GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3141710
Semester – IV
Subject Name: Microprocessor and Interfacing

Type of course: Professional Core Course

Prerequisite: Students should have in depth knowledge of Digital Logic Design.

Rationale: Microprocessor 8085 has simple architecture and an adequate instruction set that enables students to learn necessary architecture, programming and interfacing concepts. The concepts are easily transferable from this device to the microcontrollers, which are widely used in the field of industrial automation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Microcomputers and Microprocessors** Introduction to digital computer, Computer languages, Operating systems, Data representation, Microprocessor organization, Memory, Input/output devices, System bus, Microprocessor controlled temperature system.	2
2	**Microprocessor Architecture and Microcomputer Systems** Microprocessor 8085 architecture and its operations, Registers, Flags, Memory, Input/output and interfacing devices, Pin diagram, Bus timings, Demultiplexing the address/data bus, Control signals, 8085 based microcomputer, Interfacing memory, Interfacing input & output (I/O) devices, Memory mapped I/O, Testing and troubleshooting of memory and I/O interfacing circuits.	10
3	**Instructions and Timings** Programming model, Data transfer, arithmetic, logical, branch and machine control instructions, Instruction format, Addressing modes, Timing diagram of single byte, two byte, three byte instructions.	8
4	**Assembly Language Programming (ALP)** Looping, counting, and indexing, Programming using data transfer, arithmetic, logical and branching instructions, Counters and time delays, Stack and Subroutine, Code conversion, BCD arithmetic and 16-bit data operations.	12

5	**Interrupts** Basic understanding of interrupt process, Vector interrupts, Software interrupt.	**4**
6	**Interfacing** DAC and ADC, 8255A programmable peripheral interface (PPI) mode 0 and BSR mode, Seven segment multiplexed display and matrix keyboard interfacing using 8255, 8253 programmable interval timer.	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
0 to 10	**10 to 15**	**10 to 15**	**15**	**10 to 15**	**15 to 20**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

Reference Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085 - Ramesh S. Gaonkar Penram International Publishing (India) Pvt. Ltd.
2. Microcomputers and Microprocessors: The 8080, 8085 and Z-80 Programming, Interfacing and Troubleshooting by John E. Uffenbeck.
3. Microprocessor and Microcontroller fundamentals. The 8085 and 8051 Hardware and Software by William Kleitz.
4. 0000 to 8085 – Introduction to Microprocessors for Engineers and Scientists,P. K. Ghosh and P.R. Shridhar, Prentice hall of India Pvt. Ltd, 2nd edition.
5. The 8085 Microprocessor: Architecture, Programming and Interfacing, K. Udaya Kumar and B.S.Umashankar, Pearson Education.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
	After successful completion of the course students should be able to:	
CO-1	Explain various features of microprocessor, memory and I/O devices including concepts of system bus.	20
CO-2	Simulate assembly language program for general purpose automation.	30
CO-3	Apply knowledge of programming to interface memory, keyboard, display and	30

	other input/output devices with microprocessor.	
CO-4	Understand the functionality of various peripheral chips.	20

List of Experiments:

Minimum of 40 programs to be written making effective use of all the instructions, and addressing modes. Among these at least 5 programs must be of stack and subroutine and, 5 programs based on peripheral ICs.

1. Introduction to Microprocessor Trainer Kit and identify the different peripheral devices and operating system on it. Write and execute demo programs.
2. Introduction to 8085 simulator IDE and understand the steps to simulate the program using it. Write and execute demo programs. Explain various debugging techniques like single stepping, break point etc.
3. Assembly language programming using data transfer instructions.
4. Assembly language programming using arithmetic and logical instructions.
5. Assembly language programming using branching and looping instructions on trainer kit.
6. Assembly language programming using counter and time delay on trainer kit.
7. Assembly language programming using stack and subroutine on trainer kit.
8. Assembly language programming for code conversion.
9. Assembly language programming for BCD arithmetic and 16-bit data operations.
10. Interfacing and assembly language programming of ADC and DAC with microprocessor 8085.
11. Interfacing and assembly language programming of 8255 Programmable Peripheral Interfacing (PPI) device with microprocessor 8085.
12. Interfacing and assembly language programming of 8253 programmable counter / timer device with microprocessor 8085.

