Course Code	18EIC207J	Course Name	CONTROL SYSTEMS DESIGN AND ANALYSIS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Introduce the process of designing mathematical models for mechanical and electrical systems*
CLR-2 :	*Know the process of analysis for mathematical models of the designed mechanical and electrical systems.*
CLR-3 :	*Know the method of finding the system stability using time domain methodologies.*
CLR-4 :	*Know the frequency domain methods and use it for analysis purpose.*
CLR-5 :	*Provide the procedure for the design of controllers using conventional control methodologies.*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning: Blooms level (1-6)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design,	5 Modern Tool Usage	6 Society & Culture	7 Environment &	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for	PSO-2 Utilize PLC & DCS for	PSO-3 Effective management
CO-1 :	*Determine mathematical models of systems using various modeling techniques.*	*3*	*3*	-	-	2	-	-	-	-	-	-	-	-	*3*	-	-
CO-2 :	*Analyze a system using time domain specifications.*	*4*	*3*	-	-	2	-	-	-	-	-	-	-	-	*3*		-
CO-3 :	*Examine the stability of systems using time domain approach.*	*3*	*3*	-	-	*1*	-	-	-	-	-	-	-	-	*3*	-	-
CO-4 :	*Analyze a system for its stability using frequency domain specifications.*	*4*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-	-
CO-5 :	*Design different conventional controllers.*	*3*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-	-

Duration (hour)		Transfer Function	Time Domain Analysis	Stability Analysis	Frequency domain analysis	Design of Controllers
		15	15	15	15	15
S-1	**SLO-1**	*Introduction to systems with examples*	*Transfer function of First order system using Step and Ramp*	*Stability analysis using Routh's Hurwitz criterion.*	*Introduction to Frequency domain analysis and its types*	*Introduction to conventional controllers*
	SLO-2	*Open loop and closed loop systems, feedforward and feedback system*	*Transfer function of First order system using Impulse and Parabolic signal.*			
S-2	**SLO-1**	*Mathematical modeling of Mechanical Translational system*	*Transfer function of Second order system Undamped using Step Input.*	*Types of Routh Hurwitz methods*	*Magnitude and phase plots of typical systems using Bode plot and its analysis*	*Design of PI, PD Controllers*
	SLO-2	***Problem Solving – I***	*Transfer function of Second order systemunder damped system using Step Input.*			*Design of PID Controller*
S-3	**SLO-1**	*Mathematical modeling of Mechanical Rotational system*	*Transfer function of Second order system critically damped using Step Input.*	***Problem Solving**- IX*	*Problem Solving - XIV*	*Problem Solving - XIX*
	SLO-2	***Problem Solving – II***	*Transfer function of Second order system over damped system using Step Input.*			
S 4-5	**SLO-1** **SLO-2**	***Lab1:** Introduction to MATLAB*	***Lab 4:**Step, Ramp and Impulse response of first order and second order systems.*	***Lab 7:**Stability analysis of linear systems using pole – zero location of the system*	***Lab10:**Frequency response analysis using Bode Plot.*	***Lab13:**Design of PID Controller for first order and second order systems.*
S-6	**SLO-1**	*Conversions of Mechanical system to Electrical system.*	*Transient response*	***Problem Solving** - X*	*Problem Solving - XV*	*Design of lead, lag compensators*
	SLO-2		*Steady state response.*			
S-7	**SLO-1**	***Problem Solving – III***	*Steady state error analysis*	*Root locus plots of typical systems,*	*Problem Solving - XVI*	*Problem Solving - XX*
	SLO-2		*Static error constant*			

S-8	SLO-1	*Transfer function using Block diagram reduction techniques*	***Problem Solving - VI***	*Root locus analysis*	*Analysis using Polar plots*	*Problem Solving - XXI*
	SLO-2	***Rules for Block Diagram Reduction***				
S 9-10	SLO-1	***Lab 2:*** *Development of m-file programming*	***Lab 5:*** *Identification of damping in second order systems.*	***Lab 8:*** *Stability analysis of linear systems using Root Locus.*	***Lab11:*** *Frequency response analysis using Bode Plot.*	***Lab14:*** *Design of PID Based controller for Twin Rotor Multi Input Multi Output System.*
	SLO-2					
S-11	SLO-1	***Problem Solving – IV***	*Generalized Error Coefficient of control systems.*	***Problem Solving – XI***	*Problem Solving - XVII*	*Problem Solving - XXII*
	SLO-2					
S-12	SLO-1	*Transfer function using signal flow graph*	***Problem Solving - VII***	***Problem Solving – XII***	*Problem Solving - XVIII*	*Design of control system for ball and beam set up*
	SLO-2					
S-13	SLO-1	***Problem Solving – V***	***Problem Solving - VIII***	***Problem Solving - XIII***	*Nyquist Stability criterion*	*Design of control system for Twin Rotor Multi input Multi output System (TRMS) with one degree of freedom*
	SLO-2					
S 14-15	SLO-1	***Lab3:*** *Introduction to Model Based Development of Systems*	***Lab 6:*** *Time domain analysis for second order systems*	***Lab 9:*** *Performance of stability analysis on higher order systems*	***Lab12:*** *Performance of frequency analysis on higher order systems*	***Lab15:*** *A mini project on controller design of real time applications*
	SLO-2					

Learning Resources	1. *Norman S. Nise, Control Systems Engineering, 7th Edition, Wiley, 2014* 2. *D'azzo John J.; Houpis Constantine H.; Sheldon., Linear Control System Analysis and Design with MATLAB, 5th Edition, Taylor & Francis, 2003.* 3. *Farid Golnaraghi, Kuo Benjamin C., Automatic Control Systems, 10th ed., Wiley India Pvt. Ltd, 2017* 4. *Ogata.K, Modern Control Engineering, 5th edition, Pearson, 2015* 5. *Nagrath I.G, Gopal M., Control Systems Engineering, 6th edition multicolour, New Age International Publishers, 2018* 6. *"Control of Twin Rotor MIMO System (TRMS) Using PID Controller", International Journal of Advance Engineering and Research Development, ISSN:2348-6406, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	10 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	20 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	15 %	15 %	15 %	15 %	15 %	15 %	20 %	20 %
Level 4	Analyze	-	-	15 %	15 %	15 %	15 %	15 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Vijayarajeswaran, VI Microsystems Pvt.Ltd, vijay@vimicrosystems.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mr. Arockia Vijay Joseph, SRMIST*
2. S.Vijayakumar, Visteon Technical & Service Centre, svijayku@visteon.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University, fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIC201T	Course Name	ELECTRICAL AND ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	**Co-requisite Courses**	*Nil*	**Progressive Courses**	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Impart basic knowledge on the working of measuring instruments*
CLR-2 :	*Learn the methods of measurement using AC and DC bridges*
CLR-3 :	*Know the functioning and applications of Digital display devices*
CLR-4 :	*Introduce methods to identify the sources of noise in various process measurements*
CLR-5 :	*Impart the skills required to perform the calibration of laboratory instruments*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning**	**Program Outcomes (PO)**														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO 1:	PSO-2:	PSO-3:
		Bloom's level (1-6)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for continuous & discrete systems	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	*Recite the types of instruments and errors occurring in power and energy measurements*	2	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-2 :	*Formulate expression for unknown R, L and C measurement using AC and DC bridges*	2	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-3 :	*Articulate on different display devices and their applications in remote monitoring*	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	*Classify different sources of noise and recommend the remedies to overcome noise in measurement*	4	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-
CO-5 :	*Appraise the importance of calibration and perform the procedure for calibration of laboratory instruments*	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

Duration (hour)		**Electrical measurements**	**Analog measurements**	**Digital display devices**	**Measurement noise & filtering**	**Calibration of Instruments**
		9	**9**	**9**	**9**	**9**
S-1	**SLO-1**	*Introduction: Need for measurement*	*DC* ***bridges – An overview***	*Display devices : General purpose*	*Sources of measurement noise: Inductive coupling, capacitive (electrostatic) coupling*	Introduction
	SLO-2	*Industrial measurement standards*	*Low resistance measurements*	*Digital Storage Oscilloscope (DSO)*	*Noise due to multiple earths*	Metrology and calibration
S-2	**SLO-1**	*Indicating and Integrating Instruments*	*Medium resistance measurements*	*USB Oscilloscope / PC scope*	*Noise in the form of voltage transients*	*Test Uncertainty ratio*
	SLO-2	*Galvanometer and its applications*	*High resistance measurement- Megger*	*Mixed Signal Oscilloscope (MSO)*	*Thermoelectric potentials Shot noise, electrochemical potentials*	*Calibration of practical instruments*
S-3	**SLO-1**	*PMMC instruments principle*	*AC bridges- An overview*	*Mixed Domain Oscilloscope (MDO)*	*Techniques for reducing measurement noise*	*Simplified DMM calibration*
	SLO-2	*Derivation of torque equation*	*Frequency measurement-Wien's bridge*	*Digital Frequency Meter& Digital Voltmeter*	*Location and design of signal wires earthing and Shielding*	*Closed case calibration*
S-4	**SLO-1**	*PMMC as ammeter, voltmeters and ohmmeter*	*Inductance- Hay's, Anderson's, Maxwell's Q factor*	*Power Quality Analyzer*	*Introduction to analogue signal filtering*	*Laboratory Oscilloscope calibration*
	SLO-2	*Extension of ammeter& voltmeter ranges*	*Numerical problems in bridges*	*Programmable Function Generators*	*Passive analogue filters*	*Pulse response and channel bandwidth*
S-5	**SLO-1**	*Shunts & Multipliers*	*Capacitance-Schering's bridge Mutual Inductance Measurement*	*Spectrum Analyzers*	*Active analogue filters*	*Trigger system calibration*
	SLO-2	*Numerical problems*		*Human Machine Interface (HMI)*	*Other analogue signal processing operations*	*Internal triggers*

