

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING & COMMUNICATION)

(41)

### SENSOR SIGNAL PROCESSING

SUBJECT CODE: 2724114

SEMESTER: II

**Type of course:** Applied Course with emphasis on laboratory work

**Prerequisite:** Knowledge of analog and digital circuits, Signal processing

**Rationale:** Sensors have become integral part of every system. This course is a fundamental course on how to obtain sensor signals, condition them and process them in analog domain and digital domain. The course builds upon understanding characteristics of various sensors and process the signal obtained using signal processing techniques. The course emphasis more on practical issues and needs more time to be spent in laboratory.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	ESE (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

#### Content:

Sr. No.	Content	Total Hrs	% weightage
1	Introduction: Sensors and transducers. Understand characteristics of various sensors. Touch, position, displacement, proximity, velocity, motion, integrated circuit based temperature and vibration, humidity, moisture content, solar photovoltaic and accelerometer type of sensors, microphone array and image sensors.	10	24
2	Signal conditioning of sensor signals using analog circuits, understanding need of and design of filters and pre-amplifiers, zero crossing detector and wave-shaping circuits. Design of PWM circuits.	16	30
3	Signal conditioning of sensor signal using digital circuits; understand the need of level shifter. Design of Schmitt trigger, counter and shifter circuits, Controller based interfacing system. System with on chip and on device sensors.	16	30
4	Case study of design of analog systems and digital systems for various sensors. Introduction to mix-mode controller and design	08	16

## Reference Books:

1. Industrial Instrumentation, Padmanabhan, Springer
2. Practical Signal Processing, Mark Owen, Cambridge Press
3. Wireless Sensor Network: Principles and Practice, Fei Hu, X. Cao

## Course outcomes:

On successful completion of the course, the students should be able to:

- Understand various sensors and their characteristics
- Experimentally obtain the characteristics of various sensors and transducers
- Define appropriate signal conditioning requirements
- Design analog system for interfacing with sensors
- Design digital systems for interfacing with sensors
- Understand benefit of system on chip architectures for various applications

## List of Experiments:

1. Obtaining characteristics of various sensors such as position, proximity, motion and accelerometer.
2. Obtaining characteristics of various environmental sensors such as temperature and humidity and moisture content.
3. Design of analog signal processing circuits using op-amp and specialized integrated circuits for sensors.
4. Design of digital signal processing circuits using various digital integrated circuits for sensors.
5. Design of complete analog signal processing system for sensors.
6. Design of complete digital signal processing system for sensors.
7. Low power controller based signal processing techniques for sensors
8. Mixed- mode controller based signal processing for sensors
9. A project based on topics learned during the course.

## Open Ended Problems:

1. Design of low power sensor signal processing circuits with programmable logic devices for wearable sensors applications.
2. Design of signal processing hardware for on board satellite signal processing
3. Design of low power signal processing circuits with energy harvesting capability.
4. Design of microphone array signal processing

## Major equipments and software:

NI –ELVIS and My Daq cards with LABVIEW

Digital Storage Oscilloscope, DMM with data logging capability, Sensitive Power Supply

MATLAB

Agilent Virtual Instrumentation Set

Various sensors

Analog and Digital Integrated Circuits and Tester.

## List of Open Source Software/learning website:

SCILAB

Sakshat Virtual Labs, IIT Guwahati

Virtual Labs, IITB

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website