Major Equipment:

1. 8085 microprocessor trainer kit with peripheral devices
2. Computer system
3. CRO, Power supply

List of Open Source Software/learning website:

8085 simulator.
nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code:3141007
SUBJECT NAME:Professional Ethics
Semester IV

Type of course:

Prerequisite: NA

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE(E)	PA	ESE (V)	PA(I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	Concepts and theories of Business Ethics: Definitions of Ethics, Personal ethics and Business ethics, Morality and law, How are moral standards formed? Religion and Morality, Morality, Etiquette and Professional codes, Indian Ethical Traditions.	6
2	Business Ethics: Principles of personal Ethics, Principles of Professional ethics, Evolution of Ethics Over the years, Honesty, Integrity and Transparency are the touchstones of Business Ethics, Distinction Between Values and Ethics, Roots of unethical Behaviour, Ethical Decision – Making	6
3	Ethical Dilemmas, Sources and Their resolutions: What is an Ethical Dilemma, Sources of Ethical Behaviour, Code of Personal Ethics for Employees, How to Resolve an Ethical Problem, How to Resolve Ethical Dilemmas.	5
4	Ethical Decision – marking in Business: Ethical Models that Guide Decision making, Which Approach to use, Ethical Decision Marking with Cross – holder conflicts and competition, Applying Moral Philosophy to Ethical Decision Making, Kohlberg's Model of Cognitive Moral Development, Influences on Ethical Decision Making, Personal values and Ethical Decision Marking	10
5	Individual factors: Moral Philosophies and values – Moral Philosophy defined, Moral philosophies, Applying Moral Philosophy to Ethical decision Making, Cognitive moral Development, White – Collar Crime, Individual factors in Business Ethics	9
6	Human Values for Indian Managers, Lessons from Ancient Indian Education system, The law of Karma, Quality of Working life, Ethics of Vivekananda, Gandhiji, Aurobindo and Tagore.	9

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code:3141007

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	20	10	25	20	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Business Ethics by AC Fernando
2. Business Ethics by Ferrell, Fraedrich and Ferrell.
3. Ethics in Management and Indian Ethos by Biswanath Gosh

Course Outcomes: After learning the course the students will able to

Sr. No.	CO statements	Marks %Weightage
CO-1	Awareness of types of ethical challenges and dilemmas confronting members of a range of professions (business, media, police, law, medicine, research)	25
CO-2	Identify and describe relevant theoretical concepts related to professional ethics in engineering	20
CO-3	Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories	20
CO-4	Distinguish among morals, values, ethics, and the law and to explore how they each impact engineering practice	25
CO-5	Apply learning from Indian history and ethos to ethical practices in engineering.	10

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3141706
Semester – IV
Subject Name: Analog Signal Processing

Type of course: Professional Core Course

Prerequisite:

1. Fundamental of Basic electronics
2. Electronics devices like transistor, diode etc.

Rationale: This subject deals with how to process sensor's output and make it suitable for next stage of any measurement system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to OP-AMP:** 1.1 Basic ideas about: Dual input-balanced output differential amplifier, Inverting and non-inverting inputs, Dual input-unbalanced output differential amplifier, Single input-balanced output differential amplifier, Single input-Unbalanced output differential amplifier. 1.2 Basic introduction to block diagram of a typical op-amp, Basic introduction to equivalent circuit of the 741 op-amp, Schematic symbol and 8 pin functions and power supply of op-amp. 1.3 Open loop op-amp configuration, the differential amplifier, the inverting amplifier, the non-inverting amplifier, positive saturation output, negative saturation output. 1.4 Definition and explanation to the terms of op-amp as:- Input offset voltage, Input offset current, Input bias current, Total output offset voltage, Thermal drift, Differential input resistor, Input capacitance, Offset voltage adjustment range, Input voltage range, Common mode rejection ratio, Supply voltage rejection ratio, Output voltage swing, Output resistance, Output short circuit current, Supply current, Slew Rate, Average temperature coefficient of input offset voltage (and current), Long-term input offset voltage(and current). 1.5 :-Basic ideas about compensating network for offset voltages compensation, CMRR compensation, SVRR compensation, Temperature compensation	3