S-6	SLO-1	*Power measurement in ac and dc circuits*	*Practical DC bridge illustrationwith quasi digital output*	*Data Acquisition System- Modern tools*	*Signal amplification and attenuation*	*External triggers*
	SLO-2	*Construction and working principle of dynamometer Instrument*	*Practical AC bridge illustration with quasi digital output*	*Recording Instruments - principle*	*Differential amplification*	*Frequency triggers*
S-7	SLO-1	*Errors in electrodynamometer instruments*	*Cathode Ray oscilloscope (CRO)*	*Continuous & Discrete type*	*Signal linearization* *Signal integration*	*Calibration of Ammeters*
	SLO-2	*Power in poly phase circuits*	*Signal and function generators*	*Remote recording – current techniques*	*Voltage follower*	*Calibration of Voltmeters*
S-8	SLO-1	*Measurement of Energy*	*Pattern generator, sweep generator*	*Remote transmission – current techniques*	*Voltage comparator*	*Calibration standards, Intervals, Recommendations*
	SLO-2	*Induction type and digital type energy meters*	*AC & DC potentiometers*	*IoT based data recording and transmission*	*Phase-sensitive detector*	*Dynamic testing*
S-9	SLO-1	*Testing of energy meters - Phantom loading*	Instrument transformers	*Requirements and challenges*	*Lock-in amplifier*	*Case studies/Demo/Video lectures*
	SLO-2	*Numerical problems*	*Shielding & Grounding*	*Case studies*	*Signal addition & Signal multiplication*	

Learning Resources	1. *Ernst O.Doeblin and Dinesh Manik,Measurements systems, Mc Graw Hill series, 7th edition, 2019* 2. *Golding. E. W, and Widdis F.C, Electrical Measurements and Measuring Instruments, 5th edition, A.H. Wheeler & Company, 2003* 3. *Albert Helfrick and William Cooper, Modern Electronic Instrumentation & Measurements Techniques, Pearson Education, 3rd edition,2015*	*4. Liptak B G, Process Measurement Analysis, Volume 1, Instrument Engineer's Handbook, Chilton, 4th Edition, 2005.* *5. Nihal Kularatna, Digital and Analogue Instrumentation –Testing and measurement, IET publications, Reprint edition, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	20%	-	20%	-	20%	-
Level 2	Understand	60%	-	20%	-	20%	-	20%	-	20%	-
Level 3	Apply	-	-	30%	-	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	30%	-	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-		-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr.Vijayarajeswaran, MD, Vi Micro Systems Pvt. Ltd.,vijay@vimicrosystems.com	*1. Dr. J. Prakash, Professor, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Dr.R.Bakiya lakshmi, SRMIST***
2. Mr.Neelakandan mani Senior Director, CTS, pymani2010@yahoo.com	*2. Dr.Fawaz Mofdi, Damascus University,Syria, university.fawwazm@gmail.com*	*2. **Dr. A. Vimala Juliet, SRMIST***

Course Code	18EIC202J	Course Name	DIGITAL PRINCIPLES AND SYSTEM DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Instrumentation Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Know the basics of digital systems*
CLR-2 :	*Understand the process of design in combinational logic circuits*
CLR-3 :	*Impart the skills to design synchronous and Asynchronous sequential logic circuits*
CLR-4 :	*Provide and design different logic functions using transistor and MOSFET*
CLR-5 :	*Introduce the digital application with logical circuits*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning: Blooms level (1-6)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for continuous & discrete	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	*Summarize the Boolean expression in digital system*	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	*Apply combinational logic circuits for analyzing logic gate.*	3	-	2	-		-	-	-	-	-	-	-	-	2	-	-
CO-3 :	*Solve synchronous and asynchronous circuit using logic gate.*	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	*Design digital circuits for various applications.*	4	2	-	2	-	-	-	-	-	-	-	-	-		2	-
CO-5 :	*Develop digital circuit using PLA, PAL, PROM.*	4	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		***Introduction to digital design***	***Combinational circuit design***	***Synchronous and Asynchronous Sequential circuit***	***Digital Application***	***Digital computing design***
		9	***9***	***9***	***9***	***9***
S-1	**SLO-1**	*Identify digital IC and some common packages.*	*Design of Binary multiplier*	*Introduction to latches/ flip flop*	*Introduction to game control circuits*	*Memory organization and operation*
	SLO-2	*Classify digital IC according to their complexity*	*Design of Binary divider*	*Types of Flip Flop : SR D type, JK and T flip flop (Characteristic table and equation)*	*Gate circuits used in gaming circuits.*	*Classification of memories ROM, PROM, EPROM, RAM*
S-2	**SLO-1**	*Identify pin numbers on various types of IC packages.*	*Arithmetic logic unit (ALU)*	*Realization of one flip flop using other flip flops: JK,SR,T,D flip flop.*	*Combinational circuit: Odd prime number detector.*	*Content addressable memory, Charge decoupled device memory*
	SLO-2	*Timing diagram and its purpose*	*Elementary ALU design*	*Introduction to synchronous sequential circuit.*	*Introduction to elevator Control System.*	*Commonly used memory chips*
S-3	**SLO-1**	*Minterm, Canonical SOP form, Maxterms, Canonical POS form*	*Multiplexer*	*Steps involved in design of synchronous sequential circuits.*	*Elevator State Diagram, State Table, State input.*	*Programmable Logic Array(PLA)*
	SLO-2	*Simplification of switching function using K maps-POS method- SOP method*	*maps-POS method Implementation of Boolean expression using multiplexer*	*Problems in design of synchronous sequential circuit .*	*State Machine and Output Signals, Input Latches*	*Implementation of Boolean function using PLA*
S-4-5	**SLO-1**	*Lab 1: Simplification of switching function using K maps and implementation using logic gates*	*Lab 4: Realization of MUX, Realization of Boolean expression using MUX*	*Lab 7: Realization of one flip flop using another flip flop*	*Lab 10: Design and implementation of Hazard free circuit*	*Lab 13: Realize Boolean algebra using PLA*
	SLO-2					
S-6	**SLO-1**	*Quine-McCluskey method for 4 variable problem*	*Demultiplexer*	*Introduction to asynchronous sequential circuit*	*Introduction to traffic Signal Control System:*	*Programmable Array Logic (PAL)*
	SLO-2	*Quine-McCluskey method for4 variable problem with Don't care*	*Implementation of Boolean expression using demultiplexer*	*Step involved in design of asynchronous sequential circuit*	*Switching of Traffic Lights, state inputs and State output*	*Implementation of Boolean function using PAL*

S-7	SLO-1	Quine-McCluskey method for 5 variable problem	Decoders	Problems in design of asynchronous sequential circuit including races	Event detector circuit	Complex programmable logic device (CPLD)
	SLO-2	Quine-McCluskey method for 5 variable problem with Don't care	BCD to 7 segment decoders.	State diagram, state reduction	Seven segment display decoder	Introduction to VHDL programming
S-8	SLO-1	Adder: Half adder, Full adder	drivers for display devices	state assignment, state minimization	Fire place control circuits	VHDL design flow
	SLO-2	Subtractor: Half subtractor, Full subtractor	Encoder and Priority encoder	Critical and non-critical Races, Hazards.	Digital logic families: Characteristics of Digital logic families.	VHDL types and operators
S-9-10	SLO-1 SLO-2	Lab 2: Realization of combinational circuits: Half adder, Full adder, Half subtractor, Full subtractor	Lab 5: Design of BCD to 7 segment decoder	Lab 8: Design and implementation of synchronous sequential circuits	Lab 11: Design of asynchronous Counters	Lab 14: Verification of gates using simulation
S-11	SLO-1	Adder: Half adder, Full adder	Parity generator and Parity checker	Excitation table	TTL Logic, Schottky TTL Logic	Structural and Behavioral Modelling
	SLO-2	Parallel binary adder and parallel binary subtractor	Design of Code Converter: Binary to Grey	Counters, Up/Down counters	CMOS Logic	Data flow Modelling
S-12	SLO-1	Parallel adder/subtractor	Design of Code Converter: Grey to Binary	Modulo-n counter	ECL logic	Packages, subroutines
	SLO-2	Carry look ahead adder, BCD adder	Design of Code Converter: BCD to Excess 3	Johnson counter	Interfacing CMOS with TTL	Test bench
S-13	SLO-1	Timing diagram for logic circuits	Design of Code Converter: Excess 3 to BCD	Shift registers	Tristate logic	Simple VHDL program: Combinational logic circuits
	SLO-2	Magnitude Comparator for 1,2-bit Comparator	Introduction to HDL (Hardware Description Language)	serial in serial out and Parallel in parallel out	Comparison between various logic circuits	Simple VHDL program: counters
S-14-15	SLO-1 SLO-2	Lab 3: Realization of BCD adder and 2-bit Magnitude Comparator	Lab 6: Realization of Code Converters	Lab 9: Design and implementation of asynchronous sequential circuits	Lab 12: Mini Project Presentation: Realization of digital control circuits	Lab 15: Verification of Combinational logic circuits VHDL

Learning Resources	1.M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog, 6th edition, Pearson, 2018 2.Thomas L.Floyd, Digital Fundamentals, 11th edition, Pearson India, 2014	3.Charles H. Roth, Lizy K. John, Digital System Design Using VHDL, 2nd edition, Cengage learning, 2012 4. NPTEL video Lecture series on , "Digital circuits and Systems", by Prof. S.Srinivisan, IIT Madras.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	10 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	20 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	30 %	30 %	20 %	20 %	20 %	15 %	20 %	20 %
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. Neelakandan Mani, Senor Director, CTS, pymani2010@yahoo.com	**1.** Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com	1. Mrs.K.Vibha SRMIST, vibhak@srmist.edu.in
2. Mr. Vijayarajeswaran, Managing Director, VI Micro Pvt.Ltd, vijay@vimicrosystems.com	2. Dr. Mohamed Khaled Chahine, Associate Professor, Yarmouk Private University, Damascus Syria, mkchahine@gmail.com	2. Dr. A. Vimala Juliet, SRMIST,hod.eie@srmist.edu.in

Course Code	18EIC203J	Course Name	INSTRUMENT TRANSDUCERS	Course Category	C	Professional Core	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the methods of measurement & know about various types of errors in instruments
CLR-2 :	Understand the behavior of transducers under static and dynamic conditions and to model the transducers
CLR-3 :	Import knowledge on the principles and application of resistive transducer
CLR-4 :	Understand the principles and application of inductive and capacitive transducers
CLR-5 :	Introduce emerging trends in transducers
CLR-6 :	Understand the different type of sensors used in real life applications and paraphrase their importance

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning: Blooms level (1-6)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO 1 Automatic control for continuous& discrete systems	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	discuss various types of errors in instruments	2	2	-	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-2 :	Solve a mathematical model for a given system and estimate the response	3	2	2	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-3 :	Model a method for any applications to measure resistance.	3	2	-	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-4 :	Illustrate a method to measure inductance & capacitance for any applications	3	2	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO-5 :	Classify transducers based on its application like (MEMS, fiber optics, etc.,)	4	2	2	-	--	-	-	-	-	-	-	-	-	2	3	-
CO-6 :	Design any transducers for any industry applications	6	2	-	2	-	-	-	-	-	-	-	-	-	3	3	-

