Course Code	18EIC306T	Course Name	DISCRETE TIME SIGNAL PROCESSING	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:	Learning
CLR-1 :	Understand the various transform techniques applicable to discrete time signals	Blooms level (1-6)
CLR-2 :	Know the design procedure for digital IIR filters using various methods	
CLR-3 :	Know the design procedure for digital FIR filters using various methods	
CLR-4 :	Provide the exposure to the architectures of digital signal processor and applications	
CLR-5 :	Study the characteristics of a random process and its statistical parameters	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Select the required sampling rate and required DFT points to avoid aliasing in time/ frequency	4
CO-2 :	Apply different techniques in digital IIRfilter design for the given set of specifications	3
CO-3 :	Apply different techniques in digital FIRfilter design for the given set of specifications	3
CO-4 :	Use digital signal processor for various real time applications	3
CO-5 :	Infer the characteristics of a random process from its statistical parameters and design suitable adaptive filters for the same	4

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Transforms	Digital IIR filters	Digital FIR filters	Digital Signal Processor and Applications	Random process and Adaptive digital signal processing
		9	9	9	9	9
S-1	SLO-1	DTFT and DFT	Introduction	Introduction	TMS320C54X Architecture	Introduction to Statistical signal processing
	SLO-2	DFT properties	design procedures for digital IIR filters	advantages of FIR over IIR filters	Central Processing Unit	Random process
S-2	SLO-1	magnitude and phase representation	frequency transformation techniques	linear phase filters	Arithmetic and logic unit	random variables
	SLO-2	Direct computation of DFT	Design of digital IIR filters using Butterworth Filter	Fourier series method	Barrel shifter	Autocorrelation
S-3	SLO-1	Circular convolution	Design of Low pass and high pass Butterworth filter	Design of digital FIR filters using Fourier series method	Multiplier/Adder Unit,	Cross correlation
	SLO-2	Linear using circular convolution		Low pass filter design	Accumulators	Stationary/Wide-sense stationary/
S-4	SLO-1	Direct computation of IDFT	Design of band pass Butterworth filter	High pass filter design using Fourier series method	On-chip Peripherals	Ergodic random processes
	SLO-2	computational complexity	Design of band reject Butterworth filter	Band pass filter design using Fourier series method		Power Spectral Density
S-5	SLO-1	FFT:Radix2, Twiddle factor	Design of digital IIR filters using Chebyshev approximations	Band reject filter design using Fourier series method	Addressing Modes	Signal modeling
	SLO-2	Decimation in time FFT algorithm	Design examples		Examples	AR and MA processes
S-6	SLO-1	Computation of DFT using DIT algorithm	Design of digital IIR filters using Bilinear transformation method	Windowing technique: Rectangular	Application of DSP in Signal processing	ARMA processes
	SLO-2		Design examples	Triangular window		Overview of Multirate signal processing

S-7	**SLO-1**	*Decimation in frequency FFT algorithm*	*Design of digital IIR filters using Impulse Invariant transformation method.*	*Raised Cosine*	*Application of DSP in Image processing*	*Decimation*
	SLO-2			*Hamming window*		*Interpolation*
S-8	**SLO-1**	*Computation of DFT using DIF algorithm*	*Realization of IIR filters.*	*Hanning window*	*Application of DSP in Radar system.*	*Short time Fourier transform*
	SLO-2		*Direct form 1&II*	*Design examples*		*Discrete wavelet transform*
S-9	**SLO-1**	*IDFT using FFTalgorithms.*	Cascade form	*Realization of FIR filters.*	*Case study*	*Case study*
	SLO-2	*Computation of IDFT using FFT algorithm*	*Parallel form*			

Learning Resources	1. John G Proakis and Manolakis, " *Digital Signal Processing Principles, Algorithm and Applications*", Pearson, 4thEdition, 2007 2. Mithra, S.K., "*Digital Signal Processing: A Computer Based Approach*", 3rdEdition, 2005	3. Johnson, J.R.," Introduction to Digital Signal Processing", Prentice Hall of India,2009 4. NPTEL Video Lecture series on, "Digital Signal Processing" by Prof. S.C. Dutta Roy, IIT Delhi

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 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*20 %*	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	30%	-	*60 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	30%	-	-	-	*30 %*	-	*20 %*	-	*30 %*	-
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.G.Joselin Retna* ***Kumar****, SRMIST*
2. Mr. P.Prashanth, Sr.Engineer, Mitsubishi Electric India, P.Prashanth@asia.meap.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	

Course Code	18EIC401J	Course Name	INSTRUMENTATION 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:	Learning
CLR-1 :	Study the hardware components of Programmable Logic Controller	Blooms level (1-6)
CLR-2 :	Impart the knowledge on the designing aspects of signal conditioning circuits for the measurement of Level, temperature and PH.	
CLR-3 :	Understand the designing concepts of Transmitters	
CLR-4 :	Impart the designing skills needed to test Analog/ Digital PID controller,Data Loggers and Alarm Annunciator	
CLR-5 :	Familiarize with the design of orifice and control valve sizing	
CLR-6 :	Familiarize with design considerations of final control element.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Apply the knowledge of science in basic signal conditioning circuit design.	2
CO-2 :	Design signal conditioning circuits for different applications.	3
CO-3 :	Design final control element for flow control.	3
CO-4 :	Measure the real time system parameters.	3
CO-5 :	Facilitate various systems for data acquisition and control.	4
CO-6 :	Design smart transmitters for different applications	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	PSO2 Utilize PLC & DCS for control of systems	PSO3 Effective management skills
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5	2	2	-	--	-	-	-	-	-	-	-	-	2	-	-
CO-6	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Design of signal conditioning circuits	Design of transmitters	Design of data logger and PID controller	Orifice and control valve sizing	Safety Instrumented System (SIS)
		15	15	15	15	15
S-1	SLO-1	Introduction to Process Control System	Importance of Transmitters in Process Control System	Review of continuous and non continuous controllers	*Orifice Sizing*	Need, features, components, difference between basic process control system and SIS
	SLO-2	Principle operation of V/I converter	Study of Transmitter and its design features		Principles of Operations in orifice	
S-2	SLO-1	Design of V/I Converter	Design of 2 wire Anolog transmitters	*Design of ON / OFF Controller- principle*	*Liquid, Gas and steam services*	How to measure risk, risk tolerance, Safety integrity level
	SLO-2	Principle operation of I/V converter		*Design of ON / OFF Controller using Linear Integrated circuits*	Principles of Operations	Risk, safety instrumented functions
S-3	SLO-1	Design of I/V Converter	Design of 4 wire Analog Transmitters	*Electronic PID Controller* Principles of Operations and applications	Valve Parameters	Standards and Regulation – HSE-PES.AICHE-CCPS, IEC-61508, ANSI/ISA-84.00.01-2004 (IEC 61511 Mod)
	SLO-2	*Introduction to simulators*				
S 4-5	SLO-1	Lab1: *Design of regulated power supply*	Lab 4: *Design, Fabrication and Testing of 2-wire Analog Transmitter*	Lab 7*: .Design, Fabrication and Testing of Data Logger*	*Lab10:Design of Actuator and positioned*	Lab 13:Rotameter Design
	SLO-2					
S-6	SLO-1	Analog and Digital filter design and Adaptive filter design	Design of RTD based Temperature Transmitter	*Micro - controller based Data Logger*	*Valve Sizing*	ANSI/ISA – 84.01-1996, NFPA 85, API RP 556, API RP 14C, OSHA (29 CFR 1910.119
	SLO-2		zero and span adjustment	Design and its characteristics		
S-7	SLO-1	Signal conditioning circuit for Température measurement	*Capacitance based Level Transmitter*	*Data Acquisition Cards*	Sizing Steam Valves with Examples	– Process Safety Management of Highly Hazardous Chemicals

	SLO-2	Thermocouple operation	Air Purge level measurement – Principles of Operations	*Design of PC based Data Acquisition Cards*	Gases Other Than Steam	SIS design cycle - Process Control vs Safety Control
S-8	SLO-1	Signal Conditioning in Thermocouple-Principles of Operations	Design of circuits for pressure measurements bourdon gauge – design of bourdon tube.	Model Design For Temperature Control system with Data acquisition system	Three Way Valves	*Case Studies:I*
	SLO-2	Signal Conditioning in RTD - Principles of Operations			Valve Selection Summary	
S 9-10	SLO-1	*Lab 2:. I to V and V to I convertor*	*Lab 8:. Design, Fabrication and Testing of 2-wire Smart Transmitter*	*Lab 8:. Design, Fabrication and Testing of Digital PID Controller*	*Lab 11: Development of Software Program for sizing Orifice*	*Lab 14: Mini Projec:I*
	SLO-2					
S-11	SLO-1	Signal Conditioning in Thermistor-Principles of Operations	Smart flow transmitter	*Model Design for Level control system with Data acquisition system*	*valve bodies – valve characteristics*	*Case Studies:II*
	SLO-2	Design of Instrumentation amplifier	Orifice plate and Principles of Operations		*Actuator Sizing*	
S-12	SLO-1	Introduction of ECG	*Design considerations of Orifice Plate*	*Model Design for flow control system with Data acquisition system*	*Design of Actuator and positioned*	*Case Studies:III*
	SLO-2	Measurement of ECG	*Orifice plate Applications*	Various Wireless control techniques of the process control parameters.		
S-13	SLO-1	Design of a pre processing circuit for ECG Application	*Venturi Tube, Principles of Operations*		*Rotameter design and considerations*	*Preparation of documentation of Instrumentation Project. (Process Flow Sheet, Instrument Index Sheet and Instrument Specification Sheet).*
	SLO-2		*Design considerations of venturi tube*	Annuciation circuits		
S 14-15	SLO-1	*Lab 3: Design of ON/OFF Controller for Thermal Process*	*Lab 6: Design, Fabrication and Testing of Analog PID Controller*	*Lab 9: Design, Fabrication and Testing of Alarm, Annunciation Circuits*	*Lab 12: Development of Software Program for sizing Control Valve*	*Lab 15:* ***A mini project: II***
	SLO-2					

Learning Resources

1. *Ramakant Gayakwad, "Op-amps and Linear Integrated Circuits", 4th Edition, Prentice Hall, 2000*
2. *C. D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Prentice Hall, 2006.*
3. *Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2005.*
4. *R.W. Miller, "Flow Measurement Engineering Handbook", Mc-Graw Hill, New York 1996.*
5. *Roy Choudhry, D. and Shail B. Jain, "Linear Integrated Circuits", 2nd Edition, New Age International, 2003.*
6. *Bela G. Liptak, "Instrument Engineers Handbook - Process Control and Optimization", 4th Edition, Vol.2, CRC Press,2005*
7. *N.A.Anderson, Instrumentation for Process Measurment and Control, Chilton Company, 2003.*
8. *J.P. Bentley, "Principles of Measurement Systems", Pearson Education ,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 %	*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
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	18EIC402T	Course Name	INDUSTRIAL DATA 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:	Learning
CLR-1 :	Understand the basic concepts of data networks	Blooms level (1-6)
CLR-2 :	Provide knowledge on HART and Field buses	
CLR-3 :	Know the different techniques on MODBUS, PROFIBUS and other communication protocol	
CLR-4 :	Impart an overview of industrial Ethernet and its standard	
CLR-5 :	Introduce the concepts involved in wireless communication in Instrumentation systems.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Express the basic concepts of OSI models and data networks	2
CO-2 :	Analyze the protocols and layers of HART and field bus	4
-CO-3 :	Incorporate the techniques of MODBUS, PROFIBUS and other communication protocol	1
CO-4 :	Implement the significance of industrial Ethernet along with its standards	3
CO-5 :	Evaluate the techniques of wireless communication in Instrumentation systems	3

Program Outcomes (PO)													PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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	PSO – 1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze &Research
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	3	-	-	-	-	-
-	-	2	-	-	-	-	-	-	3	-	-	-	-	-
-	-	-	2	-	-	-	-	-	3	-	-	-	-	-
-	-	2	-	-	-	-	-	-	3	-	-	2	-	-

Duration (hour)		Fundamentals of Industrial Communication Networks	HART and Field bus	Profi bus and MOD bus	Industrial Ethernet	Wireless Communication
		9	9	9	9	9
S-1	SLO-1	Introduction to Modern instrumentation	Introduction to HART and smart instrumentation	Introduction to Profibus	Introduction to Industrial Ethernet	Introduction: Wireless sensor networks
	SLO-2	Introduction to control systems	HART protocol	ProfiBus protocol stack	10 Mbps Ethernet	Hardware components
S-2	SLO-1	Open systems interconnection (OSI) model	Physical layer- Analog 4–20 mA	Physical layer (layer 1)	Media systems	energy consumption of sensor nodes
	SLO-2	Representation of the OSI model	Digital frequency shift keying (FSK)	Type A cable	10Base5, 10Base2, 10BaseT	
S-3	SLO-1	Protocols	Data link layer	Type B cable	Signaling methods	Network architecture
	SLO-2	Basic structure of an information frame defined by a protocol	HART protocol implementation of OSI model layer	Data link layer (layer 2)	Medium access control	
S-4	SLO-1	Standards	Application layer- Universal commands	Hybrid medium access control	Frame transmission	sensor network scenario
	SLO-2	EIA-232 interface standard	Common practice commands, Device specific commands	Application layer	Frame reception	
S-5	SLO-1	EIA-485 interface standard	Troubleshooting	Introduction to MODbus	MAC frame format	Wireless MAC Standards
	SLO-2	Media access protocol: Command/response	HART cable length calculation	Modbus protocol structure	Differences between IEEE 802.3 and Blue Book Ethernet (V2)	Zigbee Wireless HART
S-6	SLO-1	CSMA/CD, IEEE 802.3	Introduction to foundation field bus	Function codes	IEEE 802.2 LLC	Wireless Standard for Process Industry
	SLO-2	Ethernet standard Bridges, Routers	Physical layer	Read coil or digital output status (function code 01) and Read digital input status (function code 02)	Reducing collisions	ISA100
S-7	SLO-1	TCP/IP	Wiring rules	Read holding registers (function code 03) and Reading input registers (function code 04)	Design rules	Wireless For Instrumentation
	SLO-2	Standard ETHERNET Configuration	Encoding rule, permeable and delimiters	Force single coil (function code 05)	Length of the cable segments	Standards and Technologies
S-8	SLO-1	Introduction to RS-232	Data link layer	Preset single register (function code 06)	100 Mbps Ethernet	Typical applications: Process Monitoring

	SLO-2	*RS-422 and RS-423*	*Data link layer: packet format*	*Troubleshooting*	*Media access: full-duplex*	*Maintenance Checking*
S-9	**SLO-1**	*Simple no-handshaking communications*	*Application layer*	*Common Problems and Discussion*	*Auto-negotiation*	*Safety and Environmental*
	SLO-2	*Software and hardware handshaking*	*User layer*	*Modbus Plus protocol overview*	*Fiber optic cable distances 100BaseFX*	

Learning Resources	1. *Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks Design, Installation and Troubleshooting' Newnes Publication, Elsevier 1st Edition, 2004.* 2. *Ian Verhappen and Augusto Pereira , Foundation Fieldbus, 4th Edition, Feb 29, 2012.* 3. *William Buchanan, Computer Buses, CRC Press, 2000.* 4. *A. Behrouz Forouzan ,Data Communications & Networking ,3rd Edition, Tata Mc Graw hill,2006.*	5. *Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011.* 6. *Bela G.Liptak, "Instrument Engineers' Handbook, Volume 3 : Process Software and Digital Networks", 4th Edition, CRC Press, 2011.* 7. *Lawrence (Larry) M. Thompson and Tim Shaw, "Industrial Data Communications", 5th Edition,ISA Press, 2015.* 8. *NPTEL Lecture notes on," Computer Networks" by Department of Electrical Engg, 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	*50%*	-	*20%*	-	*30 %*	-	*50%*	-	*20%*	-
Level 2	Understand	*50%*	-	*20%*	-	*40 %*	-	*50%*	-	*30%*	-
Level 3	Apply		-	*20%*	-	*30 %*	-	-	-	*30%*	-
Level 4	Analyze			40						*20%*	
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.Santhosh Eswaran, VR Savvy, info@vrsavvy.co	*1. Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1. Dr.S.UmaMaheswari, SRMIST, umamahes3@srmist.edu.in*
2. Mr. Neelakandan Mani, Senior Director, CTS, pymani2010@yahoo.com	*2. Dr. B.Chitti babu, IIITDM, Kancheepuram, bcbabu@iiitdm.ac.in*	*2. Dr. A. Vimala Juliet, SRMIST, hod.eie.ktr@srmist.edu.in*

Course Code	18EIE201T	Course Name	RELIABILITY AND SAFETY ENGINEERING	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce concepts of reliability failure models.	Blooms level (1-6)
CLR-2 :	Inculcate the concepts of redundancy and methods for improvement.	
CLR-3 :	Impart the skills of various types of maintainability test that is used in Industries.	
CLR-4 :	Understand the destructive and non-destructive reliability tests	
CLR-5 :	Understand the causes of failure and techniques used to maintain safety.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the fundamental concepts of Reliability test and reliability failure models.	2
CO-2 :	Analyze the methods used for sustained redundancy and maintenance.	4
CO-3 :	Apply the knowledge of various techniques used in Maintainability	3
CO-4 :	Examine the various reliability tests and its significance	3
CO-5 :	Infer various safety measures to prevent accidents.	4

