Name	Course code
Fundamentals of Control Systems	CE 507

Location in curricular map
Specialization Axis

Course description
This course presents students with topics relating to Control Systems which are fundamental to Industrial Automated Process Control. The characteristics of Continuous and Discrete Control Systems, making strong emphasis in the applications associated with them. The design and analysis assisted by computer software tools like Matlab is an important part of this course. The topics covered in the course are: Introduction to Control Systems, Continuous Control Systems and Discrete Control Systems.

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** fundamental concepts relating to control systems. ▪ ***Know and comprehend*** the characteristics of continuous control systems and ***apply*** them to controller analysis and design using Matlab. ▪ ***Know and comprehend*** the characteristics of discrete control systems and apply them to controller analysis and design using Matlab.

Course Content:	Hours
1. Introduction to Control Systems	6
1.1 Control system concepts.	
1.2 Mathematical modeling of physical systems	
2. Continuous control systems	12
2.1 Characteristics and specifications of control systems with feedback	
2.2 Basic control actions	
2.3 Stability	
2.4 Frequency response	
2.5 Root Locus Techniques and Design via Root Locus.	
2.6 Controller design.	
3. Discrete control systems	18
3.1 Characteristics of discrete control systems	
3.2 Sampling and reconstruction	
3.3 Characteristics of time response in discrete systems	
3.4 Stability in discrete control systems	
3.5 Digital controller design	

Learning activities guided by professor	Hours 36
1. Thematic presentation by the professor	18
2. Lab work and/or guided workshop	18
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters relating to continuous control systems theory. • Reading of articles and book chapters relating to discrete control systems theory.	15
2. Solutions to problems selected by professor. • The student must solve 4 control system problems, in which he or she will do the analysis, design and solution.	10
3. Laboratory work. • The student will do 4 lab practices using Matlab.	20
4. Integral course project. • The student will develop a final project in which he or she will solve a control systems problem using Matlab.	15

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

1. Oral or written exam.
   - The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form..
2. Deliverables.
   - Lab work reports using Matlab.
   - Solution to problems using Matlab.
   - Documentation of final project.
3. Group presentations.
   - All students must present a final project in the date and hour set in accordance by the professor and the group.
4. Participation in discussion sessions.
   - This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 25 points.
    - Laboratory work with Matlab guided by the professor 35 points
    - Solution and implementation of 4 problems 20 points.
    - Final Project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Text	Modern Control Systems	Richard C. Dorf	Prentice Hall	2000
	Text	Control Engineering using Matlab: A practical approach	Katsuhiko Ogata	Pearson Education	1999
	Ref	Modern Control Engineering	Katsuhiko Ogata	Prentice Hall	2001
	Ref	Automatic Control Systems	Benjamin C. Kuo	Willey	2002
	Ref	Process Control Instrumentation Technology	Curtis D. Johnson	Prentice Hall	2002

Name	Course code
Programmable Controller Laboratory	CE 508

Location in curricular map
Specialization Axis

Course description
The general purpose of this course is that students use with a certain degree of fluidity the technologies and programming languages of Programmable Controllers, with an emphasis in the use of diverse Programmable Controllers from various manufacturers. The student will acquire abilities and skills for the evaluation and implementation of solution alternatives for automation problems using Programmable Controllers. The course covers the following topics. Sequential control systems, Architecture and work environments of Programmable Controllers, Software and programming techniques for Programmable Controllers, Evaluation, selection and implementation of solution alternatives.

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** concepts relating to automation theory and industrial process control ▪ ***Know and comprehend*** the working of the basic elements of sequential control, as well as the interpretation and design of ladder diagrams for the solution of control systems, and ***apply*** this via lab work in problem solving. ▪ ***Know and comprehend*** the concepts relating to architecture, software and programming techniques for Programmable Controllers and ***apply*** them via lab work in problem solving. ▪ ***Know*** architectures and programming languages of Programmable Controllers of various types and ***apply*** this knowledge. ▪ ***Know***, ***comprehend*** and ***apply*** the concepts relating to architecture and software relating to Programmable Controllers to the evaluation, selection and implementation of integrated solutions for Automation and Industrial Process Control problems.