		Science of Measurement	Characteristics of Transducers	Variable Resistance Transducers	Variable Inductance and Variable Capacitance	**Miscellaneous Transducers**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	**SLO-1**	*General configuration and description of measuring Instruments*	*General input-output configuration*	*Basic principle-Potentiometer-Loading effect*	*Principles of operation, construction details*	*Piezoelectric transducer*
	SLO-2	*Basic methods of measurement*	*Selection & classification of transducers– based on physical effect, physical quantity*	*Resolution-Linearity of potentiometers*	*Inductive sensor: common types- brief discussion with respect to material, construction and input output variable*	*Hall effect transducer, Analog & Digital Hall Effect sensor*
S-2	**SLO-1**	*Functional Elements of Measurement Systems*	*Characteristics of instruments : Static characteristics: Accuracy, precision, resolution, sensitivity*	*Resistance strain gauge*	*Magnetostrictive type& Reluctance change type*	*Magneto elastic sensor*
	SLO-2	*Definition, principles of sensing and transduction*	*Characteristics of instruments : linearity, span and range, threshold, Hysteresis, Dead Time*	*Bonded type-Unbonded type strain gauge-Filament construction-*	*Mutual inductance change type,* ***Transformer Type***	*Digital transducers*
S-3	**SLO-1**	***Lab1: Identifying the components of measuring instruments.***	***Lab 4: Characteristics of RTD***	*Lab 7: Loading effect of potentiometer*	***Lab 10: Characteristics of LVDT***	***Lab13: Characteristics of Hall effect transducer, photovoltaic , LDR***
	SLO-2					
S-4	**SLO-1**					
	SLO-2					

S-5	**SLO-1**	*Units and Standards*	*Dynamic characteristics – Mathematical model of transducer*	*Material of the filament wire-Base carrier material-*	*struction,material, output input relationship, I/O curve, discussion.*	*Fiber optic sensors , IC sensor.*
	SLO-2	*Error: Classification of errors, Limiting error and probable error*	*Zero, first and second order transducers*	*strain gauge cement-Lead wire connection*	*RVDT : Construction, material*	*Photo emissive cell types, Light Dependent Resistor*
S-6	**SLO-1**	*Static analysis of random error*	*Response to impulse, step inputs*	*Resistance Thermometers- Introduction-*	*Synchros, Microsyn*	*Photovoltaic cells, Photodiodes*
	SLO-2	*Error analysis– Statistical methods*	*Response to ramp and sinusoidal inputs*	*Construction Details of Resistance thermometer-RTD Circuits*	*magneto-strictive transducers, proximity sensors*	*MEMS & NEMS sensors*
S-7	**SLO-1**	***Lab2:Determining the transfer function of a first order transducer***	*Lab5:Dynamic characteristics of Thermistor*	*Lab 8: Determination of gage factor*	***Lab 11: Characteristics of Synchros***	***Lab14 : Displacement measurement using LABVIEW and DAQ Hardware***
	SLO-2					
S-8	**SLO-1**					
	SLO-2					
S-9	SLO-1	*Problems in Statistical methods- mean, median mode, variance*	*Example for zero order system*	*Causes for Self Heating error and its mathematical expression*	*Capacitive Transducers: Principle of operation, construction details and characteristics Variable distance- parallel plate type*	*Biosensors, SMART*
	SLO-2	*Problems in Statistical methods- standard deviation, probable error of one reading*	*Principle of operation of thermistor*	*Advantages of wire resistance Thermometers*	*Variable area- parallel plate, cylindrical type, variable dielectric constant type*	***Displacement measurement using LABVIEW and DAQ Hardware***
S-10	SLO-1	*Classification of standards*	*Practical example for first order system*	*Sensitivity analysis of strain gauge bridges*	*Capacitive Transducers: calculation of sensitivity. Stretched diaphragm type*	*Fundamentals of Fiber optic sensors and its Applications*
	SLO-2	*Standards of calibration*	*Practical example for second order system*	*Compare quarter, half and full bridges using strain gages*	*Capacitor Microphone, response characteristics*	*Film sensors*
S-11	SLO-1	***Lab3:** Statistical Error analysis- Mean, SD, variance for an open loop response of thermocouple*	*Lab6:Demonstration of the dynamic characteristics of second order system.*	*Lab 9: Experiment on quarter, half and full bridges*	***Lab 12: Characteristics of capacitive transducer***	***Lab 15:A mini project on MEMS / Nano/ smart/fibre optics sensor using any software / fabrication***
S-12	SLO-2					

Learning Resources	1. Doeblin, E.O., "Measurement Systems: Applications and Design", 6th Edition, Tata McGraw-Hill Book Co., 2011. 2. Bentley, J. P., "Principles of Measurement Systems", 4th Edition, Addison Wesley Longman Ltd., UK, 2004. 3. Patranabis, D., "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd, 2010. 4. Murthy, D.V.S., "Transducers and Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.	5. LabVIEW user manual, National Instruments, April 2008 edition 6. Neubert H.K.P., "Instrument Transducers – An Introduction to their Performance and Design", Oxford University Press, Cambridge, 2003. 7. Murty D.V.S, ―Transducers and Instrumentation‖, Prentice-Hall of India Private Limited, New Delhi, Second Edition 2009. 8. Srinivasan A V, Michael D , Mc Farland, ―Smart Structures: Analysis and Design,― Cambridge University Press, 2001

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	20 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	30 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	-	30 %	30 %	20 %	20 %	20 %	15 %	20 %	20 %
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controls of Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	**Dr. A. Vimala Juliet, SRMIST**

2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	**Mrs. N. Deepa**, SRMIST

Course Code	18EIC204J	**Course Name**	ELECTRONICS FOR ANALOG SIGNAL PROCESSING	**Course Category**	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses		**Co-requisite Courses**		**Progressive Courses**	*Nil*
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Study the operation and design of BJT amplifier circuits for a given specification*
CLR-2 :	*Understand the operation of MOSFET amplifier circuits*
CLR-3 :	*Know the effects of feedback on amplifier circuits, and oscillator circuits*
CLR-4 :	*Understand the operation of power amplifier circuits.*
CLR-5 :	*Impart the knowledge on BJT and MOSFET current sources.*
CLR-6 :	*Gain hands-on experience to put theoretical concepts learned in the course to practice.*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning** Blooms level (1-6)	**Program Outcomes (PO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO1 Automatic control for continuous & discrete	PSO2 Utilize PLC & DCS for control of systems	PSO3 Effective management skills
CO-1:	*Summarize the bipolar amplifier circuits and its frequency response*	*2*	2	*1*	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	*Analyze the MOSFET amplifier circuits and its frequency response*	*4*	2	*1*	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-3:	*Apply the characteristics of feedback amplifier circuits.*	*3*	2	*1*	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-4:	*Illustrate the condition for oscillation and types of oscillator circuits*	*3*	2	*1*	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-5:	*Determine the basic circuit building blocks that are used in the IC amplifiers*	*3*	2	-	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-6:	*Design analog electronic circuits using discrete components, compare experimental and theoretical results.*	*6*	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		**BJT Amplifiers**	**FET Amplifiers**	Multistage and feedback amplifiers	**Oscillators & Power Amplifiers**	**IC Biasing & Amplifiers with Active Load**
		15	**15**	**15**	**15**	**15**
S-1	**SLO-1**	***Overview of DC analysis of BJT circuits***	***Overview of FET DC circuit analysis***	Multistage amplifier: Coupling schemes for cascading amplifier	*Oscillators: Classification*	*BJT current sources: Cascode current source, Widlar current source*
	SLO-2	***Overview of BJT models***	***Problem solving***	General analysis of N-stage cascaded amplifier	*Condition for oscillation*	*Multi-transistor current source Problem solving*
S-2	**SLO-1**	***AC load line analysis***	***Graphical analysis, load lines, and small-signal models***	Darlington pair	*RC oscillators*	*FET current sources: 2-transistor MOSFET current source*
	SLO-2	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***
S-3	**SLO-1**	***AC analysis of Common-Emitter BJT amplifier config. using hybrid-π model***	***AC analysis of Common-Source MOSFET amplifier configuration***	Cascade amplifiers	*RC phase shift*	*FET current sources: Cascade current mirror and Wilson current mirror*
	SLO-2	**Problem solving**	**Problem solving**	*Bootstrap amplifiers*	**Problem solving**	**Problem solving**
S 4-5	**SLO-1** **SLO-2**	**Lab 1: Learning to design amplifier and oscillator circuits**	**Lab 4: Determination of characteristics of UJT and application as a relaxation oscillator**	**Lab 7: Design and analyze RC oscillators**	**Lab 10: BJT & FET Current Sources**	**Lab 13: Design and analyze differential amplifier with active load**
S-6	**SLO-1**	**AC analysis of Common-Base BJT amplifier configuration using hybrid-π model**	**AC analysis of Common-Gate MOSFET amplifier configuration**	*Feedback amplifier: Advantages of negative feedback*	Wien Bridge oscillators	**Analysis of CE BJT amplifier circuit with active load**
	SLO-2	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***