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PS O2	PS O3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		RELIABILITY	CONCEPTS OF REDUNDANCY AND MAINTENANCE	MAINTAINABILITY	RELIABILITY TESTS	SAFETY
		9	9	9	9	9
S-1	SLO-1	Introduction to Reliability failure modes	Use of redundancy and system reliability	Maintainability: - Definition, basic concepts, relationship between reliability	Introduction to life	Safety: Causes of failure and unreliability
	SLO-2	Definition and basic concepts of Reliability	improvement methods	maintainability and availability	destructive tests,	measurement and prediction of human reliability
S-2	SLO-1	block diagrams of reliability	Maintenance: - Objectives	corrective maintenance time distributions and maintainability demonstration	non-destructive tests	human reliability and operator training
	SLO-2	failure data	types of maintenance	Design considerations for maintainability	estimation of parameters for exponential	Reliability and safety
S-3	SLO-1	reliability in terms of hazard rates	Preventive measures	Availability and reliability relationship.	Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules.	Safety margins in critical devices
	SLO-2	failure density function		Human factors, Spare parts planning		Origins of consumerism and importance of product knowledge
S-4	SLO-1	Design of Hazard models	condition-based and reliability centered maintenance	Maintenance staffing: Learning curves	component reliability and MIL standards	product safety
	SLO-2			Simulation	testing	product liability
S-5	SLO-1	'bath-tub' curve	Terotechnology	Maintenance resource requirements	Reliability prediction models	product safety improvement program
	SLO-2				Series and parallel systems	Definition and measurement of risk
S-6	SLO-1	Applicability of Weibull distribution	Total Productive Maintenance (TPM).	Optimal repair effort	RBD approach	– risk analysis techniques

	SLO-2	*Reliability calculation for series*	*Proactive/Reactive maintenance.*	*Maintenance planning and scheduling*	*Standby systems – m/n configuration*	*risk reduction resources*
S-7	SLO-1	*parallel series and K-out of M systems.*	*Imperfect maintenance – Maintenance policies*	*Optimal size of service facility*	*Application of Bayes' theorem*	*industrial safety and risk assessment*
	SLO-2	*A priori and a posteriori concept - mortality curve –.*	*PM versus b/d maintenance*	*Optimizing profit/downtime*	*cut and tie set method – Markov analysis*	*principles of accident prevention – accident investigation and analysis*
S-8	SLO-1	*useful life – availability maintainability – system effectiveness*	*PM schedule and product characteristics – Inspectionmodels-*	*Replacement decisions*	*Fault Tree Analysis – limitations.*	*safety "t" score, safety activity rate – problems.*
	SLO-2	*ranking of data probability plotting techniques – Hazard plotting*				
S-9	SLO-1	*Case study*	Case study	*Case study*	*Case study*	*Case studies.*
	SLO-2					

Learning Resources	1. *Andrew K.S.Jardine& Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.* 2. *BikasBadhury&S.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003* 3. *Govil, A.K., "Reliability Engineering", Tata McGraw -Hill, New Delhi,1983*	4. *Srinath L.S, "Reliability Engineering", Affiliated East-West Press Pvt. Ltd, New Delhi, 1998.* 5. *Sinha and Kale, "Introduction to Life-Testing", Wiley Eastern, New Delhi, 1992.* 6. *http://www.osha.gov/pls/oshaweb/* 7. *http://www.hse.gov.uk/legislation/hswa.htm*

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. ***Dr. A. Vimala Juliet****, SRMIST*
2. ***Mr. Vijayarajeswaran, MANAGING DIRECTOR, VI micro Pvt.Ltd, vijay@vimicrosystems.com***	***2. Prof.FawazMofdi,, Head of Electronics and Telecommunication Engineering, Damascus University, Syria.***	2. *Mrs. A. Brindha, SRMIST*

Course Code	18EIE202T	Course Name	RENEWABLE ENERGY	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Study the need of energy conversion and the various methods of energy storage.	Blooms level (1-6)
CLR-2 :	Identify the field applications of solar energy.	
CLR-3 :	Understand the Winds energy as an alternate form of energy and to know how it can be tapped.	
CLR-4 :	Gain knowledge on the applications of Geothermal & Tidal energy	
CLR-5 :	Impart the concepts of Direct Energy Conversion systems	

Course Outcomes (CO):	At the end of this course, learners will be able to:	
CO-1 :	Summarize the fundamental concepts in Energy conservation.	2
CO-2 :	Illustrate the impetus of solar energy in various domains and its applications.	3
CO-3 :	Examine the various concepts and applications of Wind energy.	3
CO-4 :	Analyze the mechanism of Geothermal and tidal energy production and its applications.	4
CO-5 :	Illustrate the applications of Direct energy Conversion systems.	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PS O2	PS O3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
2	-	-	-	-	-	-	-	-	-	-	-	3	2	-
2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Introduction to Energy Scenario	Solar Energy	Wind energy	Geothermal and Tidal Energy	Direct energy conservation system
		9	9	9	9	9
S-1	SLO-1	Environmental consequences of oil fuel use	Introduction to Solar radiation	Wind data and energy estimation	Introduction to Bio resources	Small hydro
	SLO-2	Importance of renewable sources of energy	Measurements of solar radiation and sunshine	Study of Betz limit	Biomass direct combustion	Tidal energy
S-2	SLO-1	Sustainable Design and development	Concepts of Solar spectrum	Understanding of Site selection for windfarms	Study of thermochemical conversion	Wave energy
	SLO-2	Types of RE sources	Understanding of Solar thermal collectors	Characteristics of characteristics	biochemical conversion mechanical conversion	Open and closed OTEC Cycles
S-3	SLO-1	Limitations of RE sources	Flat plate and concentrating collectors	Wind resource assessment	Study of Biomass gasifier	Limitations
	SLO-2	Present Indian and international energy scenario of conventional		Study of Horizontal axis wind turbine		
S-4	SLO-1	Indian energy scenario in domestic and industrial	Solar thermal applications	Components of wind turbine	Types of biomass gasifiers	Geothermal energy
	SLO-2			Vertical axis wind turbine	Cogeneration	Geothermal energy sources
S-5	SLO-1	Indian energy scenario in commercial and agriculture	Solar thermal energy storage techniques	Wind turbine generators and its performance	Carbonization	Types of geothermal power plants
	SLO-2		Fundamentals of solar photo voltaic conversion	Study of Hybrid systems	Pyrolysis	Applications - Environmental impact
S-6	SLO-1	Indian scenario transportation and others	Introduction to Solar cells	Wind turbines (Wind mill)	Biogas plants	Tidal Energy-Basic Principles of Tidal Power
	SLO-2	Present renewable energy status	Study of Solar PV Systems	Site Selection considerations	Digesters	Components of Tidal Power Plants

S-7	**SLO-1**	Present conventional energy status –	effect of various parameter on its performance	*Basic components of a wind energy conversion system (WECS)*	*Biodiesel production*	*Schematic Layout of Tidal Power house*
	SLO-2	Global energy status-	solar water heater- Solar Cooker-Box type	*Advantages & Limitations of WECS*	*Ethanol production*	*Advantages & Limitations of Tidal power.*
S-8	**SLO-1**	Per capita energy consumption	Solar dryer-solar greenhouse, Summer and winter greenhouse Solar PV applications	*Environmental issues - Case studies.*	*Advantages and disadvantages of biogas plants-urban waste to energy conversion-MSW incineration plant.*	*Introduction-Thermionic emission & work function-Basic Thermionic generator-*
	SLO-2	Future energy plans				
S-9	**SLO-1**	Case study	Case study	*Case study*	*Case study*	*Case studies.*
	SLO-2					

Learning Resources	1.B H Khan, "Non-Conventional Energy Resources", 2nd Edition, Tata McGraw Hill Education Pvt Ltd, 2011. 2. S.Hasan Saeed and D.K.Sharma, "Non-Conventional Energy Resources", 3rd Edition, S.K.Kataria& Sons, 2012	3. G. D. Rai, "Non-Conventional Energy Sources", 4th Edition, Khanna Publishers, 2000. 4. S.P.Sukhatme, "Solar Energy", 3rd Edition, Tata McGraw Hill Education Pvt Ltd, 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	-	-	*60 %*	-	*40 %*	-	*30 %*	-	*40 %*	-
Level 4	Analyze	-	-		-	*20%*	-	*30 %*	-	*20 %*	-
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

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2. *Mr. Vijayarajeswaran, MANAGING DIRECTOR, VI micro Pvt.Ltd, vijay@vimicrosystems.com*	*2. Prof.FawazMofdi, Head of Electronics and Telecommunication Engineering, Damascus University, Syria.*	*2. Mrs. A. Brindha, SRMIST*

Course Code	18EIE203T	Course Name	FUNDAMENTALS OF MEMS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the importance and working of various micro sensors and actuator in micro devices	Blooms level (1-6)
CLR-2 :	Know the process flow and sequence in micro fabrication of MEMS devices	
CLR-3 :	Impart the knowledge on various micro machining techniques and design tools	
CLR-4 :	Understand the significance involved in various levels of MEMS packaging	
CLR-5 :	Introduce recent developments and challenges in fabrication of MEMS devices	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the operating principle of micro sensors and actuators used in micro devices	2
CO-2 :	Analyze the various fabrication techniques used in MEMS devices	4
CO-3 :	Apply the implication of micromachining techniques to fabricate 2D and 3D micro devices and structures	3
CO-4 :	Outline the importance of bonding and sealing at various levels of MEMS packaging	4
CO-5 :	Illustrate different techniques involved in recent developments and trends in MEMS technology	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PS O2	PS O3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		Micro sensors and Actuators	Fabrication overview	Micromachining	Bonding & Sealing	Recent trends
		9	9	9	9	9
S-1	SLO-1	Introduction to MEMS and Brief recap of Macro devices	Introduction to Micro fabrication process	Introduction of micro machining(MMC) process	Introduction to MEMS packaging	MEMS materials market survey
	SLO-2	Microelectronics and Micro systems	Significance of each technique	Significance of MMC	Challenges in selection of packaging materials	MEMS market and demand forecast
S-2	SLO-1	Scaling laws in geometry	Process Description of Photolithography	Bulk MMC process – merits and demerits	Different levels of Packaging	MEMS based energy harvesting devices
	SLO-2	Silicon as ideal material and as substrate	Implementation of Photolithography	Sequence of steps	Die, device and system level	Piezo electric based micro devices
S-3	SLO-1	Si wafer production	Process Description of CVD	Significance of Isotropic etching	Challenges in packaging	Application of MEMS in automotive industry
	SLO-2	CZ process	Implementation, merits and demerits of CVD	Significance of Anisotropic etching	Plastic encapsulation and its significance	Airbag deployment system
S-4	SLO-1	Sequential steps in wafer processing	Process Description of PVD	Surface MMC process	Stages of Die Preparation	Optical MEMS Application
	SLO-2		Implementation, merits and demerits of PVD	Sequence of steps	Relevance to various processes of IC fabrication unit	Micro mirror
S-5	SLO-1	Chemical and mechanical properties of Si and compounds	Process Description, implementation of Ion implantation	Challenges in surface MMC	Types of wire bonding Thermo compression type	Micro fluidics Application
	SLO-2	Chemical and mechanical properties of Polymers, Quartz and GaAs	Oxidation process	Interfacial & Residual stresses	Thermo sonic, Ultra sonic type	Lab on chip module integration
S-6	SLO-1	Chemical, Biomedical type Micro sensors	Diffusion process	LIGA process- description, merits and demerits	Types of surface bonding – Adhesive soldering, SOI type of bonding	IR and Gas sensing

	SLO-2	Piezoelectric type of Micro sensors	Wet etching methods	Implementation process	Types of sealing- Micro shells, Hermetic sealing, Micro 'O' rings,Reactive seal	Thermal sensors working
S-7	**SLO-1**	Thermal, SMA, Piezoelectric actuators	Properties of etchants	Process Design-block diagram and description	Introduction to Nanomaterial characterization	Micro power generation
	SLO-2	Electro static type Micro Actuators	Dry etching methods	Electro-mechanical design, Thermo-electric design	Structural- XRD, SEM, AFM, EDS, XPS	Micro Thermo Electric Generators
S-8	**SLO-1**	Micro devices- operation of Micro gears and micromotors	Production of plasma	CAD- block diagram description and implementation	Optical- UV-Vis, Raman, FTIR	Chemical sensors
	SLO-2	Micro devices –operation of Micro valves and pumps	Etch stop methods		Electrical characterization	Micro humidity sensors
S-9	**SLO-1**	Case study	Case study/Demo / supporting video lectures	Simulation of simple micro structures	Case study/Demo / supporting video lectures	Micro pressure sensors
	SLO-2					Paper MEMS

Learning Resources	*1.Tai-Ran Hsu, "MEMS and MICROSYSTEMS", 22nd reprint edition, Wiley & sons, 2015* *2.M. Madou, "Fundamentals of Micro fabrication", Taylor and Francis group, 2002*	*3. Vardhan Gardener,"Micro sensors and smart devices", John Wiley & Sons,Reprint 2002* *4. NPTEL video lecture series on "Sensors & Actuators" by Prof. Hardik Pandya, 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
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2. Mr.Vijayarajeswaran, MD, Vi Micro systems Pvt.Ltd.,vijay@vimicrosystems.com	*2. Dr.D.Nedumaran, Madras University,dnmaran@gmail.com*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	18EIE204J	Course Name	FUNDAMENTALS OF DATA STRUCTURES AND ALGORITHM	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Provide the knowledge on different data types, searching and sorting algorithms for data search.	
CLR-2 :	Introduce the concepts of linked list in developing applications	
CLR-3 :	Impart skills to process data using stack and queues for real-time applications	
CLR-4 :	Understand the tree data storage structure and relate it with real-time applications	
CLR-5 :	Provide knowledge on algorithms to find shortest data search in graphs for real-time applications.	
CLR-6 :	Understand the different types of data structures and its operations for real-time programming applications	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms Level (1-6)
CO-1 :	Understand the various data search algorithms for searching and sorting.	2
CO-2 :	Analyze the different types of linked lists and its operations	4
CLO-3 :	Construct stack and queue data structures along with its operations	1
CLO-4 :	Evaluate the tree data structures, its types and operations	3
CLO-5 :	Implement graph data structure to utilize its operations in data structures.	3
CLO-6 :	Create the different data structures for to effect on real-time applications.	6

	Program Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	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	PSO – 1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze &Research
CO-1 :	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CLO-3 :	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	-	3	-	-	-	-	-	-	-	2	-	-	-	-	1
CLO-6 :	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		*Introduction*	*Array*	*Stack*	*Trees*	*Graph*
		12	12	12	12	12
S-1	SLO-1	*Introduction: Data structures*	*Operation of array*	*Implementation of stack array and linked list*	*Preliminaries*	*Definitions*
	SLO-2	*Algorithms – Searching techniques Complexity*	*Multidimensional arrays*		*Binary search trees*	*Topological sort*
S-2	SLO-1	*Sorting: Insertion sort, shell sort, Heap sort, Merge sort, Quick sort*	*Implementation of Linked List - Insertion Linked List- Deletion and Search*	*Conversion of Infix to Postfix*	*Search tree ADT*	*Minimum Spanning Tree - Kruskal's Algorithm*
	SLO-2			*Postfix Evaluation and Balancing symbols*	***AVL Tress***	*Network flow problem*
S 3-4	SLO-1	***Lab1: :*** *Implementation of Searching - Linear and Binary Search Techniques*	***Lab 4:*** *Implementation of Array – Insertion, Deletion.*	***Lab 7:*** *Implementation of stack using array and Linked List*	***Lab10:*** *Implementation of Tree using array*	***Lab 13:*** *Implementation of Graph using Array*
	SLO-2					
S-5	SLO-1	*Asymptotic notations*	*Arithmetic operation*	*Nested Function calls*	*Tress traversals*	*Shortest Path Algorithm: Dijkstra's Algorithm*
	SLO-2	*Big O, Omega*	*Implementation of Cursor Based Methodology*	*Queue ADT*	*B-Trees*	*Hashing: Hash functions – Introduction*
S-6	SLO-1	*Theta*	*Cursor linked list*	*Applications of Recursion: Tower of Hanoi*	*AVLTrees: Rotations*	*Collision avoidance*
	SLO-2	*Problem Solving*		*Implementation of Queue using array*	*Insertions*	*Separate chaining*
S 7-8	SLO-1	***Lab 2 :*** *Implementation of sorting Techniques – Insertion sort and Bubble*	***Lab 5:*** *Implementation of Linked List - Cursor Based Implementation*	***Lab 8:*** *Implementation of Queue using Array and linked list*	***Lab11:*** *Implementation of BST using linked list*	***Lab 14 :****Implementation of Shortest path Algorithm*
	SLO-2	*Sort Techniques*				
S-9	SLO-1	*Linear and Non-Linear Data Structures*	*Implementation of circular linked list*	*Circular Queue implementation*	*B-Trees Constructions*	*Open Addressing*