Course Content:	Hours
1. Sequential Logic Control Systems	8
1.1 Hardware elements for Sequential Logic Control Systems	
1.2 Ladder Diagrams	
1.3 Sequential Logic Control problems	
2. Architecture and work environments of Programmable Controllers	6
2.1 Work environments of a Programmable Controller	
2.2 Architectures of Programmable Controllers	
2.3 I/O configurations and addressing techniques	
3. Software and programming techniques for Programmable Controllers	12
3.1 Software characteristics of Programmable Controllers	
3.2 Programming techniques	
3.3 Manual programmers and auxiliary devices	
4. Evaluation, selection and implementation of solution alternatives	10
4.1 Evaluation and selection of automation solutions using Programmable Controllers	
4.2 Integrated implementation of solution alternatives	

Learning activities guided by professor	Hours 36
1. Thematic presentation by the professor	14
2. Lab work and/or guided workshop	22
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	**Hours** 60
1. Reading materials selected by professor. • Reading of articles and book chapters relating to Programmable Controller architecture and software. • Reading of technical manuals relating to Programmable Controller architecture and software. 2. Solutions to problems selected by professor. • The student must solve 4 automation problems using Programmable Controller technologies in which he or she will solve the problems as well as select and evaluate the design solution. 3. Laboratory work. • The student must do 4 lab practices. 4. Integral course project. • The student must develop a final project in which he or she solves an automation problem using a Programmable Controller. The problem may be suggested by the professor or the student.	15 10 20 15

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form..

Deliverables.

- Lab work reports.
- Solved problems and exercises report.
- Final project documentation report.

Group presentations.

- All students must present a final project in the date and hour set in accordance by the professor and the group.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 15 points.
    - Laboratory work 45 points
    - Solution of 4 problems 20 points.
    - Final Project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

Type	Title	Author	Publisher	Year
Text	Sequential Control Systems and PLC Fundamentals	Jorge Sosa López	CETYS	2006
Ref	Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls	Thomas E. Kissel	Prentice Hall	2002
Ref	Automation, Production Systems and Computer Integrated Manufacturing	Mikell P. Groover	Prentice Hall	2000

Name	**Course code**
Instrumentation and Process Control	CE 509

Location in curricular map
Specialization Axis

Course description
This course provides the student knowledge of the various elements that comprise an Instrumentation System and focuses on the analysis and design of electronic systems for signal processing of dynamic variables in Industrial Process Control Systems. The various ways to measure dynamic variables will be studied, as well as the design and implementation of electronic circuits to convert said measurements into useful data for an automated control system. For this, the student will acquire abilities and skills for the identification of various types of sensors and transducers as well as the fundamentals for the analysis, design and implementation of diverse circuits that are used in signal conditioning. The topics that are covered throughout the course are: Fundamentals of instrumentation for process control, Analog and digital signal conditioning, Transducers: Temperature, Mechanical, Optical, Design and integration of instrumentation systems for process control.

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** the concepts relating to instrumentation in industrial process control. ▪ ***Know and comprehend*** various techniques for signal conditioning, analog and digital, and ***apply*** them via lab work to the solution and implementation of problems. ▪ ***Know and comprehend*** the concepts relating to various transducers used to measure dynamic variables and ***apply*** them via lab work in problem solving. ▪ ***Know***, ***comprehend*** and ***apply*** the concepts relating to transducers and signal conditioning to the evaluation, selection and implementation of integrated solutions to automation and industrial process control problems.

Course Content:	Hours
1. Fundamentals of process control instrumentation	4
1.4 Signals and systems	
1.5 Measurement of dynamic variables in a process	
1.6 Units and standards	
2. Analog and digital signal conditioning techniques	6
2.4 Analog signal conditioning	
2.5 Digital signal conditioning	
2.6 Data acquisition systems	
3. Transducers: Temperature, Mechanical, Optical	14
3.4 Temperature Transducers	
3.5 Strain and Stress Transducers	
3.6 Position and Movement Transducers	
3.7 Flow and Pressure Transducers	
3.8 Ultrasonic Transducers	
3.9 Optic Transducers	
4. Design and integration of instrumentation systems for process control	12
4.3 Evaluation and selection of transducers and data acquisition elements	
4.4 Implementation of instrumentation solutions for automated processes	