S-7	SLO-1	***AC analysis of Common-Collector BJT amplifier config. using hybrid-π model***	***AC analysis of Common-Drain MOSFET amplifier configuration***	*Mixing and Sampling networks*	*Resonant frequency oscillators*	***Analysis of CS FET amplifier circuit with active load***
	SLO-2	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***
S-8	SLO-1	***Multi-stage amplifier configurations: CE - CE, CE - CC amplifiers***	***BJFET amplifier configuration***	*Types and effects, Voltage- Series,.*	*Hartley, Colpitts*	***DC and small-signal analysis of basic BJT differential pairs***
	SLO-2	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***	***Problem solving***
S 9-10	SLO-1 SLO-2	***Lab 2: Determination of the frequency response of CE and CS amplifiers***	*Lab 5: Design and verification of voltage divider bias for BJT and FET circuits for a given operating point.*	***Lab 8: Design and analyze LC oscillators***	***Lab 11:*** *Design and analyze negative feedback amplifier configurations*	***Lab 14: Model Practical Examination***
S-11	SLO-1	*Multi-stage amplifier configurations: CE - CB, and CC - CC amplifiers*	*Low Frequency response analysis of a basic FET CS amplifier*	*Voltage-Shunt,*	*crystal oscillators*	***DC and small-signal analysis of basic FET differential pairs***
	SLO-2	*Problem solving*	*Problem Solving*	*Current-Series*	*Power amplifiers: Class A, Class B*	***Problem solving***
S-12	SLO-1	*Low Frequency response analysis of a basic BJT CE amplifier*	*High Frequency response analysis of a basic FET CS amplifier*	*Current-Shunt amplifier circuits.*	*Class AB amplifiers*	***Analysis of BJT differential amplifier with active load***
	SLO-2	*Problem Solving*	*Problem Solving*	***Problem solving***	***Problem solving***	***Problem solving***
S-13	SLO-1	*High Frequency response analysis of a basic BJT CE amplifier*	*Design problems in MOSFET amplifier configurations*	*Introduction to Tuned Amplifiers*	*Efficiency - Distortion in power amplifiers*	***Analysis of FET differential amplifier with active load***
	SLO-2	*Problem Solving*	*Operational voltage levels*	*Types of tuned amplifiers*		***Problem solving***
S 14-15	SLO-1 SLO-2	***Lab 3: Design and verification of cascaded CE amplifier***	***Lab 6: Design and analyze MOSFET amplifier configurations***	*Lab 9: Classes of power amplifier (efficiency calculation)*	*Lab 12: Design and analyze FET CS amplifier with active load*	*Lab 15: End Semester Practical Examination*

Learning Resources	1. ***David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015*** 2. ***Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011*** 3. ***Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010*** 4. ***Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014***	5. ***Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013*** 6. ***Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill, 2015***

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	10 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	20 %	20 %	20 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	20 %	20 %	20 %	20 %	20 %	15 %	20 %	20 %
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	***1.J. Sam Jeba Kumar***
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	***2. Dr. A. Vimala Juliet***

Course Code	18EIC205T	Course Name	Signals, Systems and Communication	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Study the basic knowledge about the signals and systems
CLR-2 :	Understand the properties of Continuous time signal
CLR-3 :	Understand the properties of Discrete time signal
CLR-4 :	Gain knowledge on analog and digital communication and the effect of noise
CLR-5 :	Impart the knowledge on various wired and wireless communication and IoT

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning: Blooms level (1-6)	Program Outcomes (PO): 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for continuous & discrete systems	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	Explain the types of signals and systems	2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	Apply the concepts of continuous time signals	3	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Illustrate the properties of discrete time signals	4	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4 :	Infer the principles of analog and digital communication.	4	3	-	-	2		-	-	-	-	-	-	-	-	-	-
CO-5 :	Interpret the principles of various communications used in Instrumentation industries.	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		CLASSIFICATION OF SIGNALS AND SYSTEMS	CONTINUOUS TIME SIGNALS	DISCRETE TIME SIGNALS	COMMUNICATION SYSTEM	COMMUNICATION TECHNOLOGIES FOR INSTRUMENTATION
		9	9	9	9	9
S-1	SLO-1	**Standard signals- Step, Ramp**	**Fourier series analysis**	Baseband Sampling of CT signals	Analog communication	Various types of communication technologies
	SLO-2	**Pulse, Impulse**	**Problems-II**	Aliasing and Problems	Modulation	Applications in Instrumentation and control industries
S-2	SLO-1	Real and complex exponentials	**Spectrum of Continuous Time (CT) signals**	Reconstruction of CT signal from DT signal	Amplitude modulation and its generation	Serial communications
	SLO-2	**Sinusoids and properties**	**Demonstration using Software tools - I**	**Demonstration using Software tools -IV**	**Demonstration using Software tools -VI**	**Recommended Standards**
S-3	SLO-1	**Classification of signals – Continuous time (CT)**	Laplace Transforms and its properties in signal analysis	Fourier analysis of discrete time signals	Frequency modulation and its generation	Bidirectional communication
	SLO-2	**Discrete Time (DT) signals, Sampling**	Problems – III	Problems-V	**Demonstration using Software tools -VII**	Synchronous and asynchronous

S-4	SLO-1	*Periodic & Aperiodic signal*	*Z Transform and its properties in signal analysis*	*Duality and Parseval's Theorem*	*Effect of noise*	*Local area networks*
	SLO-2	*Deterministic & Random signals*	*Z Transform Examples*	*Problems-VI*	*Estimation of noise in analog communication*	*Ethernet Standard*
S-5	SLO-1	*Energy & Power signals*	*Fourier Transform and its properties in signal analysis*	*Discrete time Fourier Transform: Properties*	*Digital communications*	*Wireless networking*
	SLO-2	***Demonstration using Software tools - I***	*Fourier Analysis Examples*	*Relation between DTFT and Z-transform*	*vector and waveform channels*	*Zigbee*
S-6	SLO-1	***Introduction to systems***	***Differential Equation***	*Inverse DTFT*	*Introduction to Pulse Modulation*	*GSM, CDMA*
	SLO-2	*Continuous Time systems*	*Problems-IV*	*Frequency shift and circular convolution*	*PAM, PWM, PPM, PTM* ***Demonstration using Software tools -VIII***	*Bluetooth, LTE*
S-7	SLO-1	*Discrete Time systems*	*Block diagram representation and* ***impulse response***	*Fourier analysis of Discrete time signals*	*Multiplexing : TDM*	*Introduction to IoT architecture*
	SLO-2	*Linear & Nonlinear,* ***Time-variant & Time-invariant***	*System response*	*Problems-VII*	*FDM*	*Concepts and Technologies*
S-8	SLO-1	***Causal & Non-causal, Stable & Unstable***	*Convolution sum*	*DTFT of Cosine and Unit step signals*	*Quantization*	*IoT Communication Protocols*
	SLO-2	***Demonstration using Software tools - II***	*Problems – V*	***Demonstration using Software tools -V***	*Coding :PCM*	*application in Instrumentation*
S-9	SLO-1	*Practical examples - I*	*Practical examples – II*	*DFS Analysis of Discrete time signals*	*Transmitters and Receivers – General overview*	*Market survey comparison, features (Assignment)*
	SLO-2	*Problems - I*	***Demonstration using Software tools -III***	*Problems-VIII*	*Practical examples - III*	*Practical examples-IV*

Learning Resources	*1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, ―Signals and Systems, Pearson, IndianReprint, 2015.* *2. Signals Systems and Communication B P LathiPublished by BS Publication, Hyderabad (2008)* *3. Haykins. S, "Communication Systems", 4th Edition, John Wiley Inc., 2000.*	*4. K. Daniel Wong, "Fundamentals of Wireless Communication Engineering Technologies" John Wiley, 2012.* *5. NPTEL Course on Signals and system* *6. Perry Lea Internet of Things for Architects January 2018, Packt Publishing*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 2	Understand	60 %	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	-	-	30 %	-	30 %	-	30 %	-	30 %	-
Level 4	Analyze	-	-	30 %	-	30 %	-	30 %	-	30 %	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Vijayarajeswaran, VI Microsystems Pvt.Ltd, vijay@vimicrosystems.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1.* ***Dr.P.A.Sridhar****, SRMIST*
2. Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University, fawwazm@gmail.com*	*2. Dr Joselin Retna Kumar, SRMIST*

Course Code	18EIC206J	Course Name	ANALOG INTEGRATED CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the basics of operational amplifiers, their characteristics and their configurations.*
CLR-2 :	*Introduce the data sheet specifications of a given analog IC*
CLR-3 :	*Impart knowledge about the concepts and applications of timer, PLL, ADC and DAC*
CLR-4 :	*Understand the internal operation of given integrated circuits.*
CLR-5 :	*Understand the design aspects of signal conditioning circuits using operational amplifiers.*
CLR-6 :	*Impart the design aspects of multi-vibrator circuits using OPAMP / Timer for switching*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Learning: Blooms level (1-6)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for continuous& discrete systems	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	*Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques*	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	*Apply the knowledge of analog IC's to understand the operation of a given electronic circuit involving IC's*	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	*Analyze and design the linear and non-linear applications of an Op-Amp and special application IC's*	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	*Design and Analyze an electronic circuit involving IC's and evaluate its output*	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	*Compare and Infer the performance of IC based circuits with discrete component circuits for the appropriate applications*	4	2	2	-	--	-	-	-	-	-	-	-	-	2	-	-
CO-6 :	*Illustrate and discriminate the various functional applications of specific ICs ,such as Voltage regulators, PLL*	6	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		***Negative feedback systems/Introduction to Op-Amp***	***Applications of operational amplifier***	***Timer and phase locked loop***	***Analog to digital and digital to analog converters***	***Special function IC's***
		15	**15**	**15**	**15**	**15**
S-1	SLO-1	*Concept of the Op-Amp for realizing negative feedback circuits*	*Design of Differentiator using Op-Amp*	*Timer IC: Description of Functional Diagram*	*Analog switches:, – ADC ICs,*	*Analog multiplier:*
	SLO-2	*Realizing a multi stage opamp-frequency compensation-miller Op-Amp*	*Design of an Integrator using Op-Amp*	*Monostable operation*	*Market survey of ADC AND DAC*	*Single quadrant multipliers*
S-2	SLO-1	*Differential amplifier*	*Op-Amp-Ideal circuits*	*Astable operation*	*Sample and hold circuit and IC*	*Double quadrant multipliers*
	SLO-2	*Frequency compensation techniques*	*Op-Amp practical circuits*	*Schmitt Trigger*	*DAC principle, Resolution, Range – Types*	*Operational trans-conductance amplifier*
S-3	SLO-1	*Market Survey of the Op-Amp*	*V to I converters*	*PLL-Basic Principles*	*Weighted Resistor DAC*	*Power amplifier*
	SLO-2	*Analysis of Data sheets of an Op-Amp*	*I to V converters*	*Phase Detector/Comparator*	*R-2R DAC*	*Audio and video amplifiers*
S 4-5	SLO-1 SLO-2	*Lab1: Introduction to Simulators*	*Lab 4:Design and Testing of differentiator and Integrator*	*Lab 7: Design and Testing of Schmitt Trigger using op-amp.*	*Lab 10: Design and Testing of Astable using NE555 Timer.*	*Lab 13: Design and Testing of Monostable multivibrators using NE555 Timer*
S-6	SLO-1	*Differential mode and common mode equivalent circuits*	*Instrumentation amplifier circuit analysis*	*Voltage Controlled Oscillator (VCO)*	*Inverted R-2R DAC*	*Linear voltage regulator*
	SLO-2	*Single-endedoutput*	*Instrumentation amplifier available IC'S*	*Low Pass Filters*	*Multiplying DAC'S*	*Series Op-Amp Regulator*
S-7	SLO-1	*Double-ended output*	*Design of Low pass filters*	*Monolithic Phase –Locked Loop*	*Monolithic DAC'S*	*IC Voltage Regulators*