	SLO-2	*Initialization of one dimensional and two dimensional array using Pointers*	*Applications of Circular List -Joseph Problem*	*Double ended queue*	*B-Trees Search*	*Linear Probing*
S-10	SLO-1	*Declaring Structure and accessing*	*Doubly Linked List algorithms*	*Priority Queue*	*B-Trees Deletions*	*Quadratic probing*
	SLO-2			*Problem solving*	*Splay tress*	*Double Hashing*
S 11-12	SLO-1	***Lab3:** Implement Structures using Pointers*	***Lab 6:** Implementation of Doubly linked List*	***Lab 9:** Applications of Stack, Queue*	***Lab12:** Implementation of B-Trees*	***Lab 15 :**Implementation of Minimal Spanning Tree*
	SLO-2					

Learning Resources	1. *Seymour Lipschutz, Data Structures with C, McGraw Hill, 2014.* 2. *R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd Edition, Thomson India, 2005.* 3. *A.V.Aho, J.E Hopcroft ,J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003.*	4. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2015.* 5. *ReemaThareja, Data Structures Using C, 1st Edition, Oxford Higher Education, 2011.* 6. *NPTEL Video lectures on "Programming, Data structures and Algorithms",Prof.Shankar Balachandran, 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	*25%*	*25%*	*10%*	*10%*	*15 %*	*15 %*	*10%*	*10%*	*10 %*	*10 %*
Level 2	Understand	*25%*	*25%*	*10%*	*10%*	*20 %*	*20 %*	*10%*	*10%*	10 %	10 %
Level 3	Apply		-	*10%*	*10%*	*15 %*	*15%*	*10%*	*10%*	*20 %*	*20 %*
Level 4	Analyze			*20%*	*20%*			*10%*	*10%*	10 %	10 %
Level 5	Evaluate							*5%*	*5%*	-	-
Level 6	Create							*5%*	*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.,

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1. Mr. SanthoshEswaran, VR Savvy, info@vrsavvy.co	*1. Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1. **Dr.S.UmaMaheswari**, SRMIST, umamahes3@srmist.edu.in*
2. Mr. Neelakandan Mani, Senior Director, CTS, pymani2010@yahoo.com	*2. Dr. B.Chittibabu, IIITDM, Kancheepuram, bcbabu@iiitdm.ac.in*	*2. **Dr. A. Vimala Juliet**, SRMIST, hod.eie.ktr@srmist.edu.in*

Course Code	18EIE205T	Course Name	TRANSDUCERS FOR BIOMEDICAL APPLICATIONS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the transduction principles and the various electrodes used in medical field.	Blooms level (1-6)
CLR-2 :	Introduce the various temperature transducers	
CLR-3 :	Understand various biomedical Instruments used for pressure measurements	
CLR-4 :	Know the various flow and displacement transducers.	
CLR-5 :	Understand the fundamental concept of bio analytical sensors	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Differentiate the transduction principles used in biomedical applications	2
CO-2 :	Examine the temperature transducers which are used for measuring various biological parameters	3
CO-3 :	Illustrate the different instruments used for measuring pressure and their principle.	4
CO-4 :	Select suitable flow and displacement transducers for diagnosis and therapeutic applications	4
CO-5 :	Analyze the recent transducers for various applications.	4

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Transduction Principles	Temperature Transducers	Pressure Transducers	Flow and Displacement Transducers	Bioanalytical Sensors
		9	9	9	9	9
S-1	SLO-1	Overview of Transducers	Overview of temperature transducers	Overview of pressure transducers	Overview of flow and displacement transducers	Biosensors
	SLO-2	Classification of transducers	Principle and applications	Principle and applications	Principle and applications	Principle, Types and applications
S-2	SLO-1	Basic requirements of bio transducers	Thermometry	Diaphragm displacement pressure transducers	Units in flow measurement	Biologically active material and analyte.
	SLO-2	Man instrument system	Types of Thermometry	Electrical transduction methods for Catheter tip transducer	**Requirements for measurement ranges**	Types of membranes used in biosensor constructions
S-3	SLO-1	Problems encountered in measuring a living system	Thermo resistive transducer	Implantable pressure transducer	Blood flow in a single vessel	Bioaffinity based biosensors
	SLO-2	Factors influencing the choice and design of the transducer in measuring the Physiological Parameters	ResistiveTemperature Detector	Micro pressure transducer	Tissue blood flow	Microorganisms based biosensors
S-4	SLO-1	Study of biological sensors in the human body	Thermistor	vascular pressure sensors-Principle	Sensors for flow in tissue and microapplications	Biocatalysts based biosensors
	SLO-2	Basic mechanism of action	Thermistor used for cardiac output measurement	Extra and intra vascular pressure sensors	Electromagnetic Blood flow transducer	Sensors for smell, sound, vision
S-5	SLO-1	Overview of static and dynamic Characteristics	Thermo emf Transducer- thermo couples;	Occlusive cuff methods	Ultrasonic flow transducer	Microbial biosensor for ammonia and nitrogen dioxide
	SLO-2	Noise in measurements	Research papers on temperature transducer applications	Strain Gauge type Blood pressure transducers	Types of Ultrasonic transducer	optical biosensor for antibody-antigen detection
S-6	SLO-1	Human cell	Thermography	Diaphragm type capacitive pressure transducer;	Implantable flow sensors	Enzyme based glucose sensor

	SLO-2	*Generation of action potentials*	*Types of Thermography*	*Piezo electric pressure transducer*	*Need and its practical applications*	*Blood-gas sensors*
S-7	**SLO-1**	*Bio-potential electrodes*	*Biomedical Applications of Thermography*	*Intra vascular fibre optic pressure transducer*	*Contact and Non contact displacement sensors, Translational and angular accelerometers*	*PO_2 sensor*
	SLO-2	*Electrical properties of electrodes*	*Research papers on Thermal imaging applications*	*Fibre optic pressure transducer for intracranial pressure measurement in new borns*	*Elasto resistive plethysmographic transducer*	*Polarographic clark and Transcutaneous PO_2 sensor*
S-8	**SLO-1**	*Methods of use of electrodes*	*Non contact type infrared thermometry ,optical pyrometer*	*Stethoscopes, Tonometry*	*Air flow transducer for Fleish pneumotachometer*	*PCO_2 electrode*
	SLO-2	*Electrodes for electric simulation of tissue*	*Nasal air flow measurement*	*Phonocardiograph sensor*	*Capacitive and displacement transducer for respiration sensing*	*SO_2 sensor of pulse oximeter*
S-9	**SLO-1**	*Selection of electrodes*	*Temperature transducers for food and medical applications*	*Research papers on pressure transducers for bio applications*	*Research papers on flow and displacement Transducers for bioapplications*	*Research papers on biosensors*
	SLO-2	*Survey of Recent Electrodes used in clinical applications*	*Demonstration of Temperature transducer*	*Demonstration of Pressure transducer*	*Demonstration of motion sensor*	*Video Demonstration of textile based sensors*

Learning Resources	*1.JohnG.Webster,"MedicalInstrumentationApplicationandDesign",JohnWileyandsons,4th Edition New York,2009.* *2.LeslieCromwell,"BiomedicalInstrumentationandMeasurement",PrenticeHallofIndia,New Delhi, 2007Carr, J.J., Elements of Electronic Instrumentation and Measurement, Pearson Education India, 2011* *3. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGrawHill Publisher, 2003.*	*4..JamesE.MooreJr,DuncanJ.Maitland,"BiomedicalTechnologyandDevices",CRC press, 2nd Edition2013* *5 .Gabor Harsanyi, "sensors in Biomedical Applications: Fundamentals, Technology and Applications", CRC press,2000.* *6.Richard S. C. Cobbold ,"Transducers for biomedical measurements: principles and applications", Wliey, 2008*

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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, Senior Director, CTS, pymani2010@yahoo.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Mrs.N.Deepa**, SRMIST*
2. Mr. Vijayarajeswaran, Managing Director, VI Microsystems Pvt.Ltd, vijay@vimicrosystems.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. **Dr.P.A.Sridhar,** SRMIST*

Course Code	18EIE301T	Course Name	BUILDING AUTOMATION SYSTEM	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Provide a basic knowledge in intelligent building and building automation systems	Blooms level (1-6)
CLR-2 :	learn different sensors and measurement systems in BMS system	
CLR-3 :	Know the basic concepts of HVAC Air handling unit	
CLR-4 :	Understand the basic concepts of HVAC terminal unit	
CLR-5 :	Explore the BAS Architecture and different communication protocols used in building automation system	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the need of intelligent buildings and automation systems	2
CO-2 :	Illustrate the working principle of the sensors for the comfort parameters	3
CO-3 :	Categorize Air handling units for different specifications and applications	4
CO-4 :	Classify terminal units of HVAC for different specifications and applications	4
CO-5 :	Model the structure of BAS for an intelligent building with necessary communication protocol	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		Introduction to Building automation systems	Comfort parameters	HVAC Basic Concepts- Air handling unit	Terminal Unit	BAS Architecture
		9	9	9	9	9
S-1	SLO-1	Introduction to intelligent building	Temperature	Concept of Air handling unit	Concept of Variable Air Volume (VAV) system	BAS Hierarchy
	SLO-2	intelligent architecture	Enthalpy, Entropy	components in AHU	different types of VAV	Field level components
S-2	SLO-1	structure	Heat Transfer - Conduction, Convection, Radiation	different types of dampers	Design, working	Direct Digital Control (DDC)
	SLO-2	Facility management vs. intelligent buildings	Working Principle, Characteristics of RTD	Working, configuration,	series fan powered	Supervisory Controller
S-3	SLO-1	Lifecycle of building	Thermistor, Thermocouple	different types of AHU	parallel fan powered	Server, Operator Workstation (OWS)
	SLO-2	Evolution of intelligent buildings	Bimetallic strip	Design and working	pressure dependent	Different communication protocol
S-4	SLO-1	Introduction to BAS	Humidity, Specific Humidity,	Operation of different modes in AHU	supply-exhaust VAV	addressing concepts
	SLO-2	Different systems of BAS	Relative Humidity, Due point, Saturation point	humidification	dual duct VAV	Open Protocols -BACnet, LON
S-5	SLO-1	HVAC	Working principle of relative humidity sensors	dehumidification	Design, working, use of radiation coil	Profibus, Modbus
	SLO-2	HVAC Applications	mounting for humidity sensors in BAS	static pressure control	chilled beam	M-bus
S-6	SLO-1	Security system	Psychrometric chart	volume matching	CRAC unit, VRV systems	Proprietary Protocols- N2, CBUS
	SLO-2	Field Devices	Pressure, Static Pressure, Velocity pressure, Absolute Pressure	cooling, heating,	unit heater, Fan coil unit and unit ventilator	Wireless filed devices

S-7	**SLO-1**	*Fire alarm system*	*Gauge Pressure, Vacuum Pressure, Differential Pressure, Sealed Pressure*	*economizer mode*	*Chilled water system*	*controllers*
	SLO-2	*Types of Detectors*	*Working Principle of Different types of Pressure Sensors*	*Heat recovery techniques*	*Concept of refrigeration cycle, components used in refrigeration cycle*	*routers*
S-8	**SLO-1**	*Modules*	*Working of principle of different air flow sensors*	*plate heat exchanger*	*different types of chilled water system*	*coordinators*
	SLO-2	*Indicating Devices*	*Working of principle of different water flow sensors*	*heat recovery wheel*	*Working and design of different types of boilers*	*Benefits of a Wireless BAS*
S-9	**SLO-1**	*lighting systems*	*Measurement of CO2 level*	*AHU for different applications*	*Working and design of different types of heat exchanger*	*Wireless Field Bus*
	SLO-2		*Working principal of BTU meter*			*Basic Reference Model (BRM)*

Learning Resources	1. Smart Buildings by Jim Sinopoli, Butterworth-Heinemann imprint of Elsevier, 2nd Edition., 2010 2. Intelligent Building Systems by Albert Ting-Pat So, WaiLok Chan, Kluwer Academic publisher,3rd Edition., 2012.	3. Design of Special Hazards and Fire Alarm Systems by Robert Gagnon, Thomson Delmar Learning; 2nd Edition, 2007.

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, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Dr.G.JoselinRetna Kumar, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mr.J.SamJeba Kumar, SRMIST*

Course Code	18EIE302T	Course Name	ELECTRICAL ENERGY MANAGEMENT AND CONVERSION	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the different types of Energy Resources	Blooms level (1-6)
CLR-2 :	Distinguish the different types of Energy Conversion techniques from the available energy resources	
CLR-3 :	Understand the methods of Energy Audit and energy management	
CLR-4 :	Understand the methods of Energy Conservation	
CLR-5 :	Know the impact of Energy systems to the Environment	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Explain the different types of Energy Resources	2
CO-2 :	Examine the different types of Energy Conversion techniques from the available energy resources	3
CO-3 :	Outline the methods of Energy Audit and Energy management	4
CO-4 :	Select the methods of Energy Conservation	4
CO-5 :	Predict the impact of Energy systems to the Environment	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills in the implementation
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
3	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Energy Resources	Energy Conversion Techniques	Energy Audit and Management	Energy Conservation	Environmental Impact of Energy Systems
		9	9	9	9	9
S-1	SLO-1	Commercial energy – Coal, Oil	Conventional Energy Conversion	General Philosophy and need of Energy Audit and Management.	Introduction to ENCON	Environmental degradation due to energy production and utilization
	SLO-2	Natural Gas, Nuclear Power,	Reversible and Irreversible cycles	Definition and Objective of Energy Management	Approach and Modern Techniques	Primary and secondary pollutants
S-2	SLO-1	Hydro	Thermodynamics analysis	General Principles of Energy Management,	Benefits, Trends	SOx, NOx , SPM in air, thermal and water pollution
	SLO-2	***Solar Energy***	Carnot, Stirling	Energy Management Skills	***Energy Conservation Technology (Thermal Energy)***	***Depletion of ozone layer***
S-3	SLO-1	Solar radiation, measurements	Otto, Diesel, Atkinson, Brayton, Rankine	Energy Management Strategy	Energy intensive industries	Global warming, biological damage
	SLO-2	Concentrating collectors	Direct conversion of thermal to electrical energy	Energy Audit: Need, Types, Methodology and Approach.	Techno-Economic evaluation	Sociological and economical problems
S-4	SLO-1	Principle of photovoltaic conversion	Thermoelectric converters	Energy Management Approach	Efficiency improvements	Health problems due to energy plants
	SLO-2	Types of solar cells	Thermoionic converters	Understanding Energy Costs	Thermal utilities	Methods of energy impact assessment
S-5	SLO-1	Photovoltaic applications	MHD	Bench marking	Boilers, steam system	Environmental pollution limits guidelines
	SLO-2	Wind energy	Chemical to Electrical energy	Energy performance	Thermal fluid heating system	Waste as a source of energy
S-6	SLO-1	Wind data and energy estimation	Batteries	Matching energy usage to requirements	Furnaces	Industrial, domestic and solid waste

	SLO-2	*Wind energy conversion devices*	*Types – working*	*Maximizing system efficiency*	*Heating and melting applications*	*Pollution control*
S-7	**SLO-1**	*Offshore wind energy*	*Hydrogen energy*	*Optimizing the input energy requirements,*	*Refractories*	*Mechanism and devices for pollution control*
	SLO-2	*Bio-energy*	*Solar photovoltaic cells*	*Fuel and Energy substitution.*	*Fuel shift: oil. Gas, coal, biomass and renewable*	*Pollution due to vehicles and utilities*
S-8	**SLO-1**	*Biomass conversion processes*	*Energy storage systems*	*The plant energy study report*	*Energy storage*	*Method to control emission*
	SLO-2	*Types of biogas plants*	*Fuel cells – Types, Working*	*Importance, contents,*	*Techno commercial analysis*	*International standards for quality of air*
S-9	**SLO-1**	Ocean energy, Tidal, Geothermal	*Performance of fuel cell*	*Effective organization,*	*Economical aspects*	*Norms for exhaust gases*
	SLO-2	*Fuelcell and its applications*	*Applications*	*Report writing and presentation.*	*Practical energy conservation measures in government and non-government organizations*	*United nation framework convention on climate change*

Learning Resources	*1. Christen Thomas, Efficiency and Power in Energy Conversion and Storage: Basic Physical Concepts, CRC Press, 2019* *2. Frank Kreith, Energy Management and Conservation Handbook, Second Edition, CRC Press, 2016.*	*3.Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012* *4. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill,2007*

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.T.A.Balaji, Robert Bosch, Coimbatore, Balaji.TAnanthanpillai@in.bosch.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1.* ***Dr.G.Y. Rajaa Vikhram****, SRMIST*
2. Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com	***2. Dr.S.Latha, TCE, Madurai, sleee@tce.edu***	

Course Code	18EIE303T	Course Name	AUTOMOTIVE SENSORS AND SMART SYSTEMS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the basics of automotive systems, workshop safety, Multiplexed wiring systems and supporting electrical concepts.	Blooms level (1-6)
CLR-2 :	Understand the principles behind various powertrain sensors and its application across a vehicle.	
CLR-3 :	Know the principles and applications behind various body sensors and actuator technologies used in a vehicle.	
CLR-4 :	Know and understand the need of different safety and security systems.	
CLR-5 :	Know about different electronic systems and smart interactive systems in the car.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the effect of electromagnetic interference on automotive electronic systems.	2
CO-2 :	Describe the principles of powertrain sensors used in a vehicle.	2
CO-3 :	Examine the body sensors and actuator technologies involved in a car.	3
CO-4 :	Analyze the various safety and security systems involved in a car.	4
CO-5 :	Apply his/her knowledge to design new electronic supportive systems for a car.	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3		-