Learning activities guided by professor	Hours 36
1. Thematic presentation by the professor	16
2. Lab work and/or guided workshop	20
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters to know and comprehend characteristics of transducers. • Reading of technical manuals relating to hardware and software tools that will be used during the course	15
2. Solutions to problems selected by professor. • The student must solve 4 problems relating to the design and implementation of instrumentation solutions as well as the evaluation and selection of the integrated solutions.	10
3. Laboratory work. • The student will do 4 lab practices.	20
4. Integral course project. • The student will develop a final project that provides an integrated solution to an instrumentation problem for automated process control. The problem may be suggested by the professor or the student.	15

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form.

Deliverables.

- Lab work reports.
- Solved problems and exercises report.
- The student must deliver a documentation report of his or her final project.

Group presentations.

- All students must present a final project in the date and hour set in accordance by the professor and the group.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 15 points.
    - Laboratory work 45 points
    - Solution and implementation of 4 problems 20 points.
    - Final Project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

Type	Title	Author	Publisher	Year
Text	Process Control Instrumentation Technology	Curtis D. Johnson	Prentice Hall	2002
Ref	Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls	Thomas E. Kissel	Prentice Hall	2002
Ref	Introduction to Mechatronics & Measurement Systems	W. Bolton	Prentice Hall	2002

Name	Course code
Digital Controllers Laboratory	CE 510

Location in curricular map
Specialization Axis

Course description
The general purpose of this course is that students use with a certain degree of fluidity the technologies and programming languages Microcontrollers and various Digital Controllers, with an emphasis in the use of diverse types of Controllers from various manufacturers. The student will acquire abilities and skills for the evaluation and implementation of solution alternatives for automation problems using Digital Controllers The course covers the following topics. Digital control fundamentals, Microcontroller architecture and programming, Application specific digital controller architecture and programming, Evaluation, selection and implementation of solution alternatives.

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** concepts relating to Digital Controllers for Automation and Industrial Process Control. ▪ ***Know and comprehend*** concepts relating to the elements and architecture, as well as software and programming techniques for Microcontrollers and ***apply*** them via lab work in problem solving. ▪ ***Know and comprehend*** concepts relating to the elements and architecture, as well as software and programming techniques for Application Specific Digital Controllers and ***apply*** them via lab work in problem solving. ▪ ***Know***, ***comprehend*** and ***apply*** concepts relating to architecture and software of Microcontrollers and Application Specific Digital Controllers to the evaluation, selection and implementation of integrated solutions to Automation and Industrial Process Control problems.

Course Content:	Hours
1. Fundamentals of Digital Control	4
1.1 Characteristics of discrete time signals.	
1.2 Data acquisition systems and digital control	
2. Microcontroller architecture and programming	14
2.1 Microcontroller architecture	
2.2 Addressing configurations and techniques	
2.3 Microcontroller software characteristics	
2.4 Programming techniques	
3. Application specific digital controller architecture and programming	10
3.1 Measurement and control of dynamic variables using application specific digital controllers	
3.2 Application specific digital controller architecture and configurations	
3.3 Software and programming techniques	
4. Evaluation, selection and implementation of solution alternatives	8
4.1 Evaluation and selection of process control solutions using digital controllers	
4.2 Integrated implementation of solution alternatives	

Learning activities guided by professor	Hours 36
1. Thematic presentation by the professor	14
2. Lab work and/or guided workshop	22
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters to know and comprehend the characteristics, architectures and software of Microcontrollers. • Reading of articles and book chapters to know and comprehend the characteristics, architectures and software of Application Specific Digital Controllers. • Reading of technical manuals relating to architectures and software of Microcontrollers. • Reading of technical manuals relating to architectures and software of Application Specific Digital Controllers.	15
2. Solutions to problems selected by professor. • The student must solve 4 application problems using digital controllers where he or she specifies the design solution as well as the evaluation and selection of the technologies presented in the integrated solution.	10
3. Laboratory work. • The student must do 4 laboratory practices.	20
4. Integral course project. • The student will develop a final project that provides an integrated solution to a problem for automated process control using digital controllers. The problem may be suggested by the professor or the student.	15

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form.

