uc3m | Universidad Carlos III de Madrid
Vicerrectorado de Estudios
Apoyo a la docencia y gestión del grado

COURSE:		
DEGREE:	YEAR:	TERM:

WEEKLY PLANNING

WEEK	SESSION	DESCRIPTION	TEACHING (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS		DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max.Estim. 6,5h)
	1	1.INTRODUCTION (goals, skills, methodology, assessment, IEI schedule) 1.1 Usefulness of instrumentation systems and applications 1.2 Blocks of an electronic instrumentation system 2. SENSORS AND TRANSDUCERS 2.1 What a transducer is? 2.2 Pros & cons of transducers (electrical) 2.3 Active and passive sensors 2.4 Sensors classification approach INTRODUCTION EXAMPLE Sensor examples: classification	x			Students must propose an example of instrumentation system in real life and identify their main blocks. Students must propose some sensor examples they are familiar with and classify them accordingly.	1,66	

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1	2	3. TRANSDUCER PERFORMANCE –SPECIFICATIONS 3.1 Introduction: static and dynamic regime 3.2. Accuracy, precision 3.3. Calibration curve 3.4. Full-scale and measurement range 3.5. Sensitivity 3.6. Linearity 3.7. Resolution and threshold 3.8. Repeatability, reproducibility, hysteresis and stability 3.9 Bandwidth		x		Understand concepts of sensitivity, accuracy and precision, their use and units. Understand units and order of magnitude of sensitivity for 2 sensors: RTD and thermocouple. Understand concepts of linearity, resolution and hysteresis, their use and units. Identify 2 temperature sensors and evaluate their linearity: RTD and thermocouple. Exercises: static regime characteristics and classification. Exercises: sensitivity calculations and basic error analysis.	1,66	6,5
	3	4. TRANSDUCER SIGNAL CONDITIONING I 4.1 Usefulness of signal conditioning circuits 4.2 Potentiometric circuit 4.3 Wheatstone bridge	x			Understand different potentiometric circuits: when they should be used and proper circuit design. Output magnitude calculation as a function of input physical magnitude.	1,66	

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2	4	SIGNAL CONDITIONING EXERCISES: Potentiometric circuit Sensor characteristics and specifications.		x		Signal conditioning for potentiometric circuits Ro analysis for max sensitivity. Small-signal drawback. Understand Wheatstone bridge circuit properties, usefulness: small-signal, linearity, balanced, … Correct Wheatstone bridge choice when amplifying.	1,66	6,5
3	5	4. TRANSDUCER SIGNAL CONDITIONING II 4.3 Wheatstone bridge 4.4 Amplification 4.4.1. Amplifier characterisitics. 4.4.2. Load effects 4.4.3. Ideal O.A. O.A. when open loop and feedback (inverting, non-inverting, adder, substractor, etc.) 4.4.4. Differential amplification and basic designs. 4.4.5. Instrumentation amplifier	x			Identify the need for amplification Operational amplifier-based basic circuits and schemes. Understand the I-V converter to conditioning photodiodes and O.A. acting as comparators for generating alarms. Magnitudes of influence and wiring effects. Understand best amplifying option depending on the signal conditioning circuit. (Differential and) Instrumentation amplifier for Wheatstone bridge	1,66	6,5
	6	SIGNAL CONDITIONING EXERCISES: Wheatstone Bridge and Amplification		x		Exercises including Wheatstone bridge and amplifying stages.	1,66	

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4	7	5. TRANSDUCERS FOR TEMPERATURE MEASUREMENTS 5.1 Applications. Definition, scales, … 5.2. Temperature measurements through mechanical effects 5.3. Thermometry by ICs. 5.4. Resistive temperature sensors (thermistors) Exercise: full instrumentation system for temperature measurement	x			Identify most used commercial and off-the-shelf temperature sensors and their related signal conditioning circuits, being able to select among them depending on the application and their sensitivity and measurement range characteristics Prepare P1 LAB SESSION QUESTIONS (QUESTIONNAIRE 1, Q1).	1,66	6,5
	8	EXERCISES: Temperature Sensors and Instrumentation Systems.		x		Prepare P1 LAB SESSION QUESTIONS (QUESTIONNAIRE 1, Q1). Kahoot 1 activity	1,66	
5	9	5. TRANSDUCERS FOR TEMPERATURE MEASUREMENTS 5.4. Resistive temperature sensors (RTD) 5.5. Thermocouples 5.6. Comparative between temperature sensors	x			Capacity to select between different temperature sensors and their related signal conditioning circuits depending on the sensitivity, measurement range, linearity, precision,… requirements.	1,66	6,5
	10	Discussion about Lab Session 1. LAB QUESTIONNAIRE 1 (KAHOOT 1) EXERCISES: amplification		x		Prepare theoretical report about P1 LAB SESSION (in groups) Exercises with amplifying stages and temperature sensors	1,66	