Duration (hour)		Fundamentals of Automotive Electronics	Power Train Sensors	Body Sensors and Actuator Technology	Safety and Security Systems	Smart Supporting Systems
		9	9	9	9	9
S-1	SLO-1	Introduction to Automotive Electronics	Introduction to IC Powertrain and its operation	Rain Sensor	Tire pressure monitoring systems	Power Windows
	SLO-2	Outline to Automotive Sensors	Intake Air Temperature (IAT) Sensor Engine Coolant Oil Temperature Sensor	Acceleration Sensor		Smart Window Lift Control Module
S-2	SLO-1	Requirements in Automotive Sensor	Exhaust Gas Recirculation Temperature Sensor	Yaw Rate Sensor	Anti-lock braking system	Central Locking System
	SLO-2	Open and Closed Loop Control Strategies	Exhaust Gas Temperature Sensor	Chassis Level Sensor		Door Lock Indicators
S-3	SLO-1	Shop safety – General safety	Manifold Absolute Pressure (MAP) Sensor	Fuel Level Sensor	Traction Control System	Automatic Wiper systems
	SLO-2	Electrical Safety	High Pressure Fuel Sensor,	Capacitive based Pressure Sensor		Electronic Vehicle Immobilizer
S-4	SLO-1	Office Safety	Engine Oil Pressure Sensor	Steering Wheel Sensor	Adaptive Cruise Control,Types of Adaptive Cruise Control	Oil Pressure Warning System
	SLO-2	Lifting Procedures	Crankshaft Angular Position Sensor	Torque Sensor		Engine Overheat Warning System
S-5	SLO-1	Electrical wiring, Terminals & Switching	Cam Position Sensor	Actuators – Electric, Electromechanical, Electromagnetic, Hydraulic and Pneumatic	Parking guide systems	Speed Warning System
	SLO-2		Piston Position Sensor		Air Bag System	Brake Actuation Warning System
S-6	SLO-1	Multiplexed Networking	Throttle Plate Angular Position	Stepper Motors, Relays	Reversible Seat Belt Pre-tensioner	Gear Neutral Indicator
	SLO-2		Knock Sensor		Electronic Power Steering systems	Anti-Theft Alarm System

S-7	**SLO-1**	*Circuit Diagrams and Symbols*	*Oxygen Concentration Sensor*	*Applications of Body Sensors*	*Vehicle Stabilization System*	*Computer Controlled Air Conditioning Systems*
	SLO-2	*Electromagnetic Interference*	*Mass Air Flow (MAF) Rate Sensor*			
S-8	**SLO-1**	*Electromagnetic Compatibility*	*Applications*	*Applications of Actuators*	*Collision Avoidance System*	*Power & Ventilated Seats*
	SLO-2	*Use of Diagnostic Equipment – On board Diagnostics*				*Roof Control Module*
S-9	**SLO-1**	*Case Study I*	*Case Study II*	*Case study III*	*Case study IV*	*Case study V*
	SLO-2					

Learning Resources	*1. Tom Denton, "Automotive Electricals / Electronics System and Components", 3rd Edition,2004.* *2. BOSCH, "Automotive Electrics, Automotive Electronics: Systems & Components, BOSCH", 4th Edition, 2005.*	*3. Jack Erjavec," A Systems Approach to Automotive Technology" Cengage Learning, 2009.* *4. Edited by Ronald K.Jurgen, "Automotive Electronics Reliability", Vol 2, SAE International, 2010*

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	-	-	*60 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-		-	*30 %*	-	*20 %*	-	*30 %*	-
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. S Immanuel Singh,Robert Bosch Engineering and Business Solutions Private Limited, ImmanuelSingh.SundarS@in.bosch.com	*1. Dr. J. Prakash, MIT, Chennai,prakaiit@rediffmail.com*	*1. Mr. Arockia Vijay Joseph, SRMIST*
2.Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi,Damascus University, fawwazm@gmail.com*	*2. Dr.G.Joselin Retna Kumar, SRMIST*

Course Code	18EIE304T	Course Name	MACHINE LEARNING	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Know the basic knowledge about machine learning	Blooms Level (1-6)
CLR-2 :	Understand the concept of data preprocessing and supervised learning	
CLR-3 :	Provide the basic knowledge in unsupervised learning and Bayesian network	
CLR-4 :	Introduce the basic concepts of neural network and applications of machine learning in industrial sector	
CLR-5 :	Provide the adequate knowledge on industry using machine learning	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Understand the fundamental concepts and methods of machine learning	2
CO-2 :	Analyze various machine learning application based on data pre-processing and supervised learning	4
CO-3 :	Evaluate the architecture of un supervised learning and Bayesian network	3
CO-4 :	Implement the neural network architecture for industrial applications	3
CO-5 :	Construct the working of various learning algorithms of Neural network and use its application in machine learning	1

	Program Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	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	PSO – 1: ProfessionalAchievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze&Research
CO-1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
CO-4	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-
CO-5	2	3	-	-	-	-	-	-	-	-	-	-	-	-	1

Duration (hour)		INTRODUCTION	DATA PREPROCESSING AND SUPERVISED LEARNING	UN SUPERVISED LEARNING & BAYESIAN NETWORKS	NEURAL NETWORK AND APPLICATION IN INDUSTRIES	CASE STUDY
		9	9	9	9	9
S-1	SLO-1	Machine Learning Introduction	Data quality – Data preprocessing, Data Cleaning:– Handling missing data and noisy data	Hierarchical Clustering	Multi Layer Perceptron	Machine level case study: Introduction
	SLO-2			Spectral clustering	Backpropagation Learning Algorithm	
S-2	SLO-1	Types of MachineLearning- SupervisedLearning- UnsupervisedLearning	Data integration:- Redundancy and correlation analysis Continuous and Categorical Variables	Affinity propagation Probabilistic clustering	Neural Network fundamentals	Case study
	SLO-2					Fingerprint of industrial motors
S-3	SLO-1	Regression	Principal Components Analysis	Mean Shift Clustering	Activation functions	Performance of industrial motor as a fingerprint
	SLO-2	Classification	Factor Analysis	Problem Solving	Types of Loss Function	
S-4	SLO-1	The Machine Learning Process:- Data Collection and Preparation	Independent Components Analysis	Introduction		Clustering algorithm for fingerprint development
	SLO-2			Bayesian network	Optimization: Gradient Descent Algorithm	
S-5	SLO-1	Feature Selection	Supervised Learning: Linearly separable and nonlinearly separable populations	Bayesian classifier		Agglomerative Hierarchical Clustering
	SLO-2	Algorithm Choice	k-means algorithm	Inference in Bayesian classifier	Stochastic Gradient Descent	K-means clustering

S-6	**SLO-1**	*Parameter and Model Selection – Training Evaluation*	*Logistic Regression Radial Basis Function Network*	*Types of inference*	*Batch Normalization and Dropouts*	*Spectral clustering*
	SLO-2				*Applications of Neural Network.*	
S-7	**SLO-1**	*Bias-Variance Tradeoff – Under fitting and Over fitting Problems.*	*Support Vector Machines, Kernels – Risk and Loss Functions*	*Learning Bayesian from data*	*Introduction*	*Affinity propagation*
	SLO-2			*Parameters and structures*	*Relationship between machine learning and industry*	*Gaussian model mixture clustering*
S-8	**SLO-1**	*Bias and Variance*	*Support Vector Machine Algorithm*	*Modeling dynamic scenarios with Bayesian network*	*Energy sector*	*Implementation details*
	SLO-2		*Multi Class Classification*		*Oil and gas*	*Production level case study*
S-9	**SLO-1**	*Problem Solving*	*Support Vector Regression.*	*Hidden markov chain*	*Industrial Sector*	*Laser surface heat treatment*
	SLO-2		*Problem solving*		*Industrial goods and services*	*Image acquisition and response time requirement*

Learning Resources	1. *Pedro Larrañaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza., "Industrial Applications of Machine Learning", CRC Press, 2019* 2. *Tom M. Mitchell, "Machine Learning", Indian Edition, 2017* 3. *Thomas A. Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis, Springer Vieweg, 2nd Edition,2016.* 4. *Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2011* 5. *NPTEL video lectures on "Introduction to machine learning",Prof. Balaraman Ravindran, 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	*50%*	-	*20%*	-	*30 %*	-	*50%*	-	*20%*	-
Level 2	Understand	*50%*	-	*20%*	-	*40 %*	-	*50%*	-	*30%*	-
Level 3	Apply		-	*20%*	-	*30 %*	-	-	-	*30%*	-
Level 4	Analyze			*40%*						*20%*	
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. Santhosh Eswaran, VR Savvy, info@vrsavvy.co	*1. Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1. Dr.S.UmaMaheswari, SRMIST, umamahes3@srmist.edu.in*
2. Mr. Neelakandan Mani, Senior Director, CTS, pymani2010@yahoo.com	*2. Dr. B.Chitti babu, IIITDM, Kancheepuram, bcbabu@iiitdm.ac.in*	*2. Dr. A. Vimala Juliet, SRMIST, hod.eie.ktr@srmist.edu.in*

Course Code	18EIE305T	Course Name	BIOMEDICAL DEVICES AND INSTRUMENTATION	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the physical foundations of biological systems and the various electrodes used in medical field.	Blooms level (1-6)
CLR-2 :	Introduce the various physiological signal measurements	
CLR-3 :	Understand various biomedical Instruments used for non-electrical parameter measurement provide an overview about electrical parameter acquisition and recording	
CLR-4 :	Know the various medical imaging systems.	
CLR-5 :	Understand the fundamental concept of life assisting and therapeutic devices.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the operation of different medical devices.	2
CO-2 :	Determine the techniques to measure, detect and analyze thebio-signals	3
CO-3 :	Select the appropriate medical instruments for measurement	4
CO-4 :	Analyze the suitable medical imaging system for diagnosis	4
CO-5 :	Interpret the medical devices for diagnosis and therapeutic applications	2

Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
	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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Basic Concepts Of Medical Instrumentation	Biomedical Signal Acquisition And Analysis	Measurement Of Non Electrical Parameters	Medical Imaging Systems	Assisting And Therapeutic Devices
		9	9	9	9	9
S-1	SLO-1	Medical Instrumentation systems	Types and Classification of biological signals	Measurement of blood pressure	X-radiations, Introduction, Uses	Pacemakers
	SLO-2	Classification of Biomedical instruments	Generation of biological signals	Direct and Indirect method	X-ray tube	Types and pacing modes
S-2	SLO-1	Man instrument system	Filters, Amplifiers, Preamplifiers	Cardiac output Measurement	X-ray machine, image analysis	Defibrillators
	SLO-2	Problems encountered in measuring a living system	Differential amplifiers	Ficks method, Indicator dilution method, Thermo dilution method	Radiography, fluoroscopy	AC and DC defibrillators
S-3	SLO-1	Review of human body systems	Chopper amplifiers , Isolation amplifier	Blood flow Measurement	Computer tomography	Ventilators
	SLO-2	Cell and its structure	Circuit Design example	Magnetic, Ultrasonic blood flowmeter	Basic principle and working	Methods of artificial respiration, Types of ventilators
S-4	SLO-1	The heart and cardiovascular system	ECG	Blood flow meter- radiographic, thermal convection methods	Magnetic resonance imaging	Nerve and muscle stimulators
	SLO-2	Electrophysiology of cardiovascular system,	Lead systems and recording methods – Typical waveforms	Indicator dilution method	Basic principle and working	Electrotheraphy
S-5	SLO-1	Physiology of the respiratory system	EEG	Pulmonary function measurements	Positron emission tomography	Diathermy
	SLO-2	Nervous system	Lead systems and recording methods – Typical waveforms	Spirometer	Single photo emission computer tomography	Heart Lung machine
S-6	SLO-1	Bio-potentials	EMG	Plethysmography	Ultrasonography	Audio meters

	SLO-2	*Electrical activity of excitable cells*	*Lead systems and recording methods, Typical waveforms*	*Body Plethysmography*	*Endoscopy*	*Dialyzers*
S-7	**SLO-1**	*Resting and action potential*	*ERG*	*Photo Plethysmography*	*Thermal Imaging*	*Therapeutic and Prosthetic Devices*
	SLO-2	*Propagation of action potentials*	*Lead systems and recording methods , Typical waveforms*	*BSR and GSR measurements*	*Types of Thermal imaging*	*Infant Incubators*
S-8	**SLO-1**	*Bio-potential Electrodes*	*Electrical safety in medical environment*	*Blood Gas analyzers*	*Introduction to medical image analysis*	*Drug Delivery Devices*
	SLO-2	*Electrode behavior and circuit models*	*Micro and macro Shock hazards*	*Measurement of blood pH,pCO2,pO2,*	*Overview of imaging techniques*	*Artificial limb and hands*
S-9	**SLO-1**	*Types of electrodes*	*Devices to protect against electrical hazards*	*Finger- tip oximeter*	*Visit to Diagnostic centers*	*Telemetry*
	SLO-2	*Survey of recent electrodes used in biosignal acquisition*	*Leakage current Instruments for checking safety parameters of biomedical equipments*	*Survey of recent measuring devices and its features*	*Survey of recent imaging devices and its features*	*Hospital/ Industrial visit*

Learning Resources	*1.JohnG.Webster,"MedicalInstrumentationApplicationandDesign",JohnWileyandsons,4th Edition New York,2009.* *2.LeslieCromwell,"BiomedicalInstrumentationandMeasurement",PrenticeHallofIndia,New Delhi, 2007* *3.JamesE.MooreJr,DuncanJ.Maitland,"BiomedicalTechnologyandDevices",CRCpres s, 2nd Edition2013*	*4.Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, 3rd Edition, New Delhi,2014.* *5.Joseph J. Carr and John M. Brown," Introduction to Biomedical Equipment Technology", John Wiley and sons, 4th Edition, New York,2000* *6.Carr, J.J., Elements of Electronic Instrumentation and Measurement, Pearson Education India, 2011*

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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, Senior Director, CTS, pymani2010@yahoo.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mrs.N.Deepa, SRMIST*
2. Mr. Vijayarajeswaran, Managing Director, VI Microsystems Pvt.Ltd, vijay@vimicrosystems.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. P.A.Sridhar, SRMIST*

Course Code	18EIE306T	Course Name	INDUSTRIAL INTERNET OF THINGS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the internet principles and various components of IoT	Blooms level (1-6)
CLR-2 :	Give an overview of the Interconnection and Integration of the Physical World with Cyber Space.	
CLR-3 :	Understand the architecture and specifications of a given network	
CLR-4 :	Know the challenges in the deployment of IIoT and security issues	
CLR-5 :	Provide an insight into Design and Development of IoTapplication	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Apply the knowledge of Internet principles and protocols to understand the architecture and specifications of a given network	3
CO-2 :	Demonstrate a simple IoT application using prototyping boards	3
CO-3 :	Select the appropriate protocol for a specific network implementation	4
CO-4 :	Use the security level needed for a particular industrial IoT application	3
CO-5 :	Analyze and Interpret the process data using cloud based process data management tools	4

	Program Outcomes (PO)														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
	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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4 :	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-5 :	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Internet principles &IoT Overview	Physical and logical design methodologies	Protocols and clouds for IoT	Industrial IoT	IIoT Applications
		9	9	9	9	9
S-1	SLO-1	Definition and Characteristics	Requirements	different protocols	Introduction to the Industrial Internet	Introduction
	SLO-2	IoT enabling technologies	Specifications	MQTT protocol, components of MQTT	Basis of Industrial IoT	IIoT for industrial processes
S-2	SLO-1	ISO/OSI model	Device and Component Integration	CoAP -Constrained Application Protocol.	challenges in the deployment of IIoT	industrial control systems
	SLO-2		Physical design using prototyping boards	CoAP _types of messages	benefits of IIoT	PLC
S-3	SLO-1	MAC address and IP address	Sensors	request response model	applications of the industrial internet	DCS
	SLO-2	Overview of TCP/IP	actuators	features	advantages of the industrial internet	SCADA
S-4	SLO-1	Classes of IP addresses	choice of processor	XMPP-Extensible Messaging and Presence Protocol	Networked Control Systems	IIoT Applications: Smart factory
	SLO-2	Basics of DNS	interfacing and networking	Advanced Message Queuing Protocol, Features	Network delay modeling	
S-5	SLO-1	Static and dynamic addressing	Logical Design	IEEE 802.15.4	IIoT architecture	IIoT Applications: Food Industry
	SLO-2	Salient features of IPV4	Open source platforms	ZigBee protocol , Xbee modules		

S-6	**SLO-1**	*Specifications of IPV6*	*Techniques for writing embedded code*	Wireless HART, Z-Wave, Field bus	Industrial IoT: Processing	IIoT Applications: Inventory Management & Quality Control
	SLO-2	*6LoPAN*	*Case studies and examples using Python programming*	*ISA 100, Bluetooth, NFC and RFID*	Characteristics, Challenges	
S-7	**SLO-1**	functional components of IoT	*examples using Arduino/Raspberry Pi prototyping boards*	*Introduction to cloud storage models*	Architecture and design methodologies for developing IoT application for Networked Control Systems	IoT Applications: Plant Security and Safety
	SLO-2			*communication APIs*		
S-8	**SLO-1**	IoT gateways	IoT application development using Wireless Sensor Networks	*Web application framework*	*Security Issues*	IIoT Applications: Facility Management
	SLO-2	challenges,		*Designing a web API*		
S-9	**SLO-1**	service oriented architecture	*Single Node Architecture, Hardware Components*	*Web services*	*Middleware IIOT platforms*	IIoT Applications: Oil, Chemical and Pharmaceutical Industry
	SLO-2		*Energy Consumption of Sensor Nodes*	*Designing a web API*	*securing the Industrial Internet*	IIoT Applications: Manufacturing Industries

Learning Resources	1.ArshdeepBahga and Vijay Madisetti, "Internet of Things A Hands-on Approach", Universities Press (India),2015 2.Alasdair Gilchrist," Industry 4.0:The Industrial Internet of Things", Apress,2016.	3.AdrianMcEwenandHakimCassimally,"DesigningtheInternetofThings",John Wiley& Sons, 2014 4.FrancisDacosta, "Rethinking the Internet of Things", Apress Open,2013.

