A) COURSE

Course Id:	Course
5713	INDUSTRIAL INSTRUMENTATION

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
3	1	3	7	48

B) GENERAL COURSE INFORMATION:

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:	V			VI	VI
Course Type (Required/Elective)	Required			Elective	Required
Prerequisite Course:	NONE			NONE	NONE
CACEI Classification:	AI			AI	AI

C) COURSE OBJECTIVE

At the end of the course, the student will be capable of:
Upon completion of this course, the participant will be able to apply the fundamentals of industrial instrumentation, select the appropriate tools to employ in industrial processes and also to develop the ability for proposing and evaluating appropriate instrumentation for industrial automation projects

D) TOPICS (CONTENTS AND METHODOLOGY)

1. MAIN CONCEPTS OF INSTRUMENTATION		**6 Hours**
Specific Objective:	**Study the concepts, definitions and nomenclature used in modern industrial instrumentation.**	
1.1 Introduction to instrumentation 1.2 Instrumentation and control definitions 1.3 Categories for instruments 1.4 Static and dynamic responses of signals 1.5 Error and incertitude 1.6. Signal conditioning 1.7 Noise and interference 1.8 Nomenclature according to ISA 1.9 Identification codes in instrumentation 1.10 Reading and interpretation of instrumentation diagrams		
Readings and other resources	Data Sheets tools for parameter identification	
Teaching Methodologies	Presentation of topics by the teacher. Examples of using symbology	
Learning Activities	Task about instrumentation symbology in industrial plants and the calculating parameters in measuring instruments.	

2. POSITION AND ROTATION SENSORS		**8 Hours**
Specific Objective:	**Identifying the characteristics of the sensors that can be used to detect position and rotation in industrial processes.**	
2.1 Electromechanical position sensors 2.2 Resistive sensors (potentiometers). 2.3 Photoelectric sensors. 2.4 Inductive proximity sensors 2.5 Magnetic sensors: magnetic-resistive, Hall effect sensors, Reed sensors. 2.6 Capacitive proximity sensors 2.7 Resolvers, synchro/resolvers. 2.8 Linear and rotary encoders 2.9 Linear Variable Differential Transformers (LVDT) 2.10 Features and specifications for wires and accessories		
Readings and other resources	Reading scientific articles about the development of new technologies to define position and rotation through the use of sensors.	
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples to the sensors seen in this topic	
Learning Activities	Investigation of applications using this type of sensor Exercises interpretation of data sheets for these instruments Practices for identification and use of tools for identifying position.	

3. TEMPERATURE MEASUREMENT		**6 Hours**
Specific Objective:	**Select the most appropriate instrument for temperature measurement in different applications proposed instrument.**	
3.1 Glass thermometers 3.2 Bimetallic thermometer. 3.3 Selection of semiconductor devices for temperature measurement. 3.4 Identification, selection and compensation of Resistive Temperature Detectors (RTD) 3.5 Thermistors 3.6 Operating principles, selection and compensation for thermocouples. Practical application Norms for thermocouples. 3.7 Optic and infrared pyrometers.		
Readings and other resources		
Teaching Methodologies	Presentation of topics by the teacher. Using multimedia resources presenting operating temperature measurement instruments Presentation of application examples to the sensors seen in this topic	
Learning Activities	Investigation of applications using this type of sensor Exercises interpretation of data sheets for these instruments Practices for identification and use of instruments for temperature	

4. PREASURE MEASUREMENT		**6 Hours**
Specific Objective:	**Select the most appropriate measuring device in pressure.**	
4.1 Pressure units 4.2 Mechanic elements. Tube pressure gauges. 4.3 Electromechanical elements. Resistive, capacitive and magnetic transducers. Strain gauges. 4.4 Semiconductor devices for pressure measurement.		

Readings and other resources	
Teaching Methodologies	Presentation of topics by the teacher. Using multimedia resources presenting operating temperature measurement instruments Presentation of application examples to the sensors seen in this topic
Learning Activities	Investigation of applications using this type of sensor Identification exercises to providers such instruments, and analysis of the offered products.

5. SENSORS FOR LEVEL MEASUREMENT		**4 Hours**
Specific Objective:	**Select the most suitable devices for level measurement of liquids and solids in containers.**	
5.1 Direct measurement of liquid levels 5.1.1 Meter probe 5.1.2 Plumb and tape meters. 5.1.3 Glass meters 5.1.4 Float meters 5.2 Liquid level meters based on hydrostatic pressure. 5.2.1 Manometrical meters 5.2.2 Pressure gauges 5.2.3 Purge system 5.2.4 Differential pressure metters 5.3 Displacer type level measurement 5.4 Instruments based on the electric features for the liquids. 5.4.1 Conductive meters 5.4.2 Capacitive meters 5.5 Ultrasonic Meter 5.6 Radiation Meter 5.7 Lasser Meter 5.8 Solid level meters		
Readings and other resources		
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples the sensors seen in this topic Using multimedia resources presenting operation of level measurement instruments	
Learning Activities	Investigation of applications using this type of sensor	

