NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF INSTRUMENTATION AND CONTROL

COURSE PLAN – PART I			
Name of the programme and specialization	B.Tech Instrumentation and Control Engineering		
Course Title	Sensors Systems Design		
Course Code	ICHO16	No. of Credits	4
Course Code of Pre-requisite subject(s)	ICPC 17		
Session	July 2023	Section (if, applicable)	A and B
Name of Faculty	Dr. Shiraz Sohail	Department	Instrumentation and Control
Official Email	ssohail@nitt.edu	Telephone No.	04312504965
Name of Course Coordinator(s) (if, applicable)			
Official E-mail		Telephone No.	
Course Type (please tick appropriately)	Honours Course		

Syllabus (approved in BoS)

Design of signal conditioning circuits: for resistive, capacitive, thermal transducers for improving linearity, sensitivity and other required specifications and performance through hardware and software methods through theory and practical approach. Linearization, A/D conversion, temperature compensation. Noise analysis of interface circuits. Current, frequency, period or pulse-width modulation conversion

Review of transmitters: design of two wire and four wire transmitters using analog electronic circuits and IC's. EMI and EMC design consideration for sensor interfacing circuit design.

Introduction to data acquisition system: issues related to interfacing of static and dynamic sensors. Design of data acquisition for a given measurement application through theory and practical approach. Introduction to Sensor buses and sensor network protocols.

Smart sensors and digital sensor system design: Technologies and design methodology, IEEE 1451 standard and frequency sensors.

Direct sensor-microcontroller interface for resistive and capacitive transducers: design and practical implementation. Universal frequency to digital converter, universal sensors and transducer interface- features and performance, future trends in sensor circuit design.

Text Books:

1. Ramon Pallas Areny, John G. Webster, Sensors and Signal Conditioning, 2nd Edition, John Wiley and Sons, 2000.

2. Kirianaki N.V., Yurish S.Y., ShpakN.O., Deynega V.P., Data Acquisition and Signal Processing for Smart Sensors, John Wiley & Sons, Chichester, UK, 2002.

3. Ferran Reverter, Ramon PallasAreny, Direct Sensor-to Microcontroller Interface Circuits: Design and Characterization, Marcombo S.A., 2005.

4. Smart Sensors and MEMS, ed. by S.Y. Yurish and M.T. Gomes, Springer Verlag, 2005.
5. A. Custodio, R. Bragos, R. Pallas-Areny, A Novel Sensor-Bridge-to-Microcontroller Interface, in Proceedings of IEEE Instrumentation and Measurement Technology Conference, Budapest, Hungary, 21-23 May, 2001.

Reference Books

1. Thomas L. Floyd, David Buchla, Fundamentals of analog circuits, 2002- Prentice Hall.
2. Ernest O. Doebelin; Measurement System Application and Design; McGraw Hill; 5thEdition, 2003.
3. S. Y. Yurish, F. Reverter, R. Pallas-Areny, Measurement error analysis and uncertainty reduction for period-and time interval-to-digital converters based on microcontrollers, Measurement Science and Technology, Vol.16, No.8, 2005, pp.1660-1666.
4. William C. Dunn, Introduction to Instrumentation, Sensors, and Process Control, Artech House, 2005.
5. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 1993.
6. H.R. Taylor, Data Acquisition for Sensor Systems, Springer, 2010.
7. Manabendra Bhuyan, Intelligent Instrumentation: Principles and Applications, CRC Press Taylor and Francis Group, 2010.
8. B.E. Noltingk, Instrumentation Reference Book, Butterworth- Heinemann, 2nd Edition 1995.

COURSE LEARNING OBJECTIVES

1. To provide knowledge on the design of signal conditioning circuits for resistive, capacitive and thermal transducers to improve the sensor characteristics.
2. To provide knowledge on the design of transmitters with industrial standard.
3. To impart the knowledge of data acquisition system design, sensor networks and buses.
4. To provide knowledge about the smart sensor design, direct sensor microcontroller interface and universal interfacing circuit.

MAPPING OF COs with POs

Course Outcomes	Programme Outcomes (PO) (Enter Numbers only)
1. Design signal conditioning circuits for resistive, capacitive and thermal transducers	**1-5, 9-12**
2. Design transmitters for the required physical parameters using analog circuits and IC.	**1-5, 9-12**
3. Interface sensors signal with DAQ, Microcontroller and will be familiar with sensor buses and protocols.	**1-5, 9-12**
4. Design smart sensors systems with standard interfacing circuits.	**1-5, 9-12**

COURSE PLAN – PART II

COURSE OVERVIEW

A course on "sensors system design" discuss the theory and practical approaches of designing signal conditioning circuits for resistive, and capacitive transducers. In addition, a broad overview of data acquisition system along with interfacing strategies will be discussed. Further, the course also provides an overview of smart sensors and their design.