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6	11	6. STRAIN SENSORS 6.1. Applications of interest. Basic concepts: stress-strain theory. 6.2. Principle of operation. 6.3. Strain gauges: types. 6.4. Static performance and gage placement. 6.5. Signal conditioning circuits Strain sensor EXERCISE: first approach	x			Basic strain measurement principles. Basis on stress-strain theory: deformation, units, concepts, … and magnitude analysis. Signal conditioning circuits for small-signal regime.	1,66	6,5
	12	Strain Sensors: EXERCISES AND GUIDELINES		x		Exercises including Wheatstone bridge + strain + instrumentation amplifier	1,66	
7	13	QUIZ 1 (CONTROL TEST 1) and further discussion about concepts	x			Complete theoretical report about P1 LAB SESSION (in groups)	1,66	6,5
	14	LAB: P1, s1 Electronic instrumentation with temperature sensors. Calibration curve and signal conditioning implementation.		x	LAB	Lab session for implementation of an electronic instrumentation system for temperature measurement. Analysis and discussion about the lab results obtained.	1,66	
8	15	7. DISPLACEMENT AND LEVEL SENSORS 7.1. Applications. Definition, scales, … 7.2. Resistive potentiometers. 7.3. Hall effect sensors. 7.4. Inductive and capacitive sensors. 7.4.2. Measuring circuits. Wheatstone bridge with AC feed.	x			Identify most used commercial and off-the-shelf position, level and displacement sensors, being to select among them depending on the application and their sensitivity and measurement range requirements. Datasheet understanding skills. Knowledge of AC feeding basis for inductive and capacitive sensors' operation.	1,66	6,5

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	16	LAB: P1, s2 Electronic instrumentation with temperature sensors Calibration curve and signal conditioning implementation. First steps with LABVIEW		x	LAB	Complete experimental report about P1 LAB SESSION (in groups) Prepare P2 LAB SESSION QUESTIONS (QUESTIONNAIRE 2, Q2).	1,66	
9	17	4. TRANSDUCER SIGNAL CONDITIONING III 4.5 Modulation / Demodulation in instrumentation systems 4.5.1 Introduction and modulation types. Pros and cons. 4.5.2. AM modulation: characteristics and ways to implement.	x			Proper selection of modulation type, carrier frequency, filtering stage characteristics, etc. Prepare P2 LAB SESSION QUESTIONS (QUESTIONNAIRE 2, Q2).	1,66	6,5
	18	Discussion about Lab Session 2 LAB QUESTIONNAIRE 2(KAHOOT 2) EXERCISES: Modulation / Demodulation + position		x		Kahoot 2 activity Position and level sensors: EXERCISES Modulation & Demodulation exercises Prepare theoretical report about P2 LAB SESSION (in groups	1,66	
10	19	4. TRANSDUCER SIGNAL CONDITIONING III 4.6. Analog-to-Digital conversion 4.6.1. A/D and D/A conversion; definition; 4.6.2. A/D Amplitude and time discretization. Impact on the measuring performance. 4.7. Instrumentation system: a perspective and block diagram. Exercise: A/D conversion	x			Modulation, demodulation: summary. Signal conditioning: proper selection of sampling frequency, number of bits and resolution. System block diagram: basis of A/D and D/A converters Complete theoretical report about P2 LAB SESSION (in groups)	1,66	6,5
	20	LAB: P2, s1 Electronic instrumentation with strain sensors and amplification. Wheatstone bridge balancing and amplification		x	LAB	Lab session for implementation of an electronic instrumentation system for strain measurement	1,66	

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11	21	8. OPTICAL SENSORS 8.1 Light properties. Photometry: units. Optical sources and specifications 8.2. Photoconductive cells. 8.3. PN junctions: photodiodes	x			Knowledge about light properties for magnitude measuring. Identify optical sensor types. Signal conditioning circuits for optical sensors.	1,66	6,5
	22	LAB: P2, s2 Electronic instrumentation with strain sensors and amplification. LABVIEW software for virtual instrumentation: data acquisition and signal processing. Development of a LabView-based alarm system.		x	LAB	Complete experimental report about P2 LAB SESSION (in groups)	1,66	
12	23	QUIZ 2 (CONTROL TEST 2) and further discussion about concepts	x				1,66	6,5
	24	EXERCISES: basic exercises about optical sensors (phototransistors and optical fibers not included)		x		Review of basic aspects of optical sensing.	1,66	
13	25	8.3. PN junctions: phototransistors. 8.4. Photovoltaic cell and photoemissive transducers. 8.5. Fiber-optic sensors EXERCISES: optical sensors	x			Signal conditioning circuits for optical sensors. Optical sensors and signal conditioning circuits: Exercises	1,66	6,5
	26	EXERCISES: Full electronic instrumentation system for position/displacement measurement		x		Exercises including all electronic instrumentation blocks studied along the course	1,66	
	27	EXERCISES: Full electronic instrumentation system for optical sensing	x			Exercises including all electronic instrumentation blocks studied along the course	1,66	

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14	28	EXERCISES UPON REQUEST? Pending questions…		x		Exercises (to be determined). Weak points reinforcement. Review of basic aspects or unclear issues. Feedback from students	1,66	6,5
	29	Additional session				Exercises (to be determined). Weak points reinforcement. Review of basic aspects or unclear issues.	1,66	3,25
						Subtotal 1	**48**	**94**
						Total 1 *(Hours of class plus student homework)*	**142**	
15		Tutorials, handing in, etc					3,6	-
16		Assessment					4	10
17								
18								
						Subtotal 2	**8**	**10**
						Total 2 *(Hours of class plus student homework)*	**18**	
						TOTAL A *(Maximun 160 horas)*	**160**	

LABORATORIES CLASSES PROGRAMMING

	SESSION			WEEKLY PROGRAMMING FOR STUDENT
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WEEK	SESSION	DESCRIPTION	LABORATORY			DESCRIPTION	CLASS HOURS	HOMEWORK HOURS (Max. Estim. 6,5h)
	1	Tutorials, mentoring hours, etc.					1,66	6,5
	2	Study, homework, assessment and exam					1,66	
						Subtotal 3	**3,5**	**6,5**
						Total 3 *(Hours of class plus student homework)*	**10**	
						TOTAL B *(Total 3)*	**10**	
TOTAL *(Total A + Total B. Maximun 170 horas)*							**170**	