2	**An Op-amp with Negative Feedback (Closed Loop):** 2.1 Introduction, Block diagram representation of feedback configuration 2.2 -Voltage series feedback amplifier (Non-inverting amplifier with feedback), Derivation of closed loop voltage gain, Input resistance with feedback, Output resistance with feedback, Bandwidth with feedback, Total output offset voltage with feedback, Voltage follower. -Voltage shunt feedback amplifier(Inverting amplifier with feedback), Derivation of closed loop voltage gain, Input resistance with feedback, Output resistance with feedback, Bandwidth with feedback, Total output offset voltage with feedback, Current to voltage converter. -Differential amplifier with one op-amp, Voltage gain	**5**
3	**General Linear application:** 3.1 **DC Amplifier:-** - Inverting amplifier, Non-inverting amplifier, Differential amplifier - Inverting amplifier with external offset voltage-compensating network, Non-inverting amplifier with external offset voltage-compensating network, Differential amplifier with external offset voltage compensating network. 3.2 **AC Amplifier:-** - AC inverting Amplifier - AC non-inverting Amplifier 3.3 **The Peaking Amplifier** 3.4 **Summing Scaling and Averaging Amplifier** - Inverting configuration:-Summing amplifier, Scaling amplifier, Averaging amplifier - Non-inverting configuration:- Summing amplifier, Averaging amplifier - Differential configuration:- A subtractor, Summing amplifier 3.5 Voltage to Current Converter with Floating Load 3.6 Voltage to Current Converter with Grounded Load 3.7 Current to Voltage Converter 3.8 **Very High Input Impedance Circuit:-** - DC-coupled voltage follower - AC-coupled voltage follower with input resistance bootstrapped 3.9 **The Integrator**, with its 0db gain frequency (f_b) and gain limiting frequency derivation(f_a), 3.10 **The Differentiator**, with its 0db gain frequency(f_a) and gain limiting frequency derivation(f_b),	**7**
4	**Comparators and Converters:** 4.1 Basic comparator, Zero crossing detector, Schmitt trigger 4.2 Comparator characteristics, Limitation of OP-AMP as comparator 4.3 OP-AMP as voltage limiter:- Positive voltage limiter and Negative voltage limiter 4.4 **CLIPPER:-** - Positive clippers, Negative clippers - Small signal half wave rectifiers 4.5 CLAMPERS:- Positive and negative clampers 4.6 Absolute value output circuit, Peak detector, Sample and hold circuit 4.7 Digital to Analog Converter(DAC):-	**8**