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 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*40 %*	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	40 %	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	*30 %*	-	*30 %*	-	*20 %*	-	*30 %*	-
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.G.Joselin Retna Kumar, SRMIST
2. Mr. P.Prashanth, Sr.Engineer, Mitsubishi Electric India, P.Prashanth@asia.meap.com	*2.* Prof. FawazHamadMofdi, Damascus University, Syria,fawwazm@gmail.com	

Course Code	18EIE307T	Course Name	MODERN CONTROL TECHNIQUES	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Give the knowledge about Digital controllers	E
CLR-2 :	Impart the knowledge of Multi loop and multivariable control design	
CLR-3 :	Give basic knowledge in model predictive control	
CLR-4 :	Understand the methods and steps involved to design of adaptive control	
CLR-5 :	Understand the methods and steps involved to design of optimal control	
CLR-6 :	impart the applications of modern control techniques in process industries	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Determine a digital controllers for various systems	3
CO-2 :	Impart the knowledge to design a controller for MIMO systems	3
CO-3 :	Employ the elements and design of model predictive control for various systems	4
CO-4 :	demonstrate the adaptive control using various methods	4
CO-5 :	Analyze an optimal controlfor various systems by using different methods	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Engineering	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for continuous& discrete	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
3	-	-	3	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Digital Control	Multi Loop Regulatory Control	Model Predictive Control	Adaptive Control	Optimal Control
		9	9	9	9	9
S-1	SLO-1	Digital PID	Introduction Multi Loop Control	Introduction to Model Predictive Control	Introduction to Adaptive Control Linear Feedback	Introduction and Review of Basic Concepts
	SLO-2			Time Delay Systems		
S-2	SLO-1	Deadbeat's algorithm	Process Interaction	Smith Predictor Method Description on MPC Elements	effects of process variations, adaptive schemes and related adaptive control problem	Introduction, Motivation and SSApproach and Matrix Theory ,Review of Numerical Methods
	SLO-2					
S-3	SLO-1	Deadbeat's controller design	Pairing of Inputs and outputs	Types of MPC algorithms Review of MPC algorithms	Real Time parameter estimation	Static Optimization
	SLO-2					
S-4	SLO-1	Dahlin's algorithm	The Relative Gain Array	State space formulation Dynamic Matrix Control	Least squares and regression models	Optimal Control through Calculus of Variation
	SLO-2					
S-5	SLO-1	Dahlin's controller design	Construction of relative gain array	Prediction	Estimating parameters in dynamic systems	Classical Numerical Techniques for Optimal Control
	SLO-2			Measurable Disturbances		
S-6	SLO-1	Kalman's algorithm	Multi loop PID Controller	Control Algorithm	simulation of recursive estimation, Deterministic Self tuning regulators	Discrete-time Optimal Control
	SLO-2					
S-7	SLO-1	Kalman's controller design	Decoupler	Model Algorithmic Control: Process Model	Pole placement design, Direct and Indirect self-tuning regulators Stochastic and Predictive self-tuning regulators	State Dependent Riccati Equation
	SLO-2					

S-8	***SLO-1***	*Pole placement controller*	*Multi variable control*	*Prediction, Control Law*	*Unification of Direct self-tuning Regulators*	*LQ Observer and Kalman Filter Design*
	SLO-2					
S-9	***SLO-1***	*Position and velocity form of PID*	*Applications of multi loop control in various process industries*	*Case Study 1: Water heater Control using Dynamic Matrix Control*	*Linear Quadratic STR, Adaptive Predictive Control*	*Linear Quadratic Guassian Design*
	SLO-2					

Learning Resources	***1. Gopal, M., "Digital Control and State Variable Methods", Tata McGraw Hill, 3rd Edition, 2003*** ***2. Wiley John Seborg, D.E., Edgar,T.F. and Mellichamp, D.A., "Process Dynamics and Control, 3rd Edition , 2010*** ***3.Sasa V. Rakovic, William S. Levine Handbook of Model Predictive Control,– 2018,***	***4. Adaptive Control: Second Edition, Karl J. Åström, Bjorn Wittenmark - 2013*** ***5. Donald E. Kirk Optimal Control Theory: An Introduction,doverpublications,2012***

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 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	20 %	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	*30 %*	-	*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, MANAGING DIRECTOR, Vi micro Pvt.Ltd	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Mr.P.Jekan**SRMIST*
2. Mr.SrinathDesign Engineer Instrumentation, , srinath.vigneshwar@gmail.com, VA TECH WABAG	*2. Dr. Mohamed Khaled Chahine,Yarmouk Private University,Damascus Syria*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	15EIE308T	Course Name	FAULT DIAGNOSIS AND TOLERANCE SYSTEM	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Give basic knowledge in fault diagnostics and tolerance system	
CLR-2 :	Understand the methods of detection of Fault in process	
CLR-3 :	introduce the process of diagnosis of fault using different methods	
CLR-4 :	Know the steps involved todesign of controller for fault tolerant	
CLR-5 :	Give adequate information about the application of fault in electrical systems	
CLR-6 :	Know the applications of fault tolerant control in process industries	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Identify the elements and develop the model for fault diagnostics and tolerance system	3
CO-2 :	Employ the different methods for fault detection	3
CO-3 :	Interpret the methods of fault diagnostics	3
CO-4 :	Design of fault tolerant control and identify its elements	3
CO-5 :	Analyze the applications of fault tolerant system in various process and systems	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for	Utilize PLC & DCS for	Effective management
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		Introduction	Fault-Detection Methods	Fault-Diagnosis Methods	Fault-Tolerant Systems	Application
		9	9	9	9	9
S-1	SLO-1	Types of faults	Process Models	Diagnosis procedures	Fault tolerant control problem	Fault detection and diagnosis of DC motor drives
	SLO-2	different tasks of Fault Diagnosis	Fault Modelling	Diagnosis problems		
S-2	SLO-1	Implementation of Fault Diagnosis	Signal models	Diagnosis knowledge representation	Fault tolerant control architecture	DC motor control drives
	SLO-2			Typical statistical symptom		
S-3	SLO-1	Different approaches to FDD	Fault detection with limit checking	distributions Fault diagnosis	Fault-tolerant linear quadratic design	Electrical throttle valve actuator
	SLO-2	Model free approaches		Fault diagnosis with classification methods		
S-4	SLO-1	Model based approaches	Fault detection with signal models	Bayes Classification	Fault-tolerant model matching design	Fault detection and diagnosis of a centrifugal pump
	SLO-2			Examples		
S-5	SLO-1	Mathematical representation of Faults	Fault detection with process-identification methods	Polynomial Classification	Control reconfiguration of actuator or sensor failure	pipe-system
	SLO-2			Neural Networks for fault diagnosis		
S-6	SLO-1	Mathematical representation	Fault detection with parity equations	Fault diagnosis with inference methods	Fault-tolerant H∞ design	

	SLO-2	*Disturbances*		*Approximate reasoning*		*Fault detection and diagnosis of an automotive suspension*
S-7	SLO-1	*Additive and Multiplicative types*	*Fault detection with state observers*	*Hybrid neuro-fuzzy systems*	*Handling the fault recovery transients*	*Fault detection and diagnosis of an automotive pressures*
	SLO-2		*Fault detection with state estimation*	*Parity space approach*		
S-8	SLO-1	*Design of Residual generator*	*Fault detection of control loops*	*Optimization based approach*	*Progressive fault accommodation*	*Fault tolerant control of a three tank system*
	SLO-2					
S-9	SLO-1	*Residual specification and Implementation*	*Fault detection with Principal Component Analysis*	*Kalman filter approach*	*exercises*	*Fault tolerant control of a chemical process*
	SLO-2					

Learning Resources	1. ***Rolf Isermann,Fault-Diagnosis Systems, ,Springer-Verlag Berlin Heidelberg 2006*** 2. ***Janos Gertler, Fault Detection and Diagnosis in Engineering Systems, Routledge,2017.*** 3. ***Adel HaghaniAbandan Sari,Data-Driven Design of Fault Diagnosis Systems: Nonlinear Multimode Processes, Springer-Verlag 2014***	4. ***MogensBlanke, Michel Kinnaert,Jan LunzeDiagnosis and Fault-Tolerant Control,Springer-Verlag Berlin Heidelberg 2016*** 5. *israelkorian,c.Mani Krishna,Fault tolerant system,**Elsevier**2010*

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, MANAGING DIRECTOR, Vi micro Pvt.Ltd	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Mr.P.Jekan,** SRMIST*
2Mr. Neelakandan Mani, Senor Director, CTS,	*2. Prof. Fawaz Hamad Mofdi,Damascus university*	*2. **Mr.Arockia vijay Joseph,**SRMIST*

Course Code	18EIE309T	Course Name	E-VEHICLE SYSTEMS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Impart the skills to understand the electrical systems, wiring and its allied technical concepts.	
CLR-2 :	Provide students with a good understanding on batteries and its types	
CLR-3 :	Know the concepts ofbattery charging systems and its requirements	
CLR-4 :	Know and understand the electric powertrain systems and its testing methods.	
CLR-5 :	Know about the lighting systems and mandatory automotive instrumentation that supports the effortless driving.	
CLR-6 :	Impart students with the knowledge about the new developments and advancements of automotive electrical technologies.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PLO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
			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 :	Interpret the electrical systems & its allied technical concepts in an electrical vehicle application.	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2 :	Identify the role of batteries in vehicles and choose the right battery for the specified application.	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Interpret a charging system and apply for electric vehicles.	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4 :	Examine the electric powertrain systems and its requirements and advancements.	2	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-5 :	Establish the knowledge on all possible supportive systems for electric vehicles.	2	3	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-6 :	Summarize the passive restraint systems and electrical accessories in vehicles and to design and apply various electrical outlet systems for vehicles	3	3	-	-	2	-	-	-	-	-	-	-	-	-	2	-

Duration (hour)		Electrical Systems and Circuits	Batteries	Charging Systems	Electric Power Train Systems	Supporting Systems and Accessories
		9	9	9	9	9
S-1	SLO-1	System approach	Overview of Battery	Charging systems – Requirements	Challenges in the path of Transition from IC Engines to Electric Engines	Insulated and earth return systems, positive and negative earth systems,
	SLO-2		Battery Parameters	Components and operation		
S-2	SLO-1	electrical wiring, terminals and switching	Types of Battery	Testing Procedures	Requirements	Concealed headlights Lighting circuit types
	SLO-2		Lead – Acid Battery			glare and preventive methods
S-3	SLO-1	multiplexed wiring systems	Battery Charging & Discharging	Generation of electrical energy in motor vehicle, physical principles	Types of Motors	speedometer
	SLO-2	Controller Area Network Protocol	Maintenance			oil and temperature gauges
S-4	SLO-1	circuit diagrams and symbols,	Diagnosing Lead acid battery faults	Alternators	Motors and Circuits	Horns, Defoggers
	SLO-2	Requirements for two-wheelervehicles	Li-ion Battery			Power windows
S-5	SLO-1	Requirements for three-wheeler vehicles, Requirements for heavy vehicles	Types of Li-ion Battery	Characteristic curves	Operation of Motors	Wipers, washers, Blower motors
	SLO-2		Charging and Discharging			

S-6	**SLO-1**	*Electromagnetic Standards and Interference*	*Hydrogen Fuel Cell*	Charging circuits	*Testing System and Methodologies*	*HVAC*
	SLO-2	*SAE Automotive EMC Standards, IEEE Standards Related to EMC*				
S-7	**SLO-1**	*The Electromagnetic Environment of an Automobile Electronic System*	*Fuel Cell Design – Stack Size, Number of Cells, Stack Configuration*	Diagnosing charging system faults	*Diagnosing system faults*	Climatic Control Systems
	SLO-2	*EMC between various vehicular systems*				
S-8	**SLO-1**	*EMC between the vehicle and its surrounding –ensuring interference suppression and immunity to interference*	*Comparative analysis on all the batteries*	*Alternative Charging Systems*	*Updated Research on E-Power train System*	Power seats
	SLO-2					Ventilated Seats, Seat belt pretensioners
S-9	**SLO-1**	*New developments in systems and circuits*	*New Developments in Electrical Storage and Batteries*	*Case study I*	*Case study II*	*Case studyIII*
	SLO-2					

Learning Resources	*1.*BehroozMashadi and David Crolla, "Vehicle Powertrain Systems", 1st edition, Wiley, 2012 *2. Tom Denton, "Automotive Electricals / Electronics System and Components", 3rd Edition,2004.* *3. BOSCH, "Automotive Electrics, Automotive Electronics: Systems & Components, BOSCH", 4th Edition, 2005.*	*. 4. Jack Erjavec," A Systems Approach to Automotive Technology" Cengage Learning, 2009.* *5. Edited by Ronald K.Jurgen, "Automotive Electronics Reliability", Vol 2, SAE International, 2010*

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. S Immanuel Singh,Robert Bosch Engineering and Business Solutions Private Limited, ImmanuelSingh.SundarS@in.bosch.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mr. Arockia Vijay Joseph, SRMIST*
2. .Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University,fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIE310T	Course Name	INTELLIGENT SYSTEMS AND CONTROL	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the concept of machine intelligence and its real-world applications.	
CLR-2 :	Understand the theoretical principles of neural networks and fuzzy logic systems and control.	
CLR-3 :	Know and understand the process of modelling using neural modelling techniques.	
CLR-4 :	Impart the skills to implement the neural network control algorithms.	
CLR-5 :	Impart the skills to implement the different fuzzy control methodologies.	
CLR-6 :	Understand the implementation of the design of the neural and fuzzy control techniques using updated simulation tools.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Represent the concept of 'machine intelligence' and determine the real-world applications of such technologies.	2
CO-2 :	Explain the theoretical principles of Neural Networks and Fuzzy Logic, and relate those principles to neural-fuzzy modelling and fuzzy control.	2
CO-3 :	Develop the models of any system and to design neural network-based control.	3
CO-4 :	Identify and apply various neural network control algorithms	2
CO-5 :	Design different fuzzy control methodologies.	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Neural Network System	Fuzzy System	Introduction to Neural Control	Neural Control System	Fuzzy Control System
		9	9	9	9	9
S-1	SLO-1	Linear Neural Networks	Review of Conventional Sets	Adaptive Control Paradigms: Direct Adaptive Control	Visual Motor Coordination	Fuzzy Logic Controllers (FLC) – Mamdhani Type
	SLO-2		Introduction to fuzzy sets	Indirect Adaptive Control	Camera Calibration Method	Takagi-Sugeno Type
S-2	SLO-1	Multi Layered Neural Networks	Membership functions	Non-Linear Systems	Kohonen Self Organizing Map(KSOM)	Basic architecture of an FLC, Parameter optimization, Genetic Algorithm
	SLO-2		Operations on fuzzy sets	Neural Network Models & Neural Control Architecture	***Extended***Kohonen Self Organizing Map	***FLC for a single link manipulator***
S-3	SLO-1	Back Propagation Algorithm	Fuzzy relations	Network inversion in control	Visual Motor Coordination with Quantum Clustering – Motivations	Univariate Marginal Distribution Algorithm
	SLO-2		Projection of Fuzzy Relations, Cylindrical Extension of Fuzzy Relations	System identification using feedforward network.	Algorithm and General Results	Robot Arm Control
S-4	SLO-1	Radial Basis Function Networks	Fuzzy Max-Min and Max product composition Operation	Network Inversion using gradient descent and Lyapunov Function	Problems using Quantum Clustering, Training Algorithm	Fuzzy Control of a pH Reactor
	SLO-2		Linguistic Variables, Fuzzy Rule Base	Network Inversion using Extended Kalman Filter & Simulation Results	Comparison with KSOM based algorithm	
S-5	SLO-1	Adaptive Learning Rate	Fuzzy Implication Relations	Neural Model of a Robot Manipulator	Introduction to Direct Adaptive Control of Manipulators	Fuzzy Lyapunov Controller – Computing with words
	SLO-2	Weight Update Rules	Fuzzy Compositional Rules	An open loop unstable system	Direct Adaptive Control Schemes	

