS : 1)WELDING
2)SPRAYING
3)ROTATING SPINDLES
4)SPECIAL PURPOSE
.5)DISCUSS MULTIPLE END EFFECTOR SYSTEMS.
.6)DISCUSS THE SELECTION AND DESIGN OF GRIPPERS.
.7)VIDEO:OPERATING PARAMETERS OF ROBOTS.

ELN 214 -4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 2 - INTRODUCTION TO INDUSTRIAL ROBOTICS

2.4)ROBOT AND CONTROLLER OPERATION

.1)DEFINE THE TERM SERVO MECHANISMS.
.2)DISCUSS THE DIFFERENCES BETWEEN OPEN-LOOP
.3)DESCRIBE THE TYPES OF CLOSED LOOP SYSTEMS:
  1)POTENTIOMETERS
  2)OPTICAL ENCODERS
  3)RESOLVERS & SYNCHROS
.4)DISCUSS THE TYPICAL MODULES IN CONTROLLER ARCHITECTURE.
.5)VIDEO:APPLICATION OF ROBOT TECHNOLOGY.
.6)ILLUSTRATE THE USE OF NON-SERVO AND SERVO ROBOTS:
  1)NON-SERVO - AMATROL MERCURY (CLYLINDRICAL)
              - AMATROL HERCULES(")
  2)SERVO   - AMATROL PEGASUS (RECTANGULAR)
              - AMATROL POLARIS (POLAR)
              - AMATROL JUPITER (SCARA)
              - AMATROL SATURN (JOINTED SPHERICAL)
              - AMATROL CENTURI (" ")
.7)DESCRIBE THE FLEXIBLE MANUFACTURING SYSTEM ESSENTIALS.
  -FMS PYRAMID STUCTURE
.8)DESCRIBE A FLEXIBLE MANUFACTURING WORKCELL.

2.5)SENSORS AND INTERFACING

.1)DISTINGUISH BETWEEN THE TERM SENSOR AND TRANSDUCER.
.2)DESCRIBE DIFFERENT TYPES OF CONTACT SENSORS:
  1)LIMIT SWITCHES
  2)ARTIFICIAL SKIN
.3)DESCRIBE DIFFERENT TYPES OF NON-CONTACT SENSORS:
  1)PROXIMITY
  2)PHOTOELECTRIC
  3)VISION
  4)IMAGE
.4)DESCRIBE PROCESS SENSORS.
.5)DESCRIBE THE DIFFERENT TYPES OF INTERFACES:
  1)SIMPLE SENSOR
  2)WRIST
  3)ROBOT CONTROL
  4)JOINT CONTROL
  5)COORDINATE TRANSFORM
  6)TRAJECTORY
  7)COMPLEX
.6)VIDEOS - IMPLEMENTATION OF ROBOTS
          - COMPUTER VISION

BLN 214 =4

CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 2 - INTRODUCTION TO INDUSTRIAL ROBOTICS

2.6)ROBOT PROGRAMMING

.1)ROBOT LANGUAGE DEVELOPMENT
.2)LANGUAGE CLASSIFICATION : JOINT CONTROL
PRIMITIVE MOTION
STRUCTUAL PROGRAMMING
TASK-ORIENTED
.3)SAMPLE PROGRAMS : TEACH PENDANT PROGRAM
XYZ COORDINATE PROGRAM
XYZ LEADTHROUGH PROGRAM
RHINO BASIC PROGRAM
ROBOTALK
VAL

2.7)SAFETY

.1)INTRODUCTION TO ISSAC ASIMOV LAWS OF ROBOTS
.2)GENERAL PERSONNEL SAFETY
.3)OPERATOR & MTCE. PERSONNEL SAFETY
.4)OVERVIEW OF THE AMERICAN NATIONAL STANDARD FOR INDUSTIRAL ROBOTS & ROBOT SYSTEMS - SAFETY REQUIREMENTS

2.8)HUMAN INTERFACE

.1)GENERAL TRAINING
.2)OPERATOR TRAINING
.3)MTCE. TRAINING
.4)ORGANIZED LABOR & RESISTANCE
.5)VIEDO: HUMAN FACTORS IN ROBOTICS

2.9)TESTING OF INDUSTRIAL ROBOTS

.1)TEST PROGRAM FOR INDUSTRIAL ROBOTS:
-GEOMETRICAL VALUES
-KINEMATIC VALUES
-DYNAMIC VALUES
-POWER AND NOISE VALUES
-THERMAL VALUES
-NON MEASUREABLE TEST VALUES
.2)METHODS OF MEASUREMENT FOR TESTING INDUSTRIAL ROBOTS:
-MEASURING HEADS FOR GEOMETRICAL MEASUREMENTS
-TEST STANDS FOR GEOMETRICAL MEASUREMENTS
-MEASURING EQUIPMENT FOR NON-GEOMTRICAL VALUES
.3)SUMMARY
-COMPARISON OF MEASURED RESULTS
-CONCLUSIONS FROM TESTING OF ROBOTS

EVALUATION PROCEDURES

COURSE:

1. TESTS

Written tests will be conducted as deemed necessary but will usually be announced about one week in advance. Quizzes may be conducted without advance notice.

2. The following grading scheme will be used:

A	80-100
B	66-79
C	55-65
X	
R	Repeat

3. Upgrading of Incompletes:

The method of upgrading is completely at the discretion of the teacher and may consist of one or more of the following options; assigned make-up work, completing or repeating lab activities or assignments, the re-writing of block tests, the writing of a comprehensive supplemental exam. With the absence of a formal make-up period at the end of the semester, it is very difficult to meet individual student needs for remedial work and therefore it is now especially important to not count on a make-up period as a second chance to succeed, because success at this point demands a firm committment to learning.

Where a student's overall performance has been consistently unsatisfactory, an R grade may be assigned without the option of make-up work.

Attendance and assignment completion may have a bearing on whether make-up work to upgrade an X grade will be allowed.

The highest grade obtainable on a re-write test is 55%.

The following grade symbols have been approved for recording grades for the academic year for post-secondary and non-semestered students.

"A" - outstanding achievement

"B" - consistently above average achievemen

"C" - satisfactory or acceptable achievemen in areas subject to assessment

"I" - incomplete - course work not complete by mid-term assessment but expected t be complete by semester end.
NOTE: the "I" grade is acceptable at mid-term only. It is NOT an approved for end of term reporting and will n recorded at the end of a semester.

"R" - Repeat - the student has not achieve the objectives of the course and the course must be repeated.

"X" - a temporary grade that is limited in use to rare instances when no other grade will ensure justice. The "X" grade may not be assigned unless accompanied by a written authorizati from the Department Chairman. Time allowed for completing course requir ments will not exceed 120 calendar days beyond the end of the semester in which it is assigned, and should be used at the end of a term. If th final grade for the course is not r in the Admissions & Academic Record by the date indicated on the author the "X" will revert to an "R".