COURSE TEACHING AND LEARNING ACTIVITIES			(Add more rows)
S.No.	**Week/Contact Hours**	**Topic**	**Mode of Delivery**
1.	1st week to 4th week	Design of signal conditioning circuits for resistive, capacitive, thermal transducers for improving linearity, sensitivity and other required specifications and performance through hardware and software methods through theory and practical approach. Linearization, A/D conversion, temperature compensation. Noise analysis of interface circuits. Current, frequency, period or pulse-width modulation conversion	Black/ White Board, and Power point presentation
2.	5th week to 6th week	Review of transmitters – design of two wire and four wire transmitters using analog electronic circuits and IC's. EMI and EMC design consideration for sensor interfacing circuit design.	Black/ White Board, and Power point presentation
3.	7th week to 9th week	Introduction to data acquisition system, issues related to interfacing of static and dynamic sensors. Design of data acquisition for a given measurement application through theory and practical approach. Introduction to Sensor buses and sensor network protocols.	Black/ White Board, and Power point presentation
4.	10th week to 12th week	Smart sensors and digital sensor system design: Technologies and design methodology, IEEE 1451 standard and frequency sensors.	Black/ White Board, and Power point presentation
5.	13th week to 15th week	Direct sensor-microcontroller interface for resistive and capacitive transducers: design and practical implementation. Universal frequency to digital converter, universal sensors and transducer interface- features and performance, future trends in sensor circuit design.	Black/ White Board, and Power point presentation

COURSE ASSESSMENT METHODS (shall range from 4 to 6)				
S.No.	**Mode of Assessment**	**Week/Date**	**Duration**	**% Weightage**

1	Assessment I	As per academic calendar	1 hour	20%
2	Assessment II	As per academic calendar	1 hour	20%
3	Mini project	Shall be informed in the class	------	30%
CPA	Compensation Assessment*	As per academic calendar	1 hour	20%
5	Final Assessment *	As per academic calendar	3 hour	30%

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1. Anonymous feedback through minute card.

2. Direct feedback from the students by having face-to-face meeting individually / as the class as a whole.

3. Feedback from the students during the class committee meetings

4. Students' performance in the class tests

COURSE POLICY (including compensation assessment to be specified)

Re-Test policy

1. Students who have missed the first or second-class test can register with the consent faculty for the Re-Test by submitting proper valid justification in written form to write retest.

2. No Re-Test for End semester Exam.

Grading:

The passing minimum should be 35% or (Class average/2) whichever is greater.

Re-Assessment Exam

- A student may, for valid reasons on production of valid medical certificate and with the approval of HOD be permitted to withdraw from appearing for the End Sem Examination. Withdrawal application shall be valid only if it is made before the commencement of the examination.
- Those who failed in the subject may register for re-assessment examination, which will be conducted for 100% mark (Absolute grading where passing minimum is 35).
- Grades for the students who have withdrawn from writing the End Sem exam will be same as the regular assessment grades. For those who are failed or absent and appearing for reassessment, the maximum grade is restricted to 'E'.
- Re-assessment exam will be conducted in the first week of the next semester or earlier during the vacation.

Formative Assessment (FA):

1. Students who have failed after Re-Assessment Exam of the course will have to register and pass the course by Formative Assessment (FA) only.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- At least 75% attendance in each course is mandatory.
- A maximum of 10% shall be allowed under On Duty (OD) category.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
- The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION, IF ANY

- Student can meet anytime depends on the mutual availability. Course faculty will be available in the Room No. 321, Lyceum Building.
- The students can email their queries to the course faculty directly at **ssohail@nitt.edu.**

FOR APPROVAL

Course Faculty:	**CC- Chairperson:**	**HOD:**
Dr. Shiraz Sohail	(Dr. Geetha C)	**Prof. K. Dhanalakshmi**

Guidelines

a) The number of assessments for any theory course shall range from 4 to 6.

b) Every theory course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in				P.G.
2018	2017	2016	2015	
35% or (Class average/2) whichever is greater.		(Peak/3) or (Class Average/2) whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.