	SLO-2	*CMRR*	*Design of High Pass Filters*	*Applications: PLL based Synthesizer*	*A-D Converters Principle*	*Fixed Regulator used as Adjustable Regulator*
S-8	SLO-1	*Op-Amp: Internal blocks*	*Design of Band pass filters*	*Frequency Multiplication/Division AM Detection FM Demodulation*	*Direct Type-The Parallel Comparator A/D Converter*	*723 General Purpose Regulator*
	SLO-2	*Ideal characteristics of an Op-Amp*	*Design of Band reject filters*	*Quadrature and Biphasic Oscillators*	*Counter Type A/D Converter*	*Current Limit protection*
S 9-10	SLO-1 SLO-2	*Lab 2: Designing and Testing of differential amplifiers.*	*Lab 5: Design and Testing of Active Filters*	*Lab 8: Design and Testing of Phase shift oscillators using Op-amp.*	*Lab 11: Design and Testing of R-2R Ladder Type D- A Converter using Op-amp.*	*Lab 14: Design and Testing of PLL characteristics and its use as Frequency Multiplier*
S-11	SLO-1	*AC characteristics of non-ideal Op-Amp*	*Comparator*	*Oscillators-Basic Principle of sine wave Oscillators*	*Servo Tracking A/D Converter*	*Switched regulator*
	SLO-2	*DC characteristics of non-ideal Op-Amp*	*Schmitt trigger*	*Wien Bridge Oscillator*	*Successive Approximation Converter*	*Buck, Boost regulators*
S-12	SLO-1	*Inverting Op-Amp configurations*	*Multi-vibrators-Astable Multivibrator*	*RC-Phase shift Oscillator*	*Integrating Type of ADCs*	*Buck/boost regulators*
	SLO-2	*Non-inverting Op-Amp configurations,*	*MonoStable Vibrator, Bistable Multivibrator*	*Quadrature and Biphasic Oscillators*	*Charge Balancing ADC*	*Switched capacitor filter*
S-13	SLO-1	*Designing Summing amplifiers*	*Triangular wave generator, Sine wave generator*		*Dual Slope ADC*	*Isolation amplifier*
	SLO-2	*Designing Difference amplifiers*	*.Function generator - Clipper and Clamper, Log and Antilog amplifiers.*	*Generation of FM signal, Demodulation of AM, FM and FSK signals.*	*DAC/ADC Specifications*	*Opto-coupler*
S 14-15	SLO-1 SLO-2	*Lab 3: Designing and Testing of Inverting, Non inverting amplifier*	*Lab 6: Design and Testing of Multi Vibrators*	*Lab 9: Design and Testing of Wien bridge oscillators using Op-amp*	*Lab 12: Design and Testing A-D Converter using Op-amp.*	*Lab 15: **A mini project***

Learning Resources	*1. Ramakant Gayakwad, "Op-amps and Linear Integrated Circuits", 4th Edition, Prentice Hall, 2000* *2. Robert, F., Coughlin, Frederick F., Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 5th Edition, Prentice Hall, 1998. 57* *3. Sergio Franco, "Design with Operational Amplifiers and Linear Integrated Circuits", 3rd Edition, Tata McGraw-Hill, 2002.* *4. Paul R. Gray, "Analysis and Design of Analog Integrated Circuits", 5th Edition, Wiley, 2010..*	*5.Roy Choudhry, D. and Shail B. Jain, "Linear Integrated Circuits", 2nd Edition, New Age International, 2003.* *6.NPTEL video lectures series on "Electronics for Analog Signal Processing II" by Prof. K.R.K. Rao, IITM* *7.NPTEL video lecture series on "Analog Integrated Circuit Design", by Prf. Nagendra Krishnapura ,IIT Madras.* *8.LTspice- Design Center.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	10 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	20 %	20 %	20 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	20 %	20 %	20 %	20 %	20 %	15 %	20 %	20 %
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. .R.Vijayarajeswaran,MD,VI Microsystems Pvt.Ltd,vijay@vimicrosystems.com	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	1. Dr.K.A.Sunitha, SRMIST
Mr.Ganti Suraj, Graduate Engineer, KPIT Technologies,gsaisuraj@gmail.com	2. Dr.D.Nedumaran,Madras University,dnmaran@gmail.com	

Course Code	18EIC301J	Course Name	*EMBEDDED SYSTEM DESIGN*	Course Category	*C*	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Get familiarized with architecture, addressing modes and instructions of 8085 & 8086 microprocessor*
CLR-2 :	*Get acquainted with 8-bit microprocessor and be able to program in assembly Language*
CLR-3 :	*Gain knowledge on essential peripherals and the associated interfacing ICs*
CLR-4 :	*Get exposed to high Performance and advanced architectures.*
CLR-5 :	*Get acquainted with 8-bit microcontroller and be able to program in assembly Language*
CLR-6 :	*Impart the Design concepts of microcontroller based system/application*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning** Blooms level (1-6)	**Program Outcomes (PO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for continuous& discrete systems	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	*Recall and apply basic concepts of digital fundamentals to Microprocessor based personal computer system*	*2*	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	*Identify and Design a detailed software and hardware structure of the Microprocessor.*	*3*	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	*Illustrate the process of interfacing the different peripherals with Microprocessor.*	*3*	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	*Distinguish and analyze the properties of Microprocessors & Microcontrollers*	*3*	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	*Analyze and Infer the data transfer information through serial & parallel ports*	*4*	2	2	-	--	-	-	-	-	-	-	-	-	2	-	-
CO-6 :	*Express and demonstrate their practical knowledge through laboratory experiments*	*6*	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		**Architecture of 8085/8086 processor**	**Peripherals and their interfacing**	**8051 microcontroller**	**Introduction to ARM core processors**	**Applications using 8051 and arm processor**
		15	**15**	**15**	**15**	**15**
S-1	SLO-1	*Introduction to microprocessors and microcontrollers*	*Physical Memory Organization in 8086*	*Architecture of 8051 microcontroller*	*Introduction to RISC design and ARM design,*	*Selection criteria of Right Microcontroller For a Project*
	SLO-2	*Evolution and history of microprocessor,*	*Formation of System Bus*	*Power Control in 8051*	*The ARM Cortex M0 (NuvoTon- Nu-LB-LUC140)architecture*	*Interfacing of pushbutton switches and LED'S using 8051*
S-2	SLO-1	*Market Survey of various Processors*	*Interfacing RAM and EPROM chips using only Logic Gates*	*Register Set of 8051*	*CISC Processors*	*Traffic light control system using 8051*
	SLO-2	*8086 Register organization*	*Interfacing RAM/EPROM using Decoder IC and Logic Gates*	*Addressing Modes of 8051*	*Register organization of Nuvoton*	
S-3	SLO-1	*Signal descriptionOF 8086 Micro Processor*	*I/O Interfacing*	*Interrupts of 8051*	*Current program status register*	*Process control system using 8051*
	SLO-2	*Minimum Mode operations of 8086 Micro Processor*	*Interfacing 8-bit input device with 8086*	*Instruction set of 8051- Data Transfer Instructions*	*Pipelining in 8051*	
S 4-5	SLO-1 SLO-2	*Lab1:Introduction to simulators*	*Lab 4: To perform Block Data Transfer using 8086*	*Lab7:To perform Arithmetic operations using 8051*	*Lab10:**To perform Code Conversion using 8086***	*Lab 13 :Interfacing DC motors/servo motors using 8051*
S-6	SLO-1	*Maximum mode operations of 8086 Micro Processor*	*Interfacing 8-bit Output Device with 8086*	*Arithmetic Instructionsof 8051*	*Interrupts and vector table*	*Interfacing stepper motor using 8051*
	SLO-2	*Instruction set of 8086 Micro Processor-Data Transfer Instructions*	*Interfacing Printer with 8086*	*Logical Instructions*	*Executions*	
S-7	SLO-1	***Arithmetic Instructions***	***Interfacing CRT Terminal with 8086***	*Branching Instructions*	*ARM processor families*	*Interfacing Matrix key board ,With Examples*
	SLO-2	*Logical Instructions*		*Bit Manipulation Instructions*	*Market survey on the available ARM processors*	

S-8	SLO-1	*Branching Instructions*	*Programmable Interrupt Controller(8259A)*	*Assembler Directives*	*Instruction Set of ARM Processors*	*LCD Display using 8051/ Nu-LB-NUC140 controller Interfacing of seven segment display*
	SLO-2	*Machine Control Instructions*		*Parallel ports in 8051*	*Instruction Set of ARM Processors*	
S 9-10	SLO-1 SLO-2	*Lab2: To perform Arithmetic Operations using 8086*	*Lab 5:* ***To perform Code Conversion using 8086***	*Lab8:To perform Logical operations using 8051*	***Lab11:*** *Interfacing stepper motor using 8051*	*Lab14:Interfacing Matrix key board using*
S-11	SLO-1	*Need and advantages of Assembler*	*Programmable Peripheral Interface (8255)*	*External Memory Interfacing in 8051-Program Memory Interfacing*	*The thumb instruction set*	*A/D and D/A interfacing using Nu-LB-NUC140 controller*
	SLO-2	***Assembler Directives***	*Programmable Interval Timer (8254)*	***Data Memory Interfacing***	*The thumb instruction set*	
S-12	SLO-1	*Interrupts of* 8086 Micro Processor	*Programmable Communication Interface (8251A)*	Timing Diagram for external program and data memory access	Basic ARM ALP for different applications	*Case studies on Current application od advanced processors in Medical Field*
	SLO-2	*Addressing modes of 8086 Micro Processor*		8051 Serial ports	Basic ARM ALP for different applications	
S-13	SLO-1	*Addressing modes of 8086 Micro Processor*	*Programmable Keyboard and Display Controller (8279)*	***8051 Timers***	*Case Study on applications of Arm processors in Industries*	*Documentation of Mini Project*
	SLO-2	*Programing Examples*		*Programing Examples*		
S 14-15	*SLO-1* *SLO-2*	***Lab 3: Arranging in ascending and Descending order using 8086***	***Lab 6: To find the largest number in block of data using 8086***	*Lab 9:* ***To perform Block Data Transfer using 8051***	*Lab12:* ***Traffic light control system using 8051***	***Lab:13:Mini Projects***