	- D/A converter with binary - weighted resistor - D/A converter with R and 2R resistor 4.8 Analog to Digital Converters (ADC):- - Successive approximation A/D converter 4.9 Voltage to frequency and frequency to voltage converters - V/F Converter:- 1) 9400 V/F converter equivalent circuit, connection diagram, waveforms and its working. 2) V/F Design procedure, 3) Single supply operation - F/V Converter :- 1) 9400 F/V Design procedure 2) Single supply operation	
5	**Active and Passive Filters:** 5.1 Introduction to active and passive filters, Introduction to low pass and high pass filters 5.2 **Low Pass Filters:-** - Passive first order low pass filter with its transfer function, - Active first order low pass Butterworth filter with its transfer function, filter design - Active second order low pass Butterworth filter with transfer function, filter design 5.3 **High pass Filters:-** - Passive first order high pass filter with its transfer function - Active first order high pass Butterworth filter with its transfer function, filter design - Active second order high pass Butterworth filter with transfer function, filter design 5.4 **Higher Order Active Filters** :- Third order and fourth order low pass Butterworth filter 5.5 **Band Pass Filters** :- 1) Wide band Pass filter and 2) Narrow band pass filters 5.6 **Band–Reject Filters** :- 1) Wide band-reject filter and 2) Narrow band-reject filter(Notch Filter) 5.7 All Pass Filter	**6**
6	**OSCILLATORS** 6.1 Introduction to oscillator, Oscillator principles, Oscillator block diagram 6.2 Phase shift oscillator, Wien bridge oscillator, Quadrature oscillator, Square wave generator, Triangular wave generator, Sawtooth wave generator 6.3 Voltage - controlled oscillator NE/SE 566	**5**
7	**Specialized IC Applications:** 7.1 **The 555 Timer:-** - 7.1.1 :- Introduction to 555 timer IC, 555 timer pin connection diagram and block diagram - 555 timer as a monostable multivibrator :- Operation and circuit diagram - Monostable multivibrator applications :- 1) Frequency divider, 2) Pulse stretcher - 555 timer as an astable multivibrator :- Operation and circuit diagram Astable multivibrator applications :- 1) Square wave oscillator, 2) Ramp generator 7.2 **Instrumentation amplifier**	**10**

	- Instrumentation amplifier using three op-amp for resistive transducer and bridge - Instrumentation amplifier for high gain and high input impedance (Text Book 3-page 161) - Instrumentation amplifier using RTD. Circuit design for converting the change in resistance of RTD into 0 to 5 V output with compensation of offset voltages, CMRR, temperature compensation for the range of 30 ˚C to 200 ˚C. 7.3 **Special Purpose amplifiers** - Logarithmic amplifier, Isolation amplifier, Chopped stability amplifier, Programmable gain amplifier, Matching sensor to circuit (Text Book 3- page 139)	
8	**Voltage Regulators** 8.1 Fixed Voltage Regulators (78XX, 79XX series devices) 8.2 Adjustable Voltage Regulators (LM 317 series devices) 8.3 Design of ± 5V and ±15V Regulated Power Supply	**4**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**14**	**7**	**7**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. The Art of Electronics (second edition) by Paul Horowitz and Winfield Hill, Cambridge University Press
2. Op-amps and Linear Integrated Circuits by Ramakant A. Gayakward, Prentice Hall India.
3. Design with operational amplifiers and Analog integrated circuits by Sergio Franco, McGraw Hill
4. Introduction to biomedical equipment technology (fourth edition) by Joseph J Carr and John M. Brown

Course Outcomes:

After learning the course, the students should be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Use basic knowledge of electronics in amplifiers, filters, comparators converters and signal conditioning.	40

CO-2	Analyze and select an appropriate op-amp as per the application.	10
CO-3	Design the amplifier, filters, comparators, converters and signal conditioning circuits using instrumentation amplifier.	40
CO-4	Apply knowledge of voltage regulator ICs for designing of regulated power supply.	10

List of Experiments:

1. To study and perform inverting and non-inverting and differential amplifier using op-amp without feedback.
2. To study and perform offset voltages and its compensation network.
3. To study and perform CMRR configuration and its compensation network.
4. To study the effect of temperature co-efficient and its compensation network
5. To study and perform inverting and non-inverting and differential amplifier using op-amp with feedback.
6. To study and perform summing amplifier and subtractor.
7. To study and perform voltage to current converter with grounded load and with floating load.
8. To study and perform current to voltage converter.
9. To study and perform comparator circuit using op-amp and make PWM wave forms.
10. To study and perform Schmitt trigger circuit using op-amp.
11. To study and perform positive and negative clippers.
12. To study and perform positive and negative clampers.
13. To study and perform the integrator and the differentiator.
14. To study and design first order low pass filter and high pass filter using op-amp.
15. To measure frequency using Wien bridge oscillator.
16. Design and study of monostable, and astable multivibrators using IC555.
17. To study and perform instrumentation amplifier using RTD. Design a Circuit for converting the change in resistance of RTD into 0 to 5 V output with compensation of offset voltages, CMRR and temperature compensation for the range of 30 ˚C to 200 ˚C.

