SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE OUTLINE: ROBOTIC & CONTROL SYSTEMS

CODE NO.: ELN228 - 5

PROGRAM: ELECTRICAL/ELECTRONIC TECHNICIAN

SEMESTER: FOUR

DATE: JANUARY 1991

AUTHOR: ENO LUDAVICIUS

NEW: REV.: X

APPROVED: L C Crozetta 91/01/08
DEAN DATE

CALENDER DESCRIPTION

ROBOTIC & CONTROL SYSTEMS — COURSE NAME

ELN228 - 5 — COURSE NUMBER

PHILOSOPHY/GOALS:

THE STUDENT WILL BE INTRODUCED TO CLOSED-LOOP FEEDBACK SYSTEMS , INCLUDING ANALOG AND DIGITAL TRANSDUCERS, ERROR DETECTORS, SERVO AMPLIFIERS, ANALOG AND DIGITAL SYNCHRO AND RESOLVER 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) ASSIGNMENTS 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

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ROBOTIC & CONTROL SYSTEMS

SPECIFIC OBJECTIVES

BLOCK 1 - INDUSTRIAL 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.pressure,speed,numerical,computer,...)

1.2) MATHEMATICAL MODELLING 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 DIFFERENTIAL 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 response,...)
.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.

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
- ROTARY

.5) DISCUSS PNEUMATIC ACTUATION
- LINEAR
- ROTARY

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

ROBOTIC & 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.

ROBOTIC & 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 TECH.
- HIGH TECH.

.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 MECHANICAL 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.

ROBOTIC & 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
STRUCTURAL 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 INDUSTRIAL ROBOTS & ROBOT SYSTEMS - SAFETY REQUIREMENTS

2.8) HUMAN INTERFACE

.1) GENERAL TRAINING
.2) OPERATOR TRAINING
.3) MTCE. TRAINING
.4) ORGANIZED LABOUR & RESISTANCE
.5) VIDEO: 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 MEASURABLE TEST VALUES

.2) METHODS OF MEASUREMENT FOR TESTING INDUSTRIAL ROBOTS:
- MEASURING HEADS FOR GEOMETRICAL MEASUREMENTS
- TEST STANDS FOR GEOMETRICAL MEASUREMENTS
- MEASURING EQUIPMENT FOR NON-GEOMETRICAL VALUES

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SPECIFIC OBJECTIVES

BLOCK 2 - INTRODUCTION TO INDUSTRIAL ROBOTICS

2.9) TESTING OF INDUSTRIAL ROBOTS

.3) SUMMARY
- COMPARISON OF MEASURED RESULTS
- CONCLUSIONS FROM TESTING OF ROBOTS

GENERAL INFORMATION

TIMETABLE

DAY	TIME	PLACE	ACTIVITY
TUESDAY	9:30-10:30	E327	LECTURE (ALL SECTIONS)
TUESDAY	1:30- 3:30	B104	LAB (SECTION 03)
WEDNESDAY	1:30- 2:30	E237	LECTURE (ALL SECTIONS)
THURSDAY	8:30-10:30	B104	LAB (SECTION 01)
THURSDAY	10:30-12:30	B104	LAB (SECTION 02)
THURSDAY	1:30- 2:30	E327	LECTURE (ALL SECTIONS)

EVALUATION

ACTIVITY	DAY	TIME	PLACE	%
TEST #1 (BLOCK #1 MATERIAL)	FEB. 5/91 (TUESDAY)	9:30-10:30	E327	20
TEST #2 (BLOCK #2 MATERIAL)	MAR. 19/91 (TUESDAY)	9:30-10:30	E327	20
TEST #3 (BLOCK #2 MATERIAL)	APR. 16/91 (TUESDAY)	9:30-10:30	E327	20

ASSIGNMENT TOPICS	DUE DATE
1) FAMILIARIZATION WITH DC SERVO EQUIPMENT	JAN.29/91
2)	
3)	
4)	
5)	
6)	
7)	
8)	