Learning Resources	1. N.SenthilKumar,"Microprocessors and Microcontrollers", Pap/Cdredition,oxford publishers,2010 2. Ramesh S. Gaonkar, "Microprocessor Architecture Programming and Applications with 8085", 6th edition, Penram International Publishing, 2013. 3. Douglas V. Hall, "Microprocessor and Interfacing, Programming and Hardware", Revised 2nd Edition, Indian edition 2007, 11th Reprint 2010, Tata McGraw-Hill. 74 4. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.MCKinlay, "The 8051 Microcontroller and Embedded Systems", 2nd Edition 2008, 5th Reprint, 2010, Pearson Education. 5. Krishna Kant, "Microprocessor and Microcontroller Architecture programming and system design using 8085, 8086, 8051, 8096, PHI", 7 th Reprint 2011. 6. Ray, A.K. and Bhurchandi, K.M., "Advanced Microprocessor and Peripherals", 2nd Edition, Tata McGraw-Hill, 2007.	7. Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition, Thompson Delmar Learning, 2007, New Delhi. 8. Dogan Ibrahim, "Microcontroller Based Applied Digital Control", John Wiley & Sons Ltd, 2006. 9. John P.Hayes, "Computer Architecture & Organization", 3rd Edition, Tata McGraw-Hill, 1998. 10. BehroozParhami, "Computer Architecture From Microprocessor to supercomputer", Oxford Publishing, 2014 Indian Reprint. 11. Krishna Kumar, "Lecture Notes on Microprocessors and Microcontrollers", NPTEL, E-Learning Course, IISc Bangalore. 12. Pramod Agarwal, "Lecture Notes on Microprocessor", NPTEL, E-Learning Course, IIT Roorkee

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20 %*	*10 %*	*10 %*	*10 %*	*10 %*	*10 %*	*10 %*	*5 %*	*10 %*	*10 %*
Level 2	Understand	*30 %*	*20 %*	20 %	20 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*15 %*	*20 %*	*20 %*
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	*5 %*	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. .R.Vijayarajeswaran,MD,VI Microsystems Pvt.Ltd,vijay@vimicrosystems.com	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	1. Dr.K.A.Sunitha, SRMIST
2.Mr.Ganti Suraj, Graduate Engineer, KPIT Technologies,gsaisuraj@gmail.com	2. Dr.D.Nedumaran,Madras University,dnmaran@gmail.com	

Course Code	18EIC302T	Course Name	INDUSTRIAL INSTRUMENTATION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the different techniques of measurement of flow.
CLR-2 :	Know the different techniques of pressure measurement techniques.
CLR-3 :	Provide knowledge about the temperature measurement techniques.
CLR-4 :	Acquire familiarity about measurements of Level , Viscosity, Humidity, Density and Moisture
CLR-5 :	Impart knowledge in measurement techniques of Acceleration, Force Vibration.

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
		Blooms level (1-6)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for continuous& discrete systems	Utilize PLC & DCS for control of systems	Effective management skills
CO-1	*Summarize the different methods for flow measurement.*	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2	*Describe the construction & working of various industrial devices used to measure pressure.*	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3	*Analyze different techniques to measure temperature.*	4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	*Illustrate the different methods for the measurement of level, viscosity, humidity etc.,*	4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5	*Interpret how the parameters like acceleration, force, Vibration are measured*	2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Measurement Of Flow	Measurement Of Pressure/	Measurement Of Temperature	Miscellaneous Measurement Of Level , Viscosity, Humidity, Density and Moisture	Miscellaneous Measurement of Acceleration, Force Vibration
		9	9	9	9	9
S-1	SLO-1	*Practical realization of equations- Expression for flow rate through restriction-compressible and incompressible flow -Units*	*Practical realization of equations - Expression for pressure-Units of pressure - Manometer types*	*Definitions and standards – Primary and secondary fixed points – Different types of filled in system thermometers*	*Expression for level-Units of level Sight glass — Bubbler system - Float gauges – Displacer type*	*Accelerometers*
	SLO-2	***Basic principles of flow-fluid flow in open & closed channels.***		*Different types of filled in system thermometers*	*differential pressure method- Purge system*	*LVDT, Piezoelectric, Strain gauge*
S-2	SLO-1	*Variable head type flow meters: Orifice plate – Venturi tube – Flow nozzle –*	*Elastic elements: Bourdon tube*	*Sources of errors in filled in systems and their compensation*	*Electrical methods of level measurement using resistance, capacitance*	*Variable reluctance type accelerometers*
	SLO-2	*Dall tube - Pitot tube – installation and applications of head flow meters - Smart Flow Transmitter.*	*Bellows, Diaphragms and Capsules, High pressure techniques.*	*Bimetallic thermometers – IC sensors*	*Nucleonic gauge and ultrasonic gauge - Conductivity sensors*	*Mechanical type vibration instruments*
S-3	SLO-1	*Variable Area flow meter: Rota meter theory, characteristics*	*Electrical methods: Elastic elements with LVDT*	*Thermocouples: Laws of thermocouple, Fabrication of industrial thermocouples*	*Capacitive sensors -Differential pressure transmitter Hydra step methods*	*Seismic instruments as accelerometer – Vibration sensor*
	SLO-2	*installation and applications*		*Reference junctions compensation*		*Calibration of vibration pickups – Units of density and specific gravity – Baume scale and API scale*
S-4	SLO-1	*Inferential meter: Turbine flow meter*	*strain gauges – Capacitive type pressure gauge*	*Response of thermocouple*	*Solid level measurement.*	***Standards in quality managements***

	SLO-2			*Special techniques for measuring high temperature using thermocouple*	*Humidity : Units- Viscosity -terminologies - Say bolt viscometer – rotameter type viscometer*	*Preparation of project documentation*
S-5	**SLO-1**	*Mass flow meter: Angular momentum, Thermaland Coriolis type mass flow meters*	*Piezo resistive pressure sensor- Resonator pressure sensor*	*RTD –Types of RTDs*	*Dry and wet bulb psychrometers*	*process flow sheet, mechanical flow sheets, Instrument index sheet, Instrument specification sheets*
	SLO-2			*- 3 wire and 4 wire RTDs, thermistor – linearization*	*hygrometer-dew cell – Commercial type dew meter*	*Loop wiring diagrams, panel drawing and specifications,*
S-6	**SLO-1**	*Principle and constructional details of electromagnetic flow meter*	*Measurement of vacuum: McLeod gauge, Thermal conductivity gauge,*	*Radiation fundamentals – Radiation methods of temperature measurement*	*density measurement : Pressure type densitometers,*	*Plot plans, Process Information,*
	SLO-2	*Different types of ultrasonic flow meters*	*Iionization gauges, Cold cathode type and hot cathode type*	*Total radiation pyrometers – Optical pyrometers*	*Float type densitometers, Ultrasonic densitometer*	*Piping and Electrical Specifications, Installation and checkout*
S-7	**SLO-1**	*Laser Doppler anemometer systems – Vortex shedding flow meter*	*Pressure gauge selection, installation*	*Fiber optic sensor for temperature measurement – Transmitter*	*gas densitometer.*	*Hazardous area classification - Electrical and other physical hazards*
	SLO-2	*Target flow meter*	*calibration using dead weight tester.*	*Temperature sensor selection, Installation and Calibration - Smart Universal Temperature*	*Different methods of moisture measurements.*	*Chemical reaction hazards Explosion hazards – Flammability classification*
S-8	**SLO-1**	*Open channel flow measurement - Solid flow rate measurement*	*Pressure Transmitter: Conventional and Smart transmitter, Level Measurement using DPT*	***Bolometers***	*Different methods of moisture measurements.*	*Hazard control: Reliability and risk analysis – Active.*
	SLO-2	*Guidelines for selection of flow meter. Calibration of flow meters: Dynamic weighing method.*				
S-9	**SLO-1** / **SLO-2**	***Case study: collection of flow sensors from the invention to till date & measure flow using any one sensor .***	***Develop an automatic level control.***	***Prototype of temperature control for any applications.***	***Use any of the sensors learned in this unit and do a project.***	*protective systems and instrumentation – Overpressure relief – Instrumentation for control and safety - Intrinsic Safe Transmitter*

Learning Resources

1. Donald P Eckman, ―Industrial Instrumentation‖ CBS publishers and distributors, 2004.
2. Murthy, D.V.S., "Transducers and Instrumentation", 2nd Edition, Prentice Hall of India Pvt.Ltd., New Delhi, 2011.
3. Ernest O Doebelin, ―Measurement systems Application and Design‖, Tata McGraw-Hill Book Company, Fifth Edition, 2010
4. Patranabis D, "Principles of industrial Instrumentation", Tata McGraw Hill, 3rd Edition, New Delhi, Reprint 2010
5. John P Bentley, ―Principles of Measurement Systems‖, Pearson education, Third Edition, 2009
6. Gregory K McMillan and Douglas M Considine, ―Process/ Industrial Instruments and Controls Handbook‖, Tata Mc-Graw Hill, Fifth Edition, 2009
7. M.M.S.Anand, Electronics Instruments and Instrumentation Technology, , Prentice Hall of India Pvt.Ltd., New Delhi, 2004
8. NPTEL video lectures on "Industrial Instrumentation" by Prof. Alok Barua, IIT Kharagpur

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*60 %*	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controls of Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	**Dr. A. Vimala Juliet, SRMIST**
2. V. Venkateswaran, Instrumentation Consultant,vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	**Mrs. N. Deepa**, SRMIST

Course Code	18EIC303J	Course Name	PROCESS CONTROL	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Introduce mathematical modeling of various processes*
CLR-2 :	*Know the characteristics, selection and sizing of control valves.*
CLR-3 :	*Understand the effect of various control actions.*
CLR-4 :	*Know the various PID tuning methods*
CLR-5 :	*Understand the features associated with Industrial type PID controller.*
CLR-6 :	*Identify the different type of control schemes used in process industries and paraphrase their importance*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning** Blooms level (1-6))	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1 Automatic control for continuous& discrete	PSO-2 Utilize PLC & DCS for control of systems	PSO-3 Effective management skills
CO-1 :	*Develop the mathematical model of various chemical process*	2	2	-	2	-	-	-	-	-	-	-	-	2	-	2	-
CO-2 :	*Demonstrate the working and application of different type of actuators and control valves*	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3 :	*Explain the various control schemes and recommend the right control scheme for a given application.*	3	2		2	-	-	-	-	-	-	-	-	-	-	2	-
CO-4 :	*Analyze the different methods of tuning of a controller*	4	2	-	2	2	-	-	-	-	-	-	-	-	-	2	-
CO-5 :	*Create a mathematical model and implement using various advanced control schemes*	4	2	-	2	3	-	-	-	-	-	-	-	-	-	2	-
CO-6 :	*Apply the right choice of control strategy for a given process*	4	2	-	2	2	-	-	-	-	-	-	-	-	-	2	-