Major Equipment:

741 IC, OP 07, Voltage Regulator IC, NE555 IC, CRO, Function Generator

List of Open Source Software/learning website:

1. http://nptel.ac.in/video.php?subjectId=117103063
2. http://www.learnabout-electronics.org/Amplifiers/amplifiers60.php

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3141708
Semester – IV
Subject Name: Control Theory

Type of course: Professional Core Course

Prerequisite:

1. Calculus
2. Ordinary differential equations
3. Complex variables
4. Linear system concepts
5. Laplace transforms.

Rationale: To prepare students for Basics of Control Engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Control Systems** Introduction Brief History of Automatic Control Examples of Control Systems Engineering Design Control System Design Mechatronic Systems Green Engineering The Future Evolution of Control Systems Design Examples Sequential Design Example*	4
2	**Mathematical Models of Systems** Introduction Differential Equations of Physical Systems Linear Approximations of Physical Systems The Laplace Transform The Transfer Function of Linear Systems Block Diagram Models	6

	Signal-Flow Graph Models Design Examples The Simulation of Systems Using Control Design Software Sequential Design Example*	
3	**State Variable Models** Introduction The State Variables of a Dynamic System The State Differential Equation Signal-Flow Graph and Block Diagram Models Alternative Signal-Flow Graph and Block Diagram Models The Transfer Function from the State Equation The Time Response and the State Transition Matrix Design Examples Analysis of State Variable Models Using Control Design Software Sequential Design Example*	**6**
4	**Feedback Control System Characteristics** Introduction Error Signal Analysis Sensitivity of Control Systems to Parameter Variations Disturbance Signals in a Feedback Control System Control of the Transient Response Steady-State Error The Cost of Feedback Design Examples Control System Characteristics Using Control Design Software Sequential Design Example*	**6**
5	**The Performance of Feedback Control Systems** Introduction Test Input Signals Performance of Second-Order Systems Effects of a Third Pole and a Zero on the Second-Order System Response The S-Plane Root Location and the Transient Response The Steady-State Error of Feedback Control Systems Performance Indices The Simplification of Linear Systems Design Examples System Performance Using Control Design Software Sequential Design Example*	**6**
6	**The Stability of Linear Feedback Systems** The Concept of Stability The Routh-Hurwitz Stability Criterion The Relative Stability of Feedback Control Systems The Stability of State Variable Systems Design Examples	**6**

	System Stability Using Control Design Software Sequential Design Example*	
7	**The Root Locus Method** Introduction The Root Locus Concept The Root Locus Procedure Parameter Design by the Root Locus Method Sensitivity and the Root Locus PID Controllers Negative Gain Root Locus Design Examples The Root Locus Using Control Design Software Sequential Design Example*	**6**
8	**Frequency Response Methods** Introduction Frequency Response Plots Frequency Response Measurements Performance Specifications in the Frequency Domain Log Magnitude and Phase Diagrams Design Examples Frequency Response Methods Using Control Design Software Sequential Design Example*	**6**
9	**Stability in the Frequency Domain** Introduction Mapping Contours in the s-Plane The Nyquist Criterion Relative Stability and the Nyquist Criterion Time-Domain Performance Criteria in the Frequency Domain System Bandwidth The Stability of Control Systems with Time Delays Design Examples PID Controllers in the Frequency Domain Stability in the Frequency Domain Using Control Design Software Sequential Design Example*	**6**

Note: Sequential Design Example* (Tutor/Instructor/Teacher has to select one case study and carry forward same to teach all the topics of syllabus.)