Deliverables.

- Lab work reports.
- Solved problems and exercises report.
- The student must deliver a documentation report of his or her final project.

Group presentations.

- All students must present a final project in the date and hour set in accordance by the professor and the group.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 15 points.
    - Laboratory work 45 points
    - Solved problems and exercises 20 points.
    - Final Project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Text	Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls	Frank D. Petruzella	McGraw Hill	2004
	Ref	The Microcontroller Application Cookbook	Matt Gilliland, Ken Gracey	Woodglen Press	2000
	Ref	The Microcontroller Application Cookbook Vol. 2	Matt Gilliland	Woodglen Press	2002
	Ref	Automation, Production Systems and Computer Integrated Manufacturing	Mikell P. Groover	Prentice Hall	2000

Name	Course code
Automation and Control for Manufacturing	CE 511

Location in curricular map
Specialization Axis

Course description
This course provides the student knowledge of various current topics relating to Automation and Control for Manufacturing. Topics such as tendencies in programmable controllers, robotics and mechatronics, industrial networks for process control will be studied. The topics that are covered throughout the course are: Industrial Automation and Control, Controllers for Industrial Automation and Control, Robotics and Mechatronics in Industry, Industrial Networks for Process Control Applications.

Course learning outcomes

At the end of the course the student will:

- ***Know and comprehend*** the concepts, characteristics, applications and tendencies regarding industrial automation technologies and ***apply*** them to the analysis and design of solutions to Industrial Automation and Control problems.
- ***Know and comprehend*** the concepts, characteristics, applications and tendencies regarding industrial programmable controllers and ***apply*** them to the analysis and design of solutions to Industrial Automation and Control problems.
- ***Know and comprehend*** the concepts, characteristics, applications and tendencies regarding robotics and mechatronics and ***apply*** them to the analysis and design of solutions to Industrial Automation and Control problems.
- ***Know and comprehend*** the concepts, characteristics, applications and tendencies regarding industrial networks for process control and automation and ***apply*** them to the analysis and design of solutions to Industrial Automation and Control problems.

Course Content:	**Hours**
1. Industrial Automation and Process Control	9
1.1 Introduction	
1.2 Concepts relating to Industrial Automation and Process Control.	
1.3 Tendencies in Automation and Process Control.	
1.4 Evaluation of Automation and Process Control technologies.	
2. Controllers for Industrial Automation and Process Control	9
2.1 Introduction.	
2.2 Evolution of the Programmable Controller.	
2.3 Supervisory control.	
2.4 PLCs vs. PACs.	
2.5 Virtual control and instrumentation.	
3. Robotics and Mechatronics in Industry	9
3.1 Evolution of Industrial Robotics.	
3.2 Robot configurations and applications.	
3.3 Mathematical modeling.	
3.4 Mechatronics fundamentals.	
3.5 Artificial intelligence.	
4. Industrial Networks for Automation and Process Control	9
4.1 Introduction.	
4.2 Fundamentals computer networks.	
4.3 Technologies and evolution of industrial networks.	
4.4 Technology integration.	

Learning activities guided by professor	**Hours** **36**
1. Thematic presentation by the professor	18
2. Lab work and/or guided workshop	6
3. Presentation plenary and/or discussions	12
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters to know and comprehend the characteristics, architectures and software of Industrial Automation Technologies. • Reading of articles and book chapters to know and comprehend the characteristics, architectures and software of PLCs and PACs. • Reading of articles and book chapters to know and comprehend the characteristics, configurations, modeling and applications of Industrial Robots and Mechatronic Systems. • Reading of articles and book chapters to know and comprehend the characteristics, architectures and topologies of Industrial Networks for Automation and Process Control. • Reading of technical manuals relating to the technologies covered throughout the course.	20
2. Solutions to problems selected by professor. • The student will solve 3 homework assignments consisting of research topics and problems relating to the topics and technologies covered throughout the course.	20
3. Laboratory work. • The student will do 1 laboratory practice.	10
4. Integral course project. • The student will develop a final project that consists in describing an integrated solution to a real life industrial automation and process control problem.	10

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form.