Duration (hour)		***Process Dynamics***	***Final Control Elements***	***Control Action***	***Tuning of controllers***	***Advanced Control Schemes***
		15	**15**	**15**	**15**	**15**
S-1	**SLO-1**	*Need for process control*	*Need for final control elements*	*Basic control actions*	*PID controller Tuning*	*Multi-loop Control Schemes*
	SLO-2	*The process control loop*	*Signal converters*	*Continuous and Discontinuous modes of controllers*	*Need for controller tuning*	*Cascade control.*
S-2	**SLO-1**	*Process Variables and dynamics*	*I/P converter*	*Characteristics of ON- OFF controllers*	*Evaluation criteria*	*Split-range control*
	SLO-2	***Objectives and requirements of process control***	*P/I converter*	*Characteristics of Single speed floating controllers*	*One quarter decay ratio, semi empirical rules*	*Feed-forward control*
S-3	**SLO-1**	*P & I diagram*	*Pneumatic actuators*	*Problem solving*	*Time Integral performance Criteria*	*Inferential control*
	SLO-2	***Hardware elements of process control***	*Electric actuators*	*Problem solving*	*Selection of Time Integral performance Criteria*	*Ratio control*
S 4-5	**SLO-1** **SLO-2**	***Lab1: Identify the components of the process control loop.***	***Lab4: Determine the characteristics of I/P and P/I converter***	***Lab 7: Design the on-off, P,PI and PID controller for the Pressure Process***	***Lab 10: Tune the PID Controller for mathematically described process using ZN method***	***Lab13: Case study: Cascade control in various processing units***
S-6	**SLO-1**	***Servo and Regulatory operation***	Control Valves	*Basic control schemes*	*Tuning – Process reaction curve method*	*Decoupling in control schemes*
	SLO-2	*Continuous and batch processes*	*Types of control valves*	*P,I,D modes*	*Formulae and procedure*	*Auctioneering control*
S-7	**SLO-1**	*Mathematical model of level processes*	*Characteristic of Control Valves:- Inherent characteristics*	*Composite modes*	*Z-N open loop tuning technique*	*Smith predictor control scheme*

	SLO-2	*Interacting and non-interacting systems*	*Installed characteristics*	*P+I, P+D and P+I+D control modes*	*Formulae and procedure*	*Internal model control (IMC)*
S-8	**SLO-1**	*Mathematical model of two tank non interacting systems*	*Valve Positioner and its importance*	*Problem solving*	*Continuous cycling method*	*Model Predictive Control*
	SLO-2	*Mathematical model of two tank interacting systems*	***Electronic valve positioner***	*Problem solving*	*Formulae and procedure*	*Fractional order PID controller*
S 9-10	**SLO-1** **SLO-2**	***Lab 2 : Determine the characteristics of interacting system***	***Lab 5: Determine the characteristics of Pneumatically Actuated Control Valve***	***Lab 8: Design the on-off control, P,PI and PID controller for the flow Process***	***Lab 11: Tune the PID Controller for mathematically described process using ZN open loop method***	***Lab14: Case study: Feed forward control in various processing units***
S-11	**SLO-1**	*Laws and assumptions governing gas process*	*Control valve sizing*	*Reset windup*	*Damped oscillation method*	Adaptive control
	SLO-2	*Mathematical models of pressure processes*	*Guidelines for control valve sizing*	*Anti-reset windup Techniques*	*Formulae and procedure*	*Scheduled and self tuning adaptive control*
S-12	**SLO-1**	*Laws and assumptions governing thermal process*	*Cavitation and flashing*	*Auto/manual transfer*	*Stability analysis using tuning methods*	*Survey of features available in commercially available control schemes*
	SLO-2	*Mathematical models of thermal processes*	*Selection criteria*	*Direct/reverse action*	*Controller tuning with one quarter decay ratio*	
S-13	**SLO-1**	*Self-regulation*	*Position of tapping according to cavitation / flashing impacts on valves.*	*Practical forms of PID Controller*	*Problem solving*	*Piping and Instrumentation Diagram and its significance- Technical talk by industrial person.*
	SLO-2	*Degrees of freedom*	*Technical talk by Industrial person on Feature identification and model decoding of control valves- A guide to read catalogues*	*PID Implementation Issues*	*Problem solving*	
S 14-15	**SLO-1** **SLO-2**	***Lab3: Determine the characteristics of noninteracting system***	***Lab 6: Determine the characteristics of Pneumatically Actuated Control Valve (with and without Positioner)***	***Lab 9: Design on-off control, P,PI and PID controller for the level Process***	***Lab 12: Compare the responses of simple and cascade control system using MATLAB***	***Lab15: Case study:Control valve selection and sizing for a particular process.***

Learning Resources	1. Seborg ,D.E., Mellichamp, D.P., Edgar, T.F., and Doyle,F.J., III, "Process Dynamics and Control", John Wiley and Sons, 4thEdition 2016 2. *Stephanopoulos. G" Chemical Process Control - An Introduction to Theory and Practice", Prentice Hall of India,2nd Edition,2015* 3. *D.R. Coughanour, 'Process Systems analysis and Control', McGraw-Hill, 3rd Edition, 2013*	4. *Curtis D. Johnson Process Control Instrumentation Technology, 8th Edition, Pearson, 2006* 5. *NPTEL video lectures on "Chemical Process Control" by Prof. Sujit Jogwar, IITM.* 6. P.W. Murrill .,"Fundamentals of Process Control Theory", 3rd Edition-ISA Books 7. *Bela.G.Liptak., "Process Control and Optimization"., Instrument Engineers' Handbook., volume 2,CRC press and ISA, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	10 %	10 %	10 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 2	Understand	30 %	20 %	20 %	20 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	20 %	20 %	20 %	20 %	20 %	15 %	20 %	20 %
Level 4	Analyze	-	-	-	-	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	5 %	-	-
Level 6	Create	-	-	-	-	-	-	-	5 %	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Neelakandan Mani, Senior Director, CTS, pvmani2010@yahoo.com*	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	***1. Dr. A.Asuntha, SRMIST***
2. *Srinath, Design Engineer, instrumentation, VATECHWABAG,, srinath.vigneshwar@gmail.com*	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	***2.** Ms.N.Deepa, SRMIST*

Course Code	18EIC304J	Course Name	INDUSTRIAL PROCESS AUTOMATION SYSTEMS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	4	5

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	Electronics and Instrumentation Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Introduce the hardware components of Programmable Logic Controller*
CLR-2 :	Understand the logic program for control application
CLR-3 :	*Know the malfunctions and troubleshooting various types of error in Programmable Logic Controller*
CLR-4 :	*Provide basic knowledge of SCADA in the field of automation*
CLR-5 :	*Impart adequate information in interfacing DCS*
CLR-6 :	*Provide the knowledge of commissioning, maintenance and their importance on industry*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning** Blooms level (1-6)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO1 Automatic control for continuous& discrete	PSO2 Utilize PLC & DCS for control of systems	PSO3 Effective management skills
CO-1:	*Summarize the I/O modules in PLC for process control*	*2*	2	-	-	-	-	-	-	-	-	-	-	-	*1*	*3*	-
CO-2:	*Apply logical principles in ladder logic program for control applications*	*3*	2	-	-	-	-	-	-	-	-	-	-	-	2	*3*	-
CO-3:	*Analyze the input and output malfunctions in PLC*	*4*	2	2	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	Use SCADA software to demonstrate process control.	*3*	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Select the most appropriate automation technologies for a given application	*4*	2	-	-	-	-	-	-	-	-	-	-	-	*1*	*3*	-
CO-6:	*Develop a logical program for a given sequence of control problem*	*6*	2	-	2	-	-	-	-	-	-	-	-	-	*3*	*3*	-

Duration (hour)		PLC Hardware Components	PLC Programming	Troubleshooting	SCADA Elements & Communication	DCS Architecture & Application
		21	**21**	**21**	**21**	**21**
S-1	**SLO-1**	*Evolution of Programmable logic controllers*	*Timer Instructions- **On-delay timer instruction***	*PLC Enclosures PLC mounting*	*SCADA basics introduction*	*Evolution of Distributed Control System*
	SLO-2	***Architecture of a PLC***	***Off-delay timer instruction***	*Electrical noise*	*Elements of SCADA*	*DCS Architecture*
S-2	**SLO-1**	***Principles of Operations***	***Retentive timer***	*Leaky inputs and outputs*	*Functionality of SCADA*	*Local control unit*
	SLO-2	***PLC size and application***	***Cascading timer***	*Grounding*	*History of SCADA*	*Architectural parameters*
S-3	**SLO-1**	***Discrete I/O modules***	***Up counter***	***Voltage variations***	*Analog signals measurement*	***Operator interface***
	SLO-2	***Analog I/O module***	***Down counter***	***Surge control***	*Control techniques*	*Operator Interface Requirements*
S 4-7	**SLO-1** **SLO-2**	***Lab 1: study of PLC- Market survey on different PLC's, and its comparison, plc control panel wiring***	***Lab 4: Development of control logic for automatic** Bottle filling process*	***Lab 7: Development of control logic for Lift control***	***Lab 10: SCADA Development for the level process control training plant***	***Lab 13: DCS control panel wiring diagram and creating control panel layout Interfacing level transmitter to a DCS***
S-8	**SLO-1**	***Special I/O modules***	***Cascading Counter***	*Program editing*	*Discrete signals measurement*	***Operator input output devices***
	SLO-2	***Human machine interface***	***Combining counter and timer functions***	*Commissioning*	*Control techniques*	*Low-level Operator Interface*
S-9	**SLO-1**	***Alarms, Graphics Library***	***High speed Counters***	***Programming and Monitoring***	*Remote terminal unit*	*Operator displays*
	SLO-2	***Developing logic circuit from Boolean expression***	***Programs***	***Preventive maintenance***	***Analog and Discrete control***	*Engineering interface- Introduction*
S-10	**SLO-1**	***Converting Relay Schematics into plc Ladder programs***	*RS function block*	***Troubleshooting PLC software***	***Monitoring signals***	*Low-level engineering interface*
	SLO-2	***Contractors, switches***	*SR function block*	***Troubleshooting PLC hardware***	*Master terminal unit*	*High-level engineering interface*
S	**SLO-1**					