6. FLOW MEASUREMENT		**4 Hours**
Specific Objective:	**Select the most appropriate instrument for measuring the flow of liquids and vapors.**	

6.1 Differential volumetric pressure meters. 6.1.1 Nozzle 6.1.2 Pitot tube 6.1.3 Annubar tube 6.1.4 Venturi meter 6.1.5 Orifice plate 6.2 Volumetric meters of variable area 6.2.1 Rotary meters 6.3 Speed volumetric meters 6.3.1 Turbine flow meter 6.3.2 Open channel flow measurement 6.4 Volumetric meters of positive displacement 6.4.1 Rotary piston 6.4.2 Alternative piston 6.4.3 Diaphragm pressure gauge 6.5 Electromagnetic flow meters 6.6 Ultrasonic flow meters	
Readings and other resources	
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples to the sensors seen in this topic Use of multimedia showing operation of flow measurement instruments
Learning Activities	Investigation of applications using this type of sensor

7. MEASUREMENT OF OTHER VARIABLES		**3 Hours**
Specific Objective:	**Select the most appropriate sensor for light measurements and gas as variables to control**	
7.1 Light sensors 7.1.1 Photodiodes/phototransistors 7.1.2 Photovoltaic cells 7.1.3 Photoresistors 7.1.4 Opto-isolators 7.2 Gas sensors 7.2.1 Semiconductor gas sensors 7.2.2 Infrared gas sensors		
Readings and other resources	Reading scientific articles about the development of new technologies for this type of sensors.	
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples to the sensors seen in this topic	
Learning Activities	Investigation of applications using this type of sensor Exercises interpretation of data sheets for these instruments	

8. TRANSMITTERS, CONTROLLER, RECORDERS AND INDICATORS		**7 Hours**
Specific Objective:	**Identify the characteristics of the transmitters, controllers and industrial recorders; more suited to an industrial process.**	

8.1 Features of analog and digital transmitters 8.2 Criteria for transmitters selection 8.3 Transmitters 8.4 Universal transmitters 8.5 Action automatic controllers 8.6 Electric controllers 8.7 Self-operated controllers 8.8 Digital and analog indicators 8.9 Recorders 8,10 Introduction to instrumentation and digital control	
Readings and other resources	Reading scientific articles about the use and configuration of controllers, recorders and indicators.
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples to the instruments seen in this topic
Learning Activities	Investigation of applications using this type of instrument Practices for the configuration of such instruments.

9. FINAL CONTROL ELEMENTS		**4 Hours**
Specific Objective:	**Evaluate comprehensive process instrumentation systems, in instrumentation projects proposed by the teacher.**	
9.1 Control valves 9.2 Electric and pneumatic actuators 9.3 Electronic actuators 9.4 Servomotors		
Readings and other resources		
Teaching Methodologies	Presentation of topics by the teacher. Presentation of application examples to the instruments seen in this topic	
Learning Activities	Investigation of applications using this type of instrument Practices for the use of such instruments.	

E) TEACHING AND LEARNING METHODOLOGIES

Themes exposed by professor, research by students, literature review on issues related to electronic industrial instrumentation. Application of industrial instrumentation specialized software.

Visits to companies with a high level of instrumentation. Approach of practical projects involving the selection, design and evaluation of the knowledge acquired in the course.

F) EVALUATION CRITERIA:

Evaluation:	Schedule	Suggested Form of Evaluation and weighing	Topics
1st Term	Session 16	Exam 85%, Homework 15%,	Units 1 and 2
2nd Term	Session 32	Exam 85%, Homework 15%,	Units 3, 4 and 5
3rd Term	Session 48	Exam 85%, Homework 15%,	Units 6, 7, 8 and 9
Final evaluation		100% (Average of the partial evaluations)	
Other activity:			

Extraordinary Exam	According to schedule	100% Exam	100% of topics
Title Exam	According to schedule	100% Exam	100% of topics
Regularization Exam	According to schedule	100% Exam	100% of topics

G) BIBLIOGRAPHY AND ELECTRONIC RESOURCES

Main Books

a) TEXTBOOK:
INSTRUMENTACIÓN INDUSTRIAL
Creuss A.
Marcombo.

Complementary Books

a) Rivera Mejía J.
Trillas. 2007

b) ELECTRONIC PORTABLE INSTRUMENTS. DESIGN AND APPLICATIONS
Eren, H.
CRC Press. 2004

c) MANUAL DEL INGENIERO MECÁNICO
Avallone, E., Baumeister, T.
McGraw-Hill, 1999

d) SENSORES Y ACONDICIONADORES DE SEÑAL
Pallas A. Ramón
Alfaomega 2007.

e) SENSORES Y ACONDICIONADORES DE SEÑAL, PROBLEMAS RESUELTOS
Pallas A. Ramón
Alfaomega 2007.

f) FUNDAMENTALS HANDBOOK, INSTRUMENTATION AND CONTROL, VOL I AND 2
US Department of Energy (DOE)

Internet Links

- http://www.isa.org
- http://www. isamex.org
- http://www.omega.com/techref
- http://www.ni.com