S-6	**SLO-1**	*Recurrent Networks Back Propagation through Time*	*Approximate Reasoning for Discrete and Continuous Fuzzy sets using graphical representation.*	*Neural Network Training and Data insufficiency*	*Computed Torque Control*	*Controller Design for a T-S Fuzzy Model*
	SLO-2			*Generation of data.*	*Adaptive Control*	
S-7	**SLO-1**	*Recurrent Networks Real Time Recurrent Learning*	*Need of Fuzzy Control*	*Query based Learning*	*Robust Control*	*Simulation Results*
	SLO-2		*Typical Fuzzy Control System*		*Neuro Adaptive Control*	
S-8	**SLO-1**	*Self-Organising Map*	*Classical and Fuzzy PID Controller*	*Indirect Adaptive Control of a Robot Manipulator*	*Neural Network based Adaptive Control*	*Linear Controllers using T-S Fuzzy Model*
	SLO-2		*Architecture of a Mamdani type Fuzzy Control System*		*Lyapunov Based Design, Back Stepping Method*	
S-9	**SLO-1**	*Multidimensional Networks*	*T-S Fuzzy Model*	*Adaptive Neural Control for Affine Systems SISO & MIMO.*	*Backstepping Control Design using Neural Network*	*Simulations Results*
	SLO-2		*Summary*		*Simulation – Rigid Link Electrically Driven Manipulator*	

Learning Resources	1. *NPTEL Online Learning on Intelligent Systems and Control, by Prof.Laxmidhar Behera, IIT Kanpur* 2. *Passino, K.M. and S. Yurkovich. Fuzzy Control. Addison-Wesley Publishing Company, 1998, ISBN 0-201-18074-X, 2001* 3. *Donald J.Norris, Beginning Artificial Intelligence with the Raspberry Pi, Apress, 2017*	4. *Abe, S., Neural Networks and Fuzzy Systems Theory and Applications, Kluwer Academic Publisher, 2012* **5.** *Chennakesava R. Alavala, Fuzzy Logic and Neural Networks: Basic Concepts & Applications, New Age International Publishers, 2007*

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
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2. Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University, fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIE311T	Course Name	STATE SPACE CONTROL DESIGN	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Know the state space systems and the relevant techniques that can be applied to real time systems.	
CLR-2 :	Know and understand the mathematical techniques that are required to analyze and simulate the systems with state space model.	
CLR-3 :	Understand the structural properties of linear systems for the purpose of analysis.	
CLR-4 :	Know the process of design of control schemes for state space systems using the computational and mathematical techniques.	
CLR-5 :	Provide the skills to implement the different control and observer design techniques.	
CLR-6 :	Understand the software-based implementation techniques using updated simulation tools.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
			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 :	Explain the relevance of state space techniques as an underpinning methodology for the modelling, analysis, simulation and control of complex real-world systems spanning a wide range of disciplines.	2	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-2 :	Describe, classify and explain the mathematical techniques required to analyze, simulate and control systems modelled in state-space form.	3	3	-	-	2	-	-	-	-	-	-	-	-	3		-
CO-3 :	Identify and analyze the structural properties of Linear Systems	3	3	-	-	1	-	-	-	-	-	-	-	-	3	-	-
CO-4 :	Employ computational methods to design state space control techniques for systems modelled in state space form.	3	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-5 :	Design and analyze a controller with a reference input and observers.	3	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-6 :	Simulate and examine the implications of various control techniques of state space.	2	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Introduction to State Space	Analysis of Linear Systems	Structural Properties of Linear Systems	Controller Design for Linear Systems	Controller and Observer Design for Linear Systems
		9	9	9	9	9
S-1	SLO-1	Introduction to state space systems	Dynamic Response of the Continuous Time System	Stability - Linear system stability Conditions	Pole placement using state feedback	Controller design using Reference Input – Servo Control using State Feedback
	SLO-2					
S-2	SLO-1	Concepts of State, State variable and State Space Model.	Modal Decomposition.	Controllability	Eigen value placement theorem, Selection of desired poles,	Design of Feedforward Gain Matrix – Integral Control using State Feedback,
	SLO-2					
S-3	SLO-1	State space representation of linear continuous time systems using physical variables,	Problems on Modal Decomposition	Problems on Controllability	Problems: Controller Design I using Eigen value placement theorem	Problems: Controller Design using Reference Input
	SLO-2					
S-4	SLO-1	State space representation of linear continuous time systems using phase variables.	Introduction to phase portraits	Observability	Controller Design using Simulation tools	Internal Model Principle and Disturbance Rejection.
	SLO-2					

S-5	**SLO-1**	*State space representation of linear continuous time systems usingcanonical variables.*	*Analysis by phase portraits*	*Problems on Observability*	*Eigen Structure Assignment*	*Observer Design for Linear Systems -State Estimation, Full State Observers*
	SLO-2					
S-6	**SLO-1**	*Diagonalization, Linearization and Equilibrium points*	*Relationship between State space representation and transfer function*	*Minimal Realisation, Stabilizability,*	*Problems: Eigen Structure Assignment*	*Problems: Design of IdentityObserver*
	SLO-2					
S-7	**SLO-1**	*State space representation of discrete time systems.*	*Transfer functions of state-space systems*	*Problems on Minimal Realisation and Stabilizability*	*Dead Beat Control*	*Reduced Order State Observers*
	SLO-2					
S-8	**SLO-1**	*Solution of state equations*	*Discretisation of continuous time systems*	*Detectability, Duality*	*Optimal Control – Linear Quadratic Regulation (LQR) - Infinite Horizon Regulator, Receding Horizon Regulator*	*Problems: Design of Reduced Order State Observer*
	SLO-2					
S-9	**SLO-1**	*Computation of state transition matrix.*	*Study through Simulations*	*Problems on Detectability and Duality*	*Problems: Design of Regulators*	*Observer Design using Simulation Tools*
	SLO-2					

Learning Resources	*1. K.J. Astrom and R.M. Murray, Feedback Systems – An Introduction for Scientists and Engineers (download: http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page)* *2. Dorf, R.C and Bishop, R.H, 2008, Modern Control systems, 11th edition, Addison-Wesley* *3. Ogata, K, 2010, Modern control engineering, Prentice Hall, ISBN 0-13-261389-1*	*4. de Silva, C.W, 2009, Modeling and Control of Engineering Systems, CRC Press, Taylor and Francis, 978-1-4200-7686-8 Assessment* *5. Nise, N.S, 2011, Control systems engineering (6th edition), Wiley, ISBN 9780470646120* *6. Kuo, B.C and F Golnaraghi. M, F, 2009, Automatic control systems (9th edition), Prentice Hall*

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. Mr. Arockia Vijay Joseph, SRMIST*
2. Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University,fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIE312T	Course Name	INDUSTRIAL PROCESSES AND CONTROL	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Know various equipment involved in the petrochemical industries.	
CLR-2 :	Know the process of control of Distillation column, Heat exchangers, Reactors and Pump	
CLR-3 :	Understand the various processes involved in iron and steel industries.	
CLR-4 :	Know the process of control of furnaces, milling, moldings, rolling and other process.	
CLR-5 :	Understand the applications of computer in controlling the learnt processes.	
CLR-6 :	Understand the real time application of petrochemical, iron and steel industries.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Describe the process and instrumentation involved in petrochemical industries.	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2 :	Represent the control methodologies used for various process in petrochemical industries.	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Review and report the different processes involved in iron and steel industries.	2	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-4 :	Interpret and compare the control methodologies involved in iron and steel industrial processes.	3	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-5 :	Explain and relate the computer applications in the control processes through case studies.	2	3	-	2	-	-	-	-	-	-	-	-	-	-	3	-
CO-6 :	Formulate the instrumentation and control for real time applications in various processes involved in the industries.	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Introduction to Petroleum Industry Processes	Control applications in Petroleum Industry	Process Involved in Iron and Steel Industry	Control applications inIron & Steel Industry	Computer Applications in Industrial Control
		9	9	9	9	9
S-1	SLO-1	Petroleum Exploration	Temperature Control, Pressure control, Feed control of. distillation column	Introduction to Iron and Steel Industries	Control system in the Iron and Steel Industry	Evolution of computer applications in the industry
	SLO-2					
S-2	SLO-1	Production and Refining	Reflux Control	Description of the process -I	Blast Furnace stove Combustion Control system	Review of data logging, SCADA, DDC and DCS
	SLO-2		Reboiler Control			
S-3	SLO-1	Refining, Refining Capacity in India, Consumption of Petroleum products in India.	Temperature Controlof chemical reactors	Description of the process -II	Gas Controls in BOF Furnaces	Case study: Water treatment control using SCADA
	SLO-2					
S-4	SLO-1	Constituents of Crude Oil	Pressure Control of chemical reactors	Raw material preparation	Water Controls in BOF Furnaces	Analysis on the Water Treatment Control
	SLO-2					
S-5	SLO-1	Atmospheric Distillation of Crude oil	Steam Heaters, Condensers, Reboilers and Vaporizers - Cascade Control,	Iron making Blast furnaces	Control system involved in level measurement	Case study: Control of chemical reactor using SCADA
	SLO-2					

S-6	**SLO-1**	*Vacuum Distillation Process*	*Steam Heaters, Condensers, Reboilers and Vaporizers - Feed forward Control.*	*Raw Steel making*	*Strand Casting mold Level Control*	*Analysis on the Control of chemical reactor using SCADA*
	SLO-2					
S-7	**SLO-1**	*Thermal Conversion process*	*Centrifugal Pumps, Rotary Pumps and Reciprocating Pumps*	*The basic oxygen Furnace*	*Ingot Weight Measuring System*	*Case Study: Boiler control*
	SLO-2					
S-8	**SLO-1**	*Evaporators*	*Pumps: On-Off level control, Pressure control,*	*The Electric Furnace*	*Steel rolling mill Control*	*Utilities management with computer system*
	SLO-2					
S-9	**SLO-1**	*Types of Evaporators*	*Pumps: Flow control, Throttling control.*	*Analyzers in the Iron and Steel Industry, Oxygen Analyzer*	*Annealing process control, Computer Controlled BatchAnnealing*	*Case study on iron and steel manufacturing process*
	SLO-2					

Learning Resources	1. *Liptak B.G.,Instrument and Automation Engineers' Handbook: Process Measurement and Analysis, Fifth Edition, CRC Press, 2016.* 2. *Balchan.J.G., and Mumme K.I.,Process Control Structures and Applications, Van Nostrand Reinhold Company, New York, 1988.* 3. *Austin G.T and Shreeves, A.G.T., Chemical Process Industries, McGraw–Hill International student, Singapore, 1985.*	4. *Bela G. Liptak, Instrument Engineers' Handbook, Volume Two - Process Control and Optimization, 4th edition, Taylor & Francis, 2005.* 5. *Considine D. M., Process/Industrial Instruments and control Handbook, McGraw Hill, 4th Edition 1993.*

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

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2. Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University, fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIE312T	Course Name	INDUSTRIAL PROCESSES AND CONTROL	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Know various equipment involved in the petrochemical industries.	
CLR-2 :	Know the process of control of Distillation column, Heat exchangers, Reactors and Pump	
CLR-3 :	Understand the various processes involved in iron and steel industries.	
CLR-4 :	Know the process of control of furnaces, milling, moldings, rolling and other process.	
CLR-5 :	Understand the applications of computer in controlling the learnt processes.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Describe the process and instrumentation involved in petrochemical industries.	2
CO-2 :	Represent the control methodologies used for various process in petrochemical industries.	2
CO-3 :	Review and report the different processes involved in iron and steel industries.	2
CO-4 :	Interpret and compare the control methodologies involved in iron and steel industrial processes.	3
CO-5 :	Explain and relate the computer applications in the control processes through case studies.	2

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		Introduction to Petroleum Industry Processes	Control applications in Petroleum Industry	Process Involved in Iron and Steel Industry	Control applications inIron & Steel Industry	Computer Applications in Industrial Control
		9	9	9	9	9
S-1	SLO-1	Petroleum Exploration	Temperature Control, Pressure control, Feed control of. distillation column	Introduction to Iron and Steel Industries	Control system in the Iron and Steel Industry	Evolution of computer applications in the industry
	SLO-2					
S-2	SLO-1	Production and Refining	Reflux Control	Description of the process -I	Blast Furnace stove Combustion Control system	Review of data logging, SCADA, DDC and DCS
	SLO-2		Reboiler Control			
S-3	SLO-1	Refining, Refining Capacity in India, Consumption of Petroleum products in India.	Temperature Controlof chemical reactors	Description of the process -II	Gas Controls in BOF Furnaces	Case study: Water treatment control using SCADA
	SLO-2					
S-4	SLO-1	Constituents of Crude Oil	Pressure Control of chemical reactors	Raw material preparation	Water Controls in BOF Furnaces	Analysis on the Water Treatment Control
	SLO-2					
S-5	SLO-1	Atmospheric Distillation of Crude oil	Steam Heaters, Condensers, Reboilers and Vaporizers - Cascade Control,	Iron making Blast furnaces	Control system involved in level measurement	Case study: Control of chemical reactor using SCADA
	SLO-2					
S-6	SLO-1	Vacuum Distillation Process		Raw Steel making	Strand Casting mold Level Control	

	SLO-2		*Steam Heaters, Condensers, Reboilers and Vaporizers - Feed forward Control.*			*Analysis on the Control of chemical reactor using SCADA*
S-7	SLO-1	*Thermal Conversion process*	*Centrifugal Pumps, Rotary Pumps and Reciprocating Pumps*	*The basic oxygen Furnace*	*Ingot Weight Measuring System*	*Case Study: Boiler control*
	SLO-2					
S-8	SLO-1	*Evaporators*	*Pumps: On-Off level control, Pressure control,*	*The Electric Furnace*	*Steel rolling mill Control*	*Utilities management with computer system*
	SLO-2					
S-9	SLO-1	*Types of Evaporators*	*Pumps: Flow control, Throttling control.*	*Analyzers in the Iron and Steel Industry, Oxygen Analyzer*	*Annealing process control, Computer Controlled BatchAnnealing*	*Case study on iron and steel manufacturing process*
	SLO-2					

Learning Resources	1. *Liptak B.G.,Instrument and Automation Engineers' Handbook: Process Measurement and Analysis, Fifth Edition, CRC Press, 2016.* 2. *Balchan.J.G., and Mumme K.I.,Process Control Structures and Applications, Van Nostrand Reinhold Company, New York, 1988.* 3. *Austin G.T and Shreeves, A.G.T., Chemical Process Industries, McGraw–Hill International student, Singapore, 1985.*	4. *Bela G. Liptak, Instrument Engineers' Handbook, Volume Two - Process Control and Optimization, 4th edition, Taylor & Francis, 2005.* 5. *Considine D. M., Process/Industrial Instruments and control Handbook, McGraw Hill, 4th Edition 1993.*

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. Mr. Arockia Vijay Joseph, SRMIST*
2. Mr. Neelakandan Mani, CTS, pymani2010@yahoo.com	*2. Prof. Fawaz Hamad Mofdi, Damascus University, fawwazm@gmail.com*	*2. Mr. P.Jekan, SRMIST*

Course Code	18EIE313T	Course Name	DEEP LEARNING	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the mathematical concepts of Deep Learning	Blooms Level (1-6)
CLR-2 :	Understand the basics of neural network and layered learning approach to implement in real time applications	
CLR-3 :	Provide the knowledge of various neural network algorithms in deep learning	
CLR-4 :	Introduce and understand the Encoder algorithms and its applications	
CLR-5 :	Understand the concept of transfer learning and its applications in Industry	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Compile the mathematical concepts in Deep Learning	2
CO-2 :	Evaluate the powerful framework for supervised learning to apply in various industries	3
CO-3 :	Implement the architecture of Convolution Neural Networks and RNN in practical applications	3
CO-4 :	Analyze the various types of efficient Auto encoders to analyze the performance measures of system	4
CO-5 :	Create various network models in deep learning to train the system	1

	Program Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	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	PSO – 1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze&Research
CO-1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	2	1	2	-	-	-	-	-	-	-	-	-	-
CO-4	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	2	-	3	-	-	-	-	-	-	-	-	-	-	-	1