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**14**	**7**	**7**	**-**

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3141708

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Richard C. Dorf & Robert H. Bishop : Modern Control Systems, 13th Edition, Pearson, 2017
2. Norman S. Nise, Control Systems Engineering, Wiley India, Student Edition (Fifth), 2009
3. NAGRATH & GOPAL : Control system engineering, New age International Publication (1996)
4. B.C. KUO : Automatic control systems, Prentice Hall of India Ltd, 1995
5. OGATA KATSUHIKO : Modern Control Engineering, PHI, 1996

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain modeling of electrical, mechanical and electromechanical, process systems	30
CO-2	Analysis of properties of control systems, such as sensitivity, stability, tracking, in time and frequency domains	40
CO-3	Apply differential equations, transfer functions, block diagrams, and state variables in control system design.	30

List of Experiments:

1. The Simulation of Systems and models Using Control Design Software.
2. Analysis of State Variable Models Using Control Design Software
3. Analysis of Control System Characteristics Using Control Design Software
4. Identification of System Performance Using Control Design Software
5. System Stability analysis Using Control Design Software
6. The Root Locus plots and analysis study Using Control Design Software
7. Frequency Response Methods analysis study Using Control Design Software
8. Stability analysis in the Frequency Domain Using Control Design Software
9. Find Unit step, ramp, and impulse response of first and second order system using Control Design Software.
10. Derive the open loop and closed loop poles and zeros for varieties of the systems. Draw their Pole-zero map and check the system stability.

11. Draw the step response of over damped, under damped and critically damped system for the second order system having different value of damping factor.
12. Find out time domain specification of second order system using Control Design Software.

Major Equipment:

MATLAB/SCILAB Control Design Software

List of Open Source Software/learning website:

1. http://nptel.ac.in/video.php?subjectId=108102043
2. http://en.wikibooks.org/wiki/Control_Systems/Root_Locus
3. http://en.wikibooks.org/wiki/Control_Systems/Bode_Plots
4. http://en.wikipedia.org/wiki/Nyquist_stability_criterion

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3141709
Semester – IV
Subject Name: Principle of Measurement Science

Type of course: Basic Science

Prerequisite: There is no prerequisite knowledge required for this course.

Rationale: Industrial Instrumentation is a unique part of industry that deals with the measuring of variables that influence materials production and equipment during the development of a product. Every Instrument engineers have to deal with various types of Instruments in the working environment. This course describes the working principles of these measuring instruments**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**INTRODUCTION OF MEASUREMENTS**: Definition of Instrumentation. -Static Characteristic: Accuracy, Precision, Resolution, Sensitivity, Scale, Threshold, Hysteresis, Drift, Dead Zone, Repeatability, Linearity, etc. - Dynamic Characteristic: Speed of Response, Lag errors, Fidelity, Response of 1st & 2nd order system. - Types of errors etc., - Terminology and Specifications of Instruments, - Measurement Standards: Time, Frequency, Voltage, Current, 3-15 psi etc., ANSI, ASME, ADA, BS, DIN, CSMR, FCI, API, ISI, and Introduction Reliability and safety.	**5**
2	**Transducers:** Classification Electrical Transducer – Resistance, Capacitance, Inductance Type, Piezoelectric, Transduction, etc. Mechanical Transducers, Selection of Transducer	**5**
3	**TEMPERATURE MEASUREMENT**: Types, Selection, Installation, Calibration Temperature measurement using physical parameter -Electrical type temperature sensor-RTD, RTD resistance measurement with Wheatstone Bridge Circuits: two-wire circuit, three-wire circuit, four-wire measurement circuit, RTD resistance measurement with Constant Current Source. -Thermistor -Thermocouples-laws of thermocouple-fabrication of industrial	**10**