Deliverables.

- Homework reports.
- Lab work reports.
- Final project documentation report.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exams 20 points.
    - Laboratory work 30 points
    - Homework tasks 30 points.
    - Final Project 20 points
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Text	Automation, Production Systems and Computer Integrated Manufacturing	Groover, Mikell P.	Prentice Hall	2000
	Text	Introduction to Mechatronics and Measurement Systems	Alciatora, David G.	McGraw Hill Science	2002
	Ref	Sequential Control Systems and PLC Fundamentals	Jorge Sosa López	CETYS	2006
	Ref	Robotics, Mechatronics and Artificial Intelligence: Experimental Circuit Blocks for Designers	Braga, Newton C.	Newness	2001
	Ref	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	Bolton W.	Prentice Hall	2003

Name	Course code
Object Oriented Programming for Process Control	CE 507

Location in curricular map
Specialization Axis

Course description
This course is designed to give the student knowledge of topics relating to software development in an object oriented paradigm for process control applications. The topics covered in the course are: Object oriented programming concepts, The importance of software in process control, Software design for process control, Current software technologies for process control

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** the concepts, characteristics and applications of Object Oriented Software for Process Control and ***apply*** them to the analysis and design of software solutions for Process Control applications.

Course Content:	**Hours**
1. Object Oriented Programming Concepts	8
1.1. Classes and objects	
1.2. Data encapsulation and information hiding	
1.3. Messages and operations.	14
1.4. Polymorphism	
1.5. Inheritance	
1.6. Relationships between classes and objects	
2. Object oriented program design	
2.1. Definition of functionality	
2.2. Class structure design	14
2.3. Design of object dynamics	
3 The importance of software in process control	
3.1 Introduction	
3.2 Types of software for process control	
3.3 Characteristics of process control software	
4 Process control software design	
4.1 Controller software	
4.2 Software for intelligent control	
4.3 Software for design and modeling	
4.4 Simulation software	
5 Current software technologies for process control	
5.1 Design and optimization	
5.2 Application examples	

Learning activities guided by professor	**Hours** **36**
1. Thematic presentation by the professor	16
2. Lab work and/or guided workshop	20
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters to know and comprehend the characteristics of object oriented software design for process control applications.	10
2. Solutions to problems selected by professor. • The student will solve 4 homework assignments consisting of research topics and problems relating to the topics and technologies covered throughout the course.	10
3. Laboratory work. • The student will do 4 laboratory practices.	20
4. Integral course project. • The student will develop a final project that consists in the design of a software application to solve a process control problem. The problem may be defined by the professor or the student.	20

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form.

Deliverables.

- Solved problems and exercises report.
- The student must deliver a documentation report of his or her final project.

Group presentations.

- All students must present a final project in the date and hour set in accordance by the professor and the group.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 15 points.
    - Laboratory work 40 points
    - Solved problems and exercises 20 points.
    - Final Project 25 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Text	Process Control: Modeling, Design and Simulation	Bequette, Wayne B.	Prentice Hall	2002
	Ref	Design of Robust Control Systems: From Classical to Modern Practical Approaches	Marcel J. Sidi	Krieger Publishing Company	2001
	Ref	Introduction to Fuzzy Sets, Fuzzy Logic and Fuzzy Control Systems	Trung Tat Pham, Guanrong Chen	Lewis Publishers Inc.	2000

Name	Course code
Intelligent Control Systems	CE 508

Location in curricular map
Specialization Axis

Course description
This course provides the students with knowledge regarding Intelligent Control for Industrial Automated Processes. Throughout the course the student will study Fuzzy Logic Control, Neural Networks and Robust Control, with a strong emphasis in the analysis and solution of process control problems. There will be a strong focus on computer aided analysis and design throughout the course. Los topics that will be covered are: Fuzzy Logic Control, Neural Networks and Robust Control.

Course learning outcomes
At the end of the course the student will: ▪ ***Know and comprehend*** the concepts, characteristics and applications of Fuzzy Logic Control and ***apply*** them to the analysis and design of solutions to process control problems using Matlab. ▪ ***Know and comprehend*** the concepts, characteristics and applications of Neural Networks and ***apply*** them to the analysis and design of solutions to process control problems using Matlab. ▪ ***Know and comprehend*** the concepts, characteristics and applications of Robust Control and ***apply*** them to the analysis and design of solutions to process control problems using Matlab.