11-14	SLO-2	***Lab 2: Development of control logic for filling and draining of liquid in a single tank.*** ***Development of control logic for*** *Material handling*	*Lab 5:* ***Development of control logic for DC motor speed control*** ***Development of control logic for*** *Temperature control*	***Lab 8: Development of control logic for Car parking*** ***Development of control logic for*** *Servo controller*	***Lab 11: SCADA Development for the flow process control training plant***	***Lab 14: On line monitoring and control of level process using DCS***
S-15	SLO-1	***Electromagnetic control relays***	*FBD equivalents to LL*	***Trouble shooting guide***	*Communication system components*	*DCS Application in Power plant*
	SLO-2	***Sensors***	*FBD programming*	***Processor module***	*Field/RTU communication*	*Automation strategy*
S-16	SLO-1	***Output control devices***	*Data manipulation*	***Input malfunctions***	***Communication Topology***	*DCS Application in cement plant*
	SLO-2	***Seal-in circuits, Electrical Interlocking circuits, Program Scan***	*Data compare instructions*	***Output malfunctions***	*RTU/MTU communication,* ***System components***	*System architecture*
S-17	SLO-1	*PLC programming languages*	***Math instructions***	***Comparative study of PLCs in Lab***	*Monitoring alarms, Status points*	*DCS Application in steel plant*
	SLO-2	*Ladder Logic*	***IL Programming***	***Comparative study of Industrial PLCs***	*Control interfacing,* ***Parallel operator interface***	*System architecture*
S 18-21	SLO-1 SLO-2	***Lab 3: Demonstration of traffic light control sequence.*** ***Development of control logic for*** *Sequential operation of motor*	***Lab 6: Development of control logic for*** *Flow control*	*Lab 9: Study the operation of DCV's.* ***Development of control logic for Stamping machine control.***	*Lab 12:* ***SCADA Development for the temperature process control training plant***	*Lab 15: A mini project in process automation*

Learning Resources	1. *Frank D. Petruzella, "Programmable Logic Controller",Tata McGraw Hill 5th Edition, 2017.* 2. *Bolton. W, "Programmable Logic Controllers", 6thEdition, Elsevier Newnes, 2016.* 3. *Bela G Liptak, "Process Software and Digital Networks", Instrument Engineer's Hand Book, CRC, ISA, 4th Edition, 2012.*	4. Stuart Boyer A, "*SCADA : Supervisory control and data Acquisition*", Fourth Edition, ISA-The Instrumentation, Systems, and Automation Society, 2010 5. IDC Technologies, "*Practical Distributed Control Systems (DCS) for Engineers and Technicians*"2012. 6. *NPTEL Video Lecture series on "Industrial Automation and Control "by Prof. S. Mukhapadhyay, IIT Kharagpur*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20 %*	*10 %*	*10 %*	*10 %*	*10 %*	*10 %*	*10 %*	*5 %*	*10 %*	*10 %*
Level 2	Understand	*30 %*	*20 %*	20 %	20 %	10 %	10 %	10 %	5 %	10 %	10 %
Level 3	Apply	-	20 %	*20 %*	*10 %*	*20 %*	*20 %*	*20 %*	*15 %*	*20 %*	*20 %*
Level 4	Analyze	-	-	-	*10 %*	10 %	10 %	10 %	15 %	10 %	10 %
Level 5	Evaluate	-	-	-	-	-	-	-	*5 %*	-	-
Level 6	Create	-	-	-	-	-	-	-	*5 %*	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Dr.R.Vijayarajeswaran, MD, VI Microsystems Pvt. Ltd., vijay@vimicrosystems.com	**1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com**	**1.Mr. J. Sam Jebakumar, SRMIST**
2. Mr. P.Prashanth, Sr.Engineer, Mitsubishi Electric India, P.Prashanth@asia.meap.com	**2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com**	**2.Dr. G. Joselin Retna Kumar, SRMIST**

Course Code	18EIC305T	Course Name	POWER ELECTRONICS AND DRIVES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the operation of power semiconductor devices.
CLR-2 :	Understand the triggering and commutation techniques used in SCR.
CLR-3 :	Provide the knowledge about different controlled rectifier method.
CLR-4 :	Provide the skills to develop different types of inverter and chopper
CLR-5 :	Know the process of design and selection of drives in industrial applications.

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning: Blooms level (1-6)	PO 1: Engineering Knowledge	PO 2: Problem Analysis	PO 3: Design & Development	PO 4: Analysis, Design, Research	PO 5: Modern Tool Usage	PO 6: Society & Culture	PO 7: Environment & Sustainability	PO 8: Ethics	PO 9: Individual & Team Work	PO 10: Communication	PO 11: Project Mgt. & Finance	PO 12: Life Long Learning	PSO-1: Automatic control for continuous & discrete	PSO-2: Utilize PLC & DCS for control of systems	PSO-3: Effective management skills
CO-1 :	Summarize the different types of power semiconductor devices and their switching characteristics	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	Explain the triggering and commutation circuits used in SCR	2	-	2	-		-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Illustrate the operation, switching techniques and basics topologies of converters and choppers	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	Illustrate the inverters circuit and understand the harmonic reduction methods.	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	Develop the electric drives for various applications	6	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Power semiconductor devices	Triggering & commutation circuits.	Converters	Inverters and choppers	Applications
		9	9	9	9	9
S-1	SLO-1	Introduction to power semiconductor devices.	Firing circuits for thyristor.	Design of single phase half controlled rectifiers with R, RL load	Introduction to Voltage source series inverters	Introduction to D.C and A.C drives
	SLO-2	types of power electronics converters	Main features of firing circuit	Design of single phase half controlled rectifiers with RLE load.	Design of Voltage source series inverters	Open loop and Closed loop control of drives (Block diagram approach only)
S-2	SLO-1	Power diodes	Thyristor triggering circuits with R circuits	Design of single phase fully controlled rectifiers with R, RL load	Introduction to Voltage source parallel inverters	Stepper motor drives
	SLO-2	**Types of Power diodes**	Thyristor triggering circuits with RL circuits	Design of single phase fully controlled rectifiers with RLE load.	Design of Voltage source parallel inverters	Variable Frequency drives
S-3	SLO-1	power transistor	Thyristor triggering circuits with RC circuits	Three phase fully controlled rectifiers	Design of Voltage source bridge inverters	Induction Motor Drives and Synchronous Motor drives
	SLO-2	power MOSFET	Single pulse and train of pulses	Design of three phase fully controlled rectifiers with R Load	Design of 180 mode VSI	Design of PV for home appliances.
S-4	SLO-1	IGBT	Triggering the circuits with microcontroller.	Design of three phase fully controlled rectifiers with RL Load	Design of 120 mode VSI	Design of Hybrid Electric Vehicle system
	SLO-2	Characteristics of Thyristors	Triggering the circuits with Aurdino controller.	Design of three phase fully controlled rectifiers with RLE Load	PWM inverters	Literature study
S-5	SLO-1	Two transistor model of thyristor	Design problems.	Three phase fully controlled rectifiers	Design of Single pulse modulation	Introduction of Battery Operated vehicle
	SLO-2	Thyristor ratings	Commutation techniques	Design of three phase fully controlled rectifiers with R Load	Design of multiple pulse modulation	Design of Charging and discharging of battery
S-6	SLO-1	Thyristor protection	natural commutation.	Design of three phase fully controlled rectifiers with RL Load	Design of sinusoidal pulse modulation	Design of induction heating

	SLO-2	*Series operation of thyristor*	*forced commutation*	*Effect of source inductance.*	*Basic principle and working of chopper*	*Application of Induction heating*
S-7	SLO-1	*Parallel operation of thyristor*	*Types of commutation*	*Design of dual converters*	*Design of buck chopper*	*Introduction of UPS system*
	SLO-2	*Problems on dynamic characteristics of various power semiconductor device*	*Class A commutation*	*Cyclo-converter -Introduction*	*Problems on design of buck chopper*	*Design of OFF-line UPS*
S-8	SLO-1	*Problems on dynamic characteristics of Thyristor*	*Class B commutation*	*Design of single phase Step up cyclo converter with RL load.*	*Design of boost chopper.*	*Design of On-line UPS*
	SLO-2	*Problems on dynamic characteristics of MOSFET*	*Class C commutation*	*Design of single phase step down cyclo converter with RL load.*	*Problems on design of boost chopper*	*Introduction and Design of SMPS*
S-9	SLO-1	*Problems on dynamic characteristics of IGBT*	*Class D commutation*	*Introduction and design of matrix converter*	*Design of buck-boost chopper*	*Design of Flyback Converter, Push Pull Converter*
	SLO-2	*Selection of device based on its specification.*	*Class E commutation*	*Design of matrix converter with R load*	*Problems on design of buck boost chopper*	*Design of Half bridge converter, Full bridge Converter*

Learning Resources	*1. Ned Mohan, Tore M. Undeland and William P. Robb and Design", John Wiley and Sons, "Power Electronics Converter and Applications design",Third Edition, 2002.* *2. Bimbhra P. S, "Power Electronics", Khanna Publishers, Fifth Edition, 2012*	*3. G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, "Thyristorised Power controllers", New Age International Publishers, First Edition, Reprint 2005* *4. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, 3rd Edition, 2004.* *5. NPTEL video Lecture series on , "Design of Photovoltaic systems", by Prof. L. Umanand, IISc Bangalore.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*60 %*	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 5	Evaluate	-	-	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. Neelakandan Mani, Senor Director, CTS, pymani2010@yahoo.com	**1.** *Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1.* ***Mrs.K.Vibha****, SRMIST, vibhak@srmist.edu.in*
2. Mr. Vijayarajeswaran, managing director, VI Micro Pvt.Ltd, vijay@vimicrosystems.com	*2. Dr. Mohamed Khaled Chahine, Associate Professor, Yarmouk Private University Damascus Syria, mkchahine@gmail.com*	*2.* ***Dr. A. Vimala Juliet****, SRMIST, hod.eie@srmist.edu.in*