Duration (hour)		Introduction	Deep Neural Network (DNN)	Convolutional Neural Network	Auto Encoder	Case Study
		9	9	9	9	9
S-1	SLO-1	Historical trends in deep learning – Machine Learning basics	Learning XOR	Convolutional Neural Networks Introduction	Encoder	Deep Architectures in manufacturing
	SLO-2	Linear Algebra	Gradient-Based Learning	Convolution Operation	Decoder	The role of data driven intelligence in smart manufacturing.
S-2	SLO-1	Scalars, Vectors, Matrices and Tensors	Hidden Units	Problem	Auto Encoders Introduction	
	SLO-2	Eigen decomposition	Architecture Design	Motivation	Auto Encoders	Restricted Boltzmann machine and its variant
S-3	SLO-1	Singular Value Decomposition	Back-Propagation and Other Differentiation Algorithms	Pooling	Under Complete Auto Encoder	Architecture of (a) RBM, (b) DBN, and (c) DBM.
	SLO-2	Principal Components Analysis		Problem	Regularized Auto Encoder	
S-4	SLO-1	Overflow and Underflow	Programming	Convolution and Pooling as an Infinitely Strong Prior	Stochastic Auto Encoder	
	SLO-2	Poor Conditioning	Regularization for Deep Learning: Parameter Norm Penalties		Denoising Auto Encoder	Typical application scenarios of deep learning learning in smart manufacturing
S-5	SLO-1	Gradient-Based Optimization	Norm Penalties as Constrained Optimization	Variants of the Basic Convolution Function	Contractive Auto Encoder	
	SLO-2	Constrained Optimization	Regularization and Under-Constrained Problems		Auto Encoder Applications	Case study: Surface integration inspection Machinery fault diagnosis using CNN
S-6	SLO-1	Learning Algorithms: Capacity, Overfitting and Underfitting	Dataset Augmentation	Structured Outputs	Programming	Case study: Surface integration inspection

	SLO-2	*Hyperparameters and Validation Sets*	*Semi-Supervised Learning*	*Data Types*	*Dimensionality Reduction and*	*Machinery fault diagnosis using RNN*
S-7	**SLO-1**	*Estimators, Bias and Variance*	*Multitask Learning*	*Efficient Convolution Algorithms*	*Classification using Auto encoders*	
	SLO-2	*Maximum Likelihood Estimation*	*Early Stopping*	*Random or Unsupervised Features*	*Recommendation*	*Diagnostic analytics for fault assessment*
S-8	**SLO-1**	*Bayesian Statistics*	*Parameter Tying and Parameter Sharing*	*The Neuro scientific Basis for Convolutional Networks*	*Optimization for Deep Learning-Optimizers*	
	SLO-2	*Supervised Learning Algorithms*	*Sparse Representation, Drop out*	*Architecture of CNN*	*RMS prop for RNNs*	*Predictive analytics for defect prognosis*
S-9	**SLO-1**	*Unsupervised Learning Algorithms*	*Challenges in neural network optimization*		*SGD for CNNs*	
	SLO-2	*Stochastic Gradient Descent, Case study*	*Programming*	*Architecture of RNN*	*Application case study*	*Discussions and Outlook*

Learning Resources	*1. IanGoodfellow,YoshuaBengio,AaronCourville,"DeepLearning",MITPress,2016.* *2. KevinP.Murphy,"MachineLearning:AProbabilisticPerspective",MITPress,2012.* *3. Jason Brownlee,"Deep Learning with Python",ebook,2016.*	*4. Jinjiang Wang, Robert X. Gao, Yulin Ma, Dazhong Wu, 'Deep Learning for Smart Manufacturing: Methods and Applications' Journal of Manufacturing Systems, 2018.* *5. NPTEL Video lectures on "Deep Learning Part 1", Prof. Sudarshan Iyengar & Prof.Mitesh M. Khapra, 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	*50%*	-	*20%*	-	*20 %*	-	*50%*	-	*20%*	-
Level 2	Understand	*50%*	-	*20%*	-	*20 %*	-	*50%*	-	*30%*	-
Level 3	Apply		-	*20%*	-	*20 %*	-	-	-	*30%*	-
Level 4	Analyze			40%		*40 %*	-			*20%*	
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.Santhosh Eswaran, VR Savvy, info@vrsavvy.co	*1. Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1. **Dr.S.UmaMaheswari**, SRMIST, umamahes3@srmist.edu.in*
2.Mr. Neelakandan Mani, Senior Director, CTS, pymani2010@yahoo.com	*2. Dr. B.Chitti babu, IIITDM, Kancheepuram, bcbabu@iiitdm.ac.in*	*2. **Dr. A. Vimala Juliet**, SRMIST, hod.eie.ktr@srmist.edu.in*

Course Code	18EIE314T	Course Name	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the concepts of processing the signals and images	Blooms level (1-6)
CLR-2 :	Know about the generation and properties of human physiological signals	
CLR-3 :	Know about the generation and properties of biomedical images	
CLR-4 :	Impart knowledge about the various techniques used for feature extraction from biomedical signals	
CLR-5 :	Impart knowledge about the various techniques used for feature extraction from biomedical images	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Explain the basics of the digital signals and images	2
CO-2 :	Demonstrate the properties of biomedical signals.	3
CO-3 :	Determine the properties of biomedical images	3
CO-4 :	Analyze the features of biomedical signals	4
CO-5 :	Illustrate the features of biomedical images	4

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO - 1	PSO - 2	PSO - 3
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
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
-	3	-	2	-	-	-	-	-	-	-	-	-	-	-
-	3	-	2	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		INTRODUCTION TO DIGITAL SIGNAL AND IMAGE PROCESSING	PROPERTIES OF BIOMEDICAL SIGNALS	PROPERTIES OF BIOMEDICAL IMAGES	PROCESSING OF BIOMEDICAL SIGNALS	PROCESSING OF BIOMEDICAL IMAGES
		9	9	9	9	9
S-1	SLO-1	Analog, Discrete, and Digital Signals	ECG: Cardiac electrophysiology	Imaging Modalities	Cardiovascular Diseases and the ECG signal	Fourier Slice theorem
	SLO-2	Examples - I	Properties of ECG	Survey of major medical imaging modalities	Practical examples	Demonstration using software tools -XI
S-2	SLO-1	Transformation of signals and its properties	Clinical relevance	Ultrasound imaging	Processing and Feature Extraction of ECG	Image Registration methods for biomedical images
	SLO-2	Examples- II	Relation of ECG to cardiac events and disorders	Properties of Ultrasound	QRS extraction methods	Demonstration using software tools -XII
S-3	SLO-1	Fourier Transform - overview	EEG – Electroencephalogram: Signal of the Brain	X- Ray images	HRV and Poincare plot Analysis	Edge Detection techniques biomedical images
	SLO-2	Problems - I	Properties of EEG signal	Properties and features of x-Ray	Demonstration using software tools -VIII	Problems – I
S-4	SLO-1	Discrete Fourier Transform - Overview	Evoked Potentials	Physical and Physiological Principles of MRI	EEG signal processing techniques	Formulation of MRI Reconstruction
	SLO-2	Problems - II	Demonstration using software tools -V	Properties of MRI	Frequency transforms of EEG	Demonstration using software tools -XIII
S-5	SLO-1	Filtering of Signal	EEG Clinical relevance	Functional MRI	Extraction of Evoked potentials	Processing and Feature Extraction of MRI
	SLO-2	Demonstration using software tools -I	Relation of EEG signal to neurological disorders	Properties and applications of FMRI	Demonstration using software tools -IX	Demonstration using software tools -XIV
S-6	SLO-1	Introduction to Digital images	EMG – Electromyogram: Muscle activity	Applications of MRI and fMRI	EMG signal analysis	Registration with MR Images

	SLO-2	*Properties*	*Properties of EMG signal*	*Demonstration using software tools -VII*	*Time domain and Frequency domain*	*Demonstration using software tools -XV*
S-7	**SLO-1**	*Image filtering*	*EMG Clinical relevance*	*CT imaging*	*Extraction of parameters of EMG relevant to neuromuscular disorders*	*Processing of Ultrasound images – Removal of speckle noise*
	SLO-2	*Demonstration using software tools -II*	*Relation of EMG signal to neuromuscular disorders*	*Properties and features CT imaging*	*Demonstration using software tools -X*	*Demonstration using software tools -XVI*
S-8	**SLO-1**	*Image enhancement – an overview*	*EOG and ERG*	*PET and SPECT imaging*	*EOG and ERG signal analysis*	*Feature Extraction of Ultrasound Images*
	SLO-2	*Demonstration using software tools -III*	*Clinical applications of EOG and ERG*	*Properties of PET and SPECT imaging*	*Extraction of features relevant to clinical applications*	*Clinical Examples*
S-9	**SLO-1**	*Image restoration - overview*	*Practical examples*	*Surgical Applications: A survey of surgical applications of medical image processing.*	*Practical Examples*	*Image Registration - Comparison of CT, MRI, and Ultrasonic Images*
	SLO-2	*Demonstration using software tools -IV*	*Demonstration using software tools -VI*	*Clinical Examples*	*Demonstration using software tools -X*	*Clinical examples*

Learning Resources	1. *Kayvan Najarian, Robert Splinter, Biomedical Signal and Image Processing, 2nd Edition, 2012.* 2. *Rangaraj M. Rangayyan, "Biomedical Signal Analysis", Wiley-IEEE Press, 2nd Edition, 2015.* 3. *N.Vyas, " Biomedical Signal Processing" ,First edition, University Science Press, New Delhi 2011*	4. *NPTEL course 'Biomedical signal processing', Prof. Sudipta Mukhopadhyay, IIT Kharagpur* 5. *MIT Open Courseware, 'Biomedical Signal and Image Processing'*

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	-	-	*60 %*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	-	-	*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 K.A.Sunitha, SRMIST*

Course Code	18EIE401T	Course Name	CYBER SECURITY FOR INDUSTRIAL AUTOMATION	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the basic knowledge in industrial automation and control systems	Blooms level (1-6)
CLR-2 :	Know the basic concepts of information system security for industrial control systems	
CLR-3 :	Understand the difference between IACS and IT paradigms	
CLR-4 :	Impart the adequate information about risk management for IACS	
CLR-5 :	Introduce the security methodologies and approaches for IACS	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Describe the basic concepts of industrial automation and control systems	2
CO-2 :	Illustrate any application with add-on security features in industrial control systems	3
CO-3 :	Select the software with IT paradigms for IACS	4
CO-4 :	Analyze the risk management approach for IACS	4
CO-5 :	Examine the security methodologies for industrial systems	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for continuous& discrete	Utilize PLC & DCS for control of systems	Effective management skills in the implementation
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
3	-	3	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Industrial Automation and Control System(IACS) Fundamental Concepts	Information System Security Technology	IACS Culture versus IT Paradigms	Risk Management for IACS	Cyber security Design and Implementation
		9	9	9	9	9
S-1	SLO-1	IACS - Introduction	Information System Security Fundamentals	Differences in Culture, Philosophy, and Requirements	Risk Management	Cyber security lifecycle
	SLO-2	SCADA Systems	Terminologies	Comparison between IT and IACS Issues	Risk Relationships	Conceptual design process
S-2	SLO-1	Distributed Control Systems	Threat Matrix	Considerations in Adapting IT Security methods to IACS	Cybersecurity Management Systems	Detailed design process
	SLO-2	***Safety Instrumented Systems***	Type and Classes of Attack	Threats and Motivations for Attackers	***Risk Analysis***	Firewall design
S-3	SLO-1	IACS - Protocol	Additional System Security	Threat Sources	Addressing Risk	Remote access design
	SLO-2	OSI Model	Policies, Standards	IT and IACS comparisons from a Standards Perspective	Monitoring and Improving the IACS	Intrusion detection design
S-4	SLO-1	TCP/IP Model	Guidelines and Procedures	Technological Trends	Integrated Enterprise Risk Management	Security Standards, Guidelines
	SLO-2	OPC for Process Control	Malicious Codes and Attacks	Smart Grid and its trends	Guide for Applying Risk Management Framework	NIST – Guide to ICS Security, ***Management Controls***
S-5	SLO-1	TCP, DNP3 Protocol	Firewalls	Smart Grid Protocols	Insider Threat	Operational Controls, Technical Controls
	SLO-2	Utility Communication Architecture	Cryptography	Mapping of Emerging Technology	Threat Example	ANSI/ISA security technologies, Blocking Access Control
S-6	SLO-1	Profibus	Digital Signatures	Example Automation System	Stuxnet	Encryption Technologies, Physical Security Controls

	SLO-2	*Controller Area Network*	*Attacks against Cryptosystems*	*Bulk Generation*	*Defensive Approaches*	*Personal Security Controls, NERC – Critical Infrastructure Protection*
S-7	**SLO-1**	*Ethernet/IP*	*Virtual Private Network*	*Transmission Domain*	*Electromagnetic Pulse*	*Critical Cyber Asset Identification*
	SLO-2	*Open safety Protocol*	*IPsec*	*Distribution Domain*	*HEMP*	*Security Management Controls*
S-8	**SLO-1**	*Issues in IACS security*	*Transport mode*	*Operations Domain*	*Solar*	*Personal and Training*
	SLO-2	*Information Security*	*Tunnel mode*	*Service Provider Domain*	*IEMI*	*Electronic Security*
S-9	**SLO-1**	*Approaches of Information Security*	*Secure sockets layer*	*Markets Domain*	*Protection measures*	*Physical Security of Critical Cyber Assets*
	SLO-2	*Applications*	*Physical and economic damage*	*Customer Domain*	*Standards – IEC & IEEE*	*Recovery Plans*

Learning Resources	1. *Edward J,M.Colbert, Cyber Security of SCADA and other Industrial Control Systems , Springer, 2016* 2. *Ronald L Krutz., Industrial Automation and Control System Security Principles, ISA., 2013* 3. *David J. Teumim, Network Security, ISA, 2010*	4. *Perry S.Marshall. Industrial Ethernet 2nd edition., ISA, 2004*

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. T.A.Balaji, Robert Bosch, Coimbatore, Balaji.TAnanthanpillai@in.bosch.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Dr.G.Y. Rajaa Vikhram**, SRMIST, rajaaviy@srmist.edu.in*
2. Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com	***2. Dr.S.Latha, TCE, Madurai, sleee@tce.edu***	

Course Code	18EIE402J	Course Name	ELECTRO- PNEUMATICS AND HYDRAULICS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the hardware components of Pneumatics.	
CLR-2 :	Introduce the need of Fluid power system.	
CLR-3 :	Know different types of pumps used in Hydraulics.	
CLR-4 :	Introduce various types of Direction Control Valves.	
CLR-5 :	Provide the knowledge on Commissioning, Maintenance and their importance in industry.	
CLR-6 :	Identify the malfunctions and troubleshooting various types of error.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Summarize the structure of pneumatic control system.	2	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-2 :	Illustrate the appropriate control components in pneumatic control systems.	3	2	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-3 :	Use the appropriate pump for a fluid power system.	3	2	-	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-4 :	Analyze electro pneumatic circuits in fluid power system.	4	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5 :	Develop appropriate fluid power system for the given application.	6	3	-	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-6 :	Examine the basic problems and troubles in fluid power systems.	3	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

Duration (hour)		Pneumatic Components	Hydraulic Components	Directional Control Valves(DCV)	Design Of Pneumatic Circuits	Application, Maintenance And Trouble Shooting
		12	12	12	12	12
S-1	SLO-1	Fluid power	Introduction to fluid power system	Types of Valve Actuation	Pneumatic circuit design consideration	Development of pneumatic circuits applied to machine tools
	SLO-2	Fluid Power System Structure	Pascal's Law	Construction, operation of 3/2 solenoid operated DCVs	Air pressure losses in pipelines	Presses control
S-2	SLO-1	Properties of Air-Boyle's Law	Hydraulic fluids	Construction, operation of 5/2 solenoid operated DCVs	Control of a cylinder using limit switch	Material handling systems
	SLO-2	Guy-Lussac's Law, Charle's Law	Hydraulic pumps -Gear pump	Construction, operation of 5/3 solenoid operated DCVs	Dual cylinder sequence circuits	Automotive
S 3-4	SLO-1	Lab1: Direction control of a single-acting cylinder	**Lab 4:** Demonstration of **T**wo-hand safety control	**Lab 7:** Development of control for Time-dependent control of a double-acting cylinder	**Lab10:** Development of control for Sequential control of 3 double-acting cylinders	Lab13: Development of control for Cascading circuits
	SLO-2					
S-5	SLO-1	Advantages of Pneumatics	Vane and Piston pumps	Flow Control Valve	synchronizing and sequencing circuits	Packaging industries
	SLO-2	Components of Pneumatic Systems	Pump Performance	Special Purpose valves	classification	Manufacturing automation
S-6	SLO-1	Structure of Pneumatic Control System	Pump Noise	Pneumatic Cylinders-Single Acting Cylinder	Sequential circuit design for simple applications using cascade method	Wear of moving parts due to solid particles
	SLO-2	Fluid conditioners	Characteristics and Selection	Double Acting Cylinder	Cascade method	Problem caused by gases in hydraulic fluids

S 7-8	**SLO-1**	***Lab 2 :*** *Development of control for Slow-speed extension, rapid retraction of a SAC*	*Lab 5: Development of control for Time dependent control of a single acting cylinder.*	***Lab 8:*** *Development of control for Sequential control of 2 double-acting cylinders*	*Lab11: PLC control panel wiring*	***Lab14:*** *Demonstration of Stamping machine control*
	SLO-2					
S-9	**SLO-1**	*Air Preparation*	*Hydraulic accessories Reservoirs, Pressure Switches*	*Multi positioning Cylinder*	*Servo control*	*Maintenance of Fluid Power circuits*
	SLO-2	*Piston Compressor*	*Filters*	*Rotary Actuator*	*Proportional control*	*Trouble shooting of Fluid Power circuits*
S-10	**SLO-1**	*Rotary Compressor*	*Types and selection*	*Safety Consideration*	*PLC based control*	*Safety aspects involved in Hydraulics*
	SLO-2	*Air Filter*	*Hydraulic Accumulator*	*Pneumatic Symbols.*	*Installation of pneumatic system*	*Safety aspects involved Pneumatics*
S 11-12	**SLO-1**	***Lab3:*** *Control of a double-acting cylinder(DAC) with Impulse valve*	*Lab 6: Development of control for Continuous Reciprocation of a DAC with Impulse Valve and Reed Switches*	*Lab 9: Demonstration of Sequential control of 2 double-acting cylinders with impulse valves and signals overlapping*	*Lab12: Development of control using ladder logic program*	*Lab15: A mini project on Electro pneumatic Application.*
	SLO-2					