Course Content:	**Hours**
1. Fuzzy Logic Control	12
1.1 Fundamentals of Fuzzy Logic Control	
1.2 Design of Fuzzy Logic Controllers	
1.3 Application examples	12
2. Neural Networks	
2.1 Fundamentals of Neural Networks	
2.2 Design of Neural Networks for Process Control	
2.3 Application examples	
3. Robust Control	
3.1 Fundamentals of Robust Control	
3.2 Design and Optimization	12
3.3 Application examples	

Learning activities guided by professor	**Hours** **36**
1. Thematic presentation by the professor	18
2. Lab work and/or guided workshop	18
3. Presentation plenary and/or discussions	OP
4. Small group activities guided by professor	OP
5. Individual activities guided by the professor	OP

Independent learning activities:	Hours 60
1. Reading materials selected by professor. • Reading of articles and book chapters to know and comprehend the concepts and characteristics relating to Fuzzy Logic Control for process control applications. • Reading of articles and book chapters to know and comprehend the concepts and characteristics relating to Neural Networks for process control applications. • Reading of articles and book chapters to know and comprehend the concepts and characteristics relating to Robust Control for process control applications.	20
2. Solutions to problems selected by professor. • The student must solve 3 problems relating to Fuzzy Logic Control applications. • The student must solve 3 problems relating to Neural Network applications. • The student must solve 3 problems relating to Robust Control applications.	20
3. Laboratory work. • The student must do 3 laboratory practices.	20
4. Integral course project. • The student will develop a final project that consists in the design the solution to a process control problem using either Fuzzy Logic Control, Neural Networks, Robust Control or a combination of these, and with the aid of Matlab. The problem may be defined by the professor or the student.	OP

Evaluation procedures and instruments:

The evaluation procedures and instruments for the course are the following:

Oral or written exam.

- The student must prove he or she understands and comprehends the topics covered throughout the course either in an oral or written form.

Deliverables.

- Reports of solved problems and exercises using Matlab.

Participation in discussion sessions.

- This will not be evaluated.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Oral or written exam 20 points.
    - Laboratory work 40 points
    - Solved problems and exercises 40 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Text	A First Course in Fuzzy and Neural Control	Hung T. Nguyen, Nadipuram R. Prasad, Carol L. Walker, Ebert A. Walker	CRC Press	2002
	Text	Design of Robust Control Systems: From Classical to Modern Practical Approaches	Marcel J. Sidi	Krieger Publishing Company	2001
	Ref	Essentials of Robust Control	Kemin Zhou, John C. Doyle	Prentice Hall	1997
	Ref	Introduction to Fuzzy Sets, Fuzzy Logic and Fuzzy Control Systems	Trung Tat Pham, Guanrong Chen	Lewis Publishers Inc.	2000

Course name:	**Course code:**
Application Project	CS 501

Location in curricular map:
Terminal Axis

Course description:
Throughout the course, the student will develop pan application project that demonstrates the capacity for analysis, team work, interpretation and application of knowledge and tools acquired throughout the masters program

Course learning outcomes:
The student will be capable of applying the knowledge and abilities acquired throughout the courses of the masters program, contributing to the development of practical solutions that benefit the community.

Course Content	Hours
1. Definition of application pre-project.	**16**
2. Ethics in professional services.	**4**
3. Project presentation.	**4**
4. Follow up by professor.	**4**
5. Presentation of pre results.	**4**
6. **Presentation of final results.**	**4**

Learning activities:	
• **Guided activities:** - Presentation of subject by professor. - Presentation by guest researchers. - Discussions of subjects and cases. - Final project presentation.	**36**
• **Independent activities:** - Applied research case reading. - Information gathering. - Research reports. - Problem analysis. - Solution design.	**60**

Evaluation criteria and procedures:
The evaluation instruments are the following: Homework and research work Final project research Participation The points distribution for each instrument will be established in accordance with the group in the first class session.

Bibliography

	Type	Title	Author	Publisher	Year
1	None				