A) COURSE

Course Id:	Course
5982	Control Engineering II

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
3	2	3	8	48 theroy 32 practice

B) GENERAL COURSE INFORMATION

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:	IX				VII
Course Type (Required/Elective)	Required				Required
Prerequisite Course:	Control Engineering I and Microcontrollers				Control Engineering I and Microcontrollers
CACEI Classification:	IA				IA

C) COURSE OBJECTIVE

At the end of the course, the student will be capable of:

Known as the digital computers can be use to process control in real time.

Apply the Z transform to analyze data systems sampled.

Design digital controllers to obtain a good dynamic response using sampled signals and quantized in amplitude.

Program and/or adjust control algorithms on a digital device (computer, microcontrollers, processor, signal digital, FPGA, etc.) for handling a real time process improving its performance.

D) TOPICS (CONTENTS AND METHODOLOGY)

1. Introduction to the control systems		**3 hours**
Specific Objective:	Known terminology necessary that it uses in this subject and the elements as shape the control systems highlighting those of digital type or computer.	

1.1. Control systems.
1.2. Control by computer.
1.3. Requirements of the control by computer.
1.4. Hardware
1.5. Software.
1.6. Sensors.

Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

2. Sampled data systems	**4 hours**
Specific Objective:	That the student identifies the characteristics of the discrete-time systems and apply Sampling theorem.
2.1 Introduction. 2.2 Analysis of the sampler and holder. 2.3 Sampling theorem. 2.4 Spectrum of a sampled signal and the “aliasing”. 2.5 Choice of sampling period.	
Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

3. Z transform and discrete systems	**10 hours**
Specific Objective:	That the student analyzes the characteristics of the discrete-time systems.
3.1 Discrete-time systems. 3.2 Z transform and its properties. 3.3 Z inverse transform. 3.4 Pulse transfer function. 3.5 Discretization of continuous systems represented by differential equations. 3.6 Block Diagrams. 3.7 State variables and equations of state.	
Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

4. Introduction to systems identification	**6 hours**
Specific Objective:	That the student interprets the basics of system identification.
4.1 Introduction. 4.2 Identifying of static and dynamic systems. 4.3 System identification least squares. 4.4 Recursive Least Squares.	

Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

5. Transitory response analysis of the state error and stability of data systems.	**12 hours**
Specific Objective:	The student will know the differences between temporal response of a continuous-time system and discrete time and the stability criteria for the latter type of system
5.1 Step response. 5.2 Compare the time response of a sampled data system and a continuous time. 5.3 Correspondence between the plane s and the plane z. 5.4 Jury`s stability criterion. 5.5 Analysis of steady-state error.	
Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

6. Design of digital control systems	**13 hours**
Specific Objective:	That the student defines the characteristics of the feedback control systems design, type digital.
6.1 Specifications of the control system. 6.2 Controller design by Ragazzini method 6.3 Design of phase delay controllers, phase lead and phase delay-lead. 6.4 Design of PID controllers. 6.5 Tuning of PID controllers. 6.6 Rules of Ziegler-Nichols. 6.7 Realization of digital controllers. 6.8 Design by pole placement. 6.9 Programmation of a controller in a digital device.	
Readings and other resources	Readings to investigation of concepts, as well as to complement and strengthen the topics discussed in class.
Teaching methods	Exhibition topics by teacher and / or students; use of some didactic techniques like teamwork, learning based in problems and/or projects; development of lab practices according topics covered in class.
Learning activities	Presentation of topics, analysis and modeling principles outlined thereof, numerical exercises, discussion of results and homework, partial exams and lab practices.

E) TEACHING AND LEARNING METHODOLOGIES

- In class they will develop individually and team exercises topics to promote abstract and analytical reasoning.
- Some teaching techniques that encourage meaningful learning, in some of the topics of the course are used.

- Management, search and interpreting of information related to the topics will be promoted.
- The use of ICTs will be promoted through homework or projects.
- The use of lab will be promoted like an experimentation tool and comparison of the concepts covered in the course.

F) EVALUATION CRITERIA

1. It will perform 3 partial exams with maximum duration of 1 hour. These exams represent 80% of the partial grade. Each exam will focus on the topics covered in the period. The exams will have a theory part and other of problems.
2. It will assign compulsory homework that students must deliver in the date stipulated.
3. The final grade will be integrated to the next way: Final grade = (sum of partial grades)/3.
4. The date of the exams will accord in class according with the specified dates by school secretary of the college.

Suggested Form of Evaluation and weighing	Schedule	Include	Weighing
First partial exam Written exam: 80% Homeworks, simulations, didactic techniques: 20% Total 100%	Session 16	Topics 1 y 2	33 %
Second partial exam Written exam: 80% Homeworks, simulations, didactic techniques: 20% Total 100%	Session 32	Topics 3 y 4	33%
Third partial exam Written exam: 80% Homeworks, projects: 20% Total 100%	Session 48	Topics 5 y 6	33 %
Total	16 weeks (48 Sessions)		
Ordinary exam		It is the average partial qualifications.	
Lab		Prove necessary to pass the course	
Extraordinary exam		Written theoretical exam of all units 100%	
Title exam		Written theoretical exam of all units 100%	
Regularization exam		Written theoretical exam of all units 100%	

G) BIBLIOGRAPHY AND ELECTRONIC RESOURCES

Main Books

Digital control system analysis and design
C. Phillips, H. T. Nagle, A. Chakrabortty Fourth edition
Pearson 2015

Microcontroller based applied digital control
D. Ibrahim Wiley 2006

An Introduction to identification
J. P. Norton Dover 2009

Complementary Books

Control de sistemas discretos
O. Reinoso, J.M.S. Zúñiga, R.A. Santoja, F. Torres McGraw-Hill 2004

Digital control systems: design, identification and implementation Ioan Doré Landau, Gianluca Zito
Springer 2006

Computer-controlled systems. Theory and design
K.J. Astrom y B. Wittenmark Prentice Hall 1997

Internet Links

http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-30-feedback-control-systems-fall-2010/