	thermocouples-signal conditioning -cold junction compensation-special techniques for measuring high temperature using thermocouples-Radiation methods of temperature measurement	
4	**PRESSURE MEASUREMENT**: Types, Selection, Installation, Calibration , Units of pressure –manometers -different types -elastic type pressure gauges -Bourdon tube bellows-diaphragms -Bell Gauge -Measurement of pressure using Electrical transducer as secondary transducer -vacuum pressure measurement -Mechanical gauges -Mcleod gauge -thermal conductivity gauges-Ionization gauge cold cathode and hot cathode types. Differential pressure measurement -flapper-nozzle assembly. Piston type pressure measurement; Dead Weight Piston Gauges	**10**
5	**LEVEL MEASUREMENT**: Types, Selection, Installation, Calibration, Electrical methods -Resistive, Inductive & Capacitive -Measurement of Level using Gamma rays -Ultrasonic Methods -Measurement of Liquid level using Float type -Displacer type -Air-Purge system, Solid Level measurement -Hydrostatic types. Level Switches.	**10**
6	**FLOW MEASUREMENT**: Types, Selection, Installation, Calibration, Types of flow; Units of flow -volumetric and mass flow; Importance of flow measurement, Mechanical Flow meters: Variable head type flow meters -variable area flow meters, Mass flow meters, Electrical flow meters -EM flow meter -turbine flow meter -Ultrasonic flow meter -Vortex flow meter -Direct and Indirect methods -open-channel & solid flow measurement -Flow Meter Selection and Designs.	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**21**	**7**	**7**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Instrument Engineers' Handbook: Process Measurement and Analysis by B. G Liptak.
2. Handbook of Applied Instrumentation by D. M. Considine and Sidney David Ross, McGraw – Hill Publication.
3. Encyclopedia of Instrumentation and Control by D. M. Considine, Kriege Publication Co.
4. Instrumentation Reference Book by Walt Boyes, Butterworth – Heinemann Publisher.

5. Introduction to Instrumentation and Control by A. K. Ghosh, 4th edition, PHI publications
6. Industrial Instrumentation by K. Krishnaswamy and S. Vijayachitra, New Age International Publication.
7. Measurement Systems: Application and Design by E. D. Doeblin, McGraw – Hill Publication

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain basic concept in measurement of temperature, level, pressure and flow sensors	30
CO-2	Interpret various measurement terms, errors and identify sensor and their relevant specification	35
CO-3	Analyze the performance of Temperature, pressure, level, flow sensor and their relevant application related to industry.	35

List of Experiments:

1. Characterization of Thermocouples.(J/T/K/R/S)
   Equipment: Oven, thermocouples, Multimeter, thermocouple reference table, Thermocouple
2. Characterization of RTD (PT100)
   Equipment: Oven, PT100 probe, RTD simulator, Temperature indicator, Multimeter
3. Measurement of flow using rotameter
   Equipment: Rotameter
4. measurement of flow using DP cell
   Equipment: Differential Pressure Transmitter, or Manometer etc.
5. Flow coefficient of Orifice:
   Orifice installed in a pipe of a liquid fluid, Manometer or DPT.
6. Flow Coefficient of Venturi:
   Venturi installed in a pipe of a liquid fluid, Manometer or DPT.
7. Measurement of Level using Capacitance type of Level Sensor
8. Calibration of pressure gauge using dead weight pressure tester and preparation of report
   Equipment: Dead weight pressure tester setup, Standard weight set.

Major Equipment:

Specified with list of experiments: Dead weight tester, universal calibrator, Temperature bath, Voltage/ current Simulator, RTD/ Thermocouple calibrators, Flow meters, etc.

List of Open Source Software/learning website:

1. http://nptel.ac.in/video.php?subjectId=108105064
2. http://www.onlinevideolecture.com/electrical-engineering/nptel-iit-kharagpur/industrial-instrumentation/?course_id=514
3. https://www.isa.org