Learning Resources	1. *Anthony Esposito, "Fluid Power with Applications", Pearson education, 7th edition, 2014* 2. *Majumdar, "Pneumatic system: Principles and Maintenance", Tata McGraw Hill, 7th edition 2008* 3. *Joshi.P., Pneumatic Control", Wiley India, 2008*	4. *Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.* 5. *Frank D. Petruzella, "Programmable Logic Controller",Tata McGraw Hill 5th Edition, 2017.* 6. *NPTEL Video Lecture series on "Fundamental of Industrial oil Hydraulics and Pneumatics" by Prof.R.Maiti,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 %*	*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. *Mr.J.Sam Jeba Kumar, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant,vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	2. *Dr. G. Joselin Retna Kumar, SRMIST*

Course Code	18EIE403T	Course Name	MULTISENSOR AND DECISION SYSTEMS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Impart in depth knowledge of multisensor fusion Concepts	Blooms level (1-6)
CLR-2 :	Incorporate the ability to use data and information from multiple sources and make informed decisions based on that data	
CLR-3 :	Understand the importance of various algorithms in the field of multisensor fusion	
CLR-4 :	Understand the concepts of Decision systems	
CLR-5 :	Impart the skills to solve various complex problems requiring the application of multisensory and decision Techniques	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Explain the importance and need for multisensor fusion and decision systems	2
CO-2 :	Describe and Examine the main components, architectures and design issues in multisensor and decision systems	3
CO-3 :	Select and Examine the appropriate architectures in the field of multisensor fusion	3
CO-4 :	Develop creative and critical thinking in providing and evaluating solutions to complex multisensor and decision systems and effectively communicate and analyses such solutions	4
CO-5 :	Effectively present appropriate design methodology, analyze and evaluatethe solutions in multisensor and decision systems	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
2	-	-	-	-	-	-	-	-	-	-	-	2	1	-
2	-	-	-	-	-	-	-	-	-	-	-	1	1	-
2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
3	-	2	-	-	-	-	-	-	-	-	-	1	-	-

Duration (hour)		Introduction to multisensor systems for monitoring	Mutli Sensor Data Compression &Multi Sensor Tracking	Kalman filtering for multisensor data fusion	Fault diagnosis using state estimators	Introduction to decision systems for design
		9	9	9	9	9
S-1	SLO-1	Introduction, sensors and sensor data	Signal tracking and multisensory data compression	Taxonomy of algorithms for multisensor data fusion	Introduction	Introduction to decision systems*for monitoring,*
	SLO-2	Use of multiple sensors,	Compression sensing of Audio Signals	Identity declaration.	State Observer	Design aspects
S-2	SLO-1	Benefits of data fusion	Compressing multi sensor data by grouping and amplitude scaling	And Estimation	State Estimators	Decision Types Decision trees Design aspects
	SLO-2	Fusion applications	Compressing multi sensor data for IOT applications	Kalman filtering, practical aspects of Kalman filtering,	Norms based residual evaluation	Logical Decision Framework
S-3	SLO-1	Fusion Node Properties	Parameter Estimation	Extended Kalman filters	threshold computation	Value of information
	SLO-2	Fusion Network	Bayesian curve fitting	Decision level identify fusion	Statistical methods based residual evaluation	Choice of Decision Criteria
S-4	SLO-1	Network Topologies	Maximum Likelihood	Knowledge based approaches	threshold settings	Design of Experiments
	SLO-2	Representation	Least Squares	Data information filter,	Generalized Likelihood Ratio Approach	Decision systems for change detection
S-5	SLO-1	Parameter Estimation	Least Gaussian Model: Line fitting	Extended information filter	Marginalized Likelihood Ratio Approach	Examples

	SLO-2	*Robust statistics*	*Chang Point Detection*	Decentralized estimation	*Fault diagnosis with classification networks:* *Simple pattern classification*	*Decision systems for diagnosis*
S-6	**SLO-1**	*Sequential Bayesian Interface*	*Probalistic subspace*	*scalable decentralized estimation*	*bayes classification*	Examples
	SLO-2	*Bayesian Decision Theory*	*Generalized Milliman Formula*	*Sensor fusion and approximate agreement*	*Geometric classifiers*	*Fault Diagnosis and Detection using Decision systems*
S-7	**SLO-1**	*Mathematical tools used: Algorithms, ,*	*Introduction and Need Of Tracking*	*Optimal sensor fusion using range trees recursively*	*Polynomial classifiers*	*Decision system for design and operation*
	SLO-2	*co-ordinate transformations,*	*Bayesian multiple target tracking*	*Data association*	*Decision trees*	*Human and automation Examples*
S-8	**SLO-1**	*Rigid body motion.*	*Sensors for peace applications,*	*Distributed dynamic sensor fusion*	*Neural network for fault diagnosis,*	*Multi-objective optimization and decision-making*
	SLO-2	*Dependability*	*Systems and legal requirements for monitoring in peace operations*	*High performance data structures*	*Multilayer perceptionnetwork*	*Case Studies-I*
S-9	**SLO-1**	*Markov chains*	*Information fusion terminology*	*. Representing ranges and uncertainty in data structures*	*Radial basis functions network*	*Multi-disciplinary optimization and decision-making*
	SLO-2	*Meta – heuristics.*	*Multitarget/multisensor tracking*	*Designing optimal sensor systems with in dependability bounds*	*Clustering and self-organizing network*	*Case studies -II*

Learning Resources	*1.David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992. 2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998.* *2.Rolflsermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.*	*3.H.B. Mitchell, Multi-Sensor Data Fusion: An Introduction ,Springer Publications,20007* *4.Gregory S. Parnell ,, Patrick J. Driscoll), Dale L. Henderson ,Decision Making in SystemsEngineering and Management (Wiley Series in Systems Engineering and Management 2nd Edition, Wiley Publishers.2010.* *5. Rolf Isermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.*

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	-	-	*60%*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	-	-	*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
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	18EIE404T	Course Name	SYSTEM ON CHIP	Course Category	E	Professional Elective	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:	Learning (Blooms level 1-6)
CLR-1 :	Introducethe components of processor architecture and knowledge about design complexity	
CLR-2 :	Know the functional and nonfunctional performance of the system early in the design process to support SOC design decisions.	
CLR-3 :	Provide the hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.	
CLR-4 :	Impart theknowledge of memory design considering hardware/software tradeoffs.	
CLR-5 :	Understand Interconnect bus architectures and SOC customization using FPGA	

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 :	Summarize the system architecture and SOC design requirements.	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2 :	Solve the various functional constraints involved in the selection of processor for soc.	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Apply the skills of hardware and software tradeoffs for SOC memory design.	3	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-4 :	Outline the interconnections in the architecture	4	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-5 :	Analyze the mechanism of SOC customization	4	3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Duration (hour)		SYSTEM ARCHITECTURE	PROCESSOR SELECTION FOR SOC	MEMORY DESIGN	INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION	FPGA BASED EMBEDDED PROCESSOR- Case studies and Applications
		9	9	9	9	9
S-1	SLO-1	*Components of the system*	*Overview of SOC*	*SoC external memory*	*Bus architectures*	*Hardware software task partitioning*
	SLO-2	*Processor architectures*	*soft processors, processor core selection*	*SoC internal memory*	*SoC standard buses*	*FPGA fabric Immersed Processors*
S-2	SLO-1	*Memory and addressing*	*Basic concepts – instruction set, branches, interrupts and exceptions*	*Scratch pads and cache memory*	*AMBA*	*Soft Processors and Hard Processors*
	SLO-2	*system level interconnection*	Basic programming	*cache organization and write policies*	*Core Connect*	*Tool flow for Hardware/Software Co-design*
S-3	SLO-1	*SoC design requirements and specifications*	*Basic elements in instruction handling*	*strategies for line replacement at miss time*	*Processor customization approaches*	*Interfacing Processor with memory and peripherals*
	SLO-2	*design integration*				*Types of On-chip interfaces*
S-4	SLO-1	*design complexity*	*Minimizing pipeline delays*	*split I- and D caches*	*Reconfigurable technologies*	*Wishbone interface*
	SLO-2			*multilevel caches*	*mapping designs onto reconfigurable devices*	*Avalon Switch Matrix*
S-5	SLO-1	*cycle time, die area and cost*	*reducing the cost of branches*	*SoC memory systems*	*Architectural Design Exploration*	*OPB Bus Interface*

	SLO-2				Chip Types and Classifications	Applications
S-6	SLO-1	ideal and practical scaling	Robust processors	board based memory systems		Creating a Customized Microcontroller
	SLO-2	area-time-power tradeoff in processor design,	Vector processors	simple processor/memory interaction	FPGA based design	Overview of CYCLONE V Family architecture
S-7	SLO-1	Configurability analysis	Superscalar processors	HW/SW co-design: analysis, partitioning	Architecture of FPGA	Multiport memory controller architecture
	SLO-2	System-level methodologies and tools	VLIW processors	real-time scheduling	FPGA interconnect technology	
S-8	SLO-1	SoC design methodologies and tools	Applications of SOC	hardware acceleration	FPGA memory	CYCLONE V SOC FPGAs hard processor system
	SLO-2					
S-9	SLO-1	Case study	Case study	Case study	Case study	Case studies.
	SLO-2					

Learning Resources	*1. Michael J.Flynn, Wayne Luk,,Computer system Design: System on-Chip, Wiley-India, 2012.* *2. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, 3rd Editions, Morgan Kaufman Publishers, 2012.* *3. Ron Sass and Andrew G. Schmidt, Morgan Kaufmann (MK), ―Embedded System design with Platform FPGAs, Elsevier,2010.* *4. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays", Springer Verlag London Ltd., 2009.*	*5. SudeepPasricha and NikilDutt, On-Chip Communication Architectures - System on Chip Interconnect, Elsevier, 2008.* *6. R. Zurawski (Editor), Embedded Systems Handbook, CRC Press.* *7. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis, Verification, Springer, 2009.* *https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/hb/cyclone-v/cv_54001.pdf*

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	-	-	*60%*	-	*30 %*	-	*30 %*	-	*30 %*	-
Level 4	Analyze	-	-	-	-	*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. ***Dr. A. Vimala Juliet****, SRMIST*
2. ***Mr. Vijayarajeswaran, MANAGING DIRECTOR, VI micro Pvt.Ltd, vijay@vimicrosystems.com***	***2.Prof.FawazMofdi, Head of Electronics and Telecommunication Engineering, Damascus University, Syria.***	2. *Mrs. A.Brindha,SRMIST*

Course Code	18EIE405T	Course Name	PROCESS DATA ANALYTICS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Understand the design dynamics of process data.	
CLR-2 :	Impart knowledge on different methods of linear regression analysis.	
CLR-3 :	Know the applications for various model selection and regularization methods.	
CLR-4 :	Understand the process in developing appropriate soft sensors using simulation tools.	
CLR-5 :	Provide the right classifier for the application based on data.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms Level (1-6)
CO-1 :	Associate statistical terms related to data analytics	2
CO-2 :	Predict the selection of right regression method for an application	3
CO-3 :	Analyze the performance of various model selection and regularization methods.	4
CO-4 :	Select appropriate tools for soft sensor development.	4
CO-5 :	Determine the right classifier for a given application	3

Program Outcomes (PO)															
1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
Engineering	Problem Analysis	Design &	Analysis, Design,	Modern Tool	Society & Culture	Environment & Sustainability	Ethics	Individual & Team	Communication	Project Mgt. &	Life Long Learning	Automatic control for continuous & discrete systems	Utilize PLC & DCS	Effective management
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Review of Data Relations, Data Pre processing and Visualization	Correlation and Regression	Resampling, Model Selection & Regularization	Classification, Clustering and Decision Trees	Software implementation for Data Analytics
		9	9	9	9	9
S-1	SLO-1	Data Scales	Linear Correlation	Cross Validation- The validation set approach	Classification Criteria- Naïve Bayes Classifier.	Vectors and Matrices
	SLO-2	Iris Data Set	Correlation and Causality	Leave-One-Out Cross Validation	Support Vector Machine (SVM) and ROC curve	Element access
S-2	SLO-1	Set and Matrix Representation	Chi-Square test for problem solving	k-Fold Cross Validation	Nearest Neighbor Classifier	Loading and plotting data from file
	SLO-2	Relations	Assessing Model Accuracy	Cross Validation on Classification problems	Learning Vector Quantization	Examples of loading and plotting data- smart watches, ECG signals, etc,.
S-3	SLO-1	Dissimilarity Measures	Linear Regression:- Simple Linear Regression	Subset Selection – best subset selection	Decision Trees	Saving data to a file
	SLO-2	Sequence Relations		Stepwise selection		Mean, Median, Mode and Variance
S-4	SLO-1	Issues in Data Analytics- Missing data, data outliers and false data.	Linear Regression - Assessing accuracy of Model	Choosing the optimal model	Clustering- Cluster Partitions	Functions of a Random Variable
	SLO-2		Multiple Linear Regression-Estimating Regression Coefficient	Shrinkage methods	Sequential Clustering	Bayesian Inference
S-5	SLO-1	Data Purification and handling	Qualitative Predictors in Regression Model	Ridge regression	Prototype based Clustering	Covariance
	SLO-2	Sampling and Quantization	Comparing Linear Regression with K-Nearest Neighbours	Least absolute shrinkage and selection operator (LASSO)	Fuzzy Clustering	Multivariate Distribution

S-6	**SLO-1**	Filtering	Logistic Regression	Selecting the tuning parameter	Relational Clustering	Multivariate normal Distribution
	SLO-2	Data Transformation	Logistic Model	High dimension data	Cluster Tendency assessment, Cluster Validity	Linear functions of Multivariate data
S-7	**SLO-1**	Data Integration	Estimating Regression Coefficient	Regression in high dimension data	Self-Organizing Maps	Curve fitting, weighted averages & Least Squares.
	SLO-2	Data Visualization - Diagrams	Making Predictions		Basic Decision Trees- Regression Tree.	Data Visualization and Graphics using R software
S-8	**SLO-1**	Principal Component Analysis	Multiple Logistic Regression	Interpreting results in High Dimension	Classification Tree.	X-Y plots
	SLO-2	Histogram and Spectral Analysis	Linear Discriminant Analysis		Bagging	Graphics model
S-9	**SLO-1**	Multi-dimensional Scaling, Auto associator, Sammon Mapping	Quadratic Discriminant Analysis	Dimension reduction methods – Principal Component Regression, Partial Least Squares	Random Forest	Text computations for data analysis
	SLO-2				Boosting	R program & Evaluator

Learning Resources	*1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer Texts in Statistics,2014.* *2. Thomas A. Runkler, "Data Analytics: Models and Algorithms for Intelligent Data Analysis", Springer Vieweg, 2nd Edition,2016.*	*3. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press,2013* *4.William Menke and Joshua Menke, "Environmental Data Analytics with MATLAB", Elsevier, 2012.,* *5. John Chambers, " Software for Data Analysis: Programming with R", Springer, 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
Mr. Neelakandan Mani, Senior Director, CTS.e-mail: pymani2010@yahoo.com	*Dr.J.Prakash, Professor MIT, Chennai. e-mail: prakaiit@gmail.com*	*Mrs.S.Sharanya, SRMIST. E-mail: sharanys@srmist.edu.in*
Mr. Vijayarajeswaran, Managing Director, VI Micro Pvt.Ltd. e-mail: vijay@vimicrosystems.com	*Mr.Vandian, Dalhousie University, Halifax, Canada. e-mail: vn482345@dal.ca*	

Course Code	18EIE406T	Course Name	SYSTEM IDENTIFICATION	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce the various model structures for system identification	
CLR-2 :	Provide the concept of estimating the parameter of input - output models using various parameter estimation models.	
CLR-3 :	Know the concept of recursive plant model identification in open loop system.	
CLR-4 :	Understand the various methods of closed loop system identification.	
CLR-5 :	Introduce the applications of system identification in process industries.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CLO-1 :	Classify the model structure for linear and nonlinear system.	2
CLO-2 :	Develop the linear representation of a dynamic system in discrete time systems.	4
CLO-3 :	Design the recursive plant model identification and analyze the validation in open loop system.	4
CLO-4 :	Design the recursive plant model identification and validation in closed loop system.	4
CLO-5 :	Apply the system identification methods to new model structure and identify the appropriate model for unknown system.	3

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	PSO-2 Utilize PLC & DCS for	PSO-3 Effective management
CLO-1 :	2	-	-	-	-	-	-	-	-	-	-	2	-	2	-
CLO-2 :	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CLO-3 :	2	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CLO-4 :	2	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CLO-5 :	2	-	-	-	-	-	1	-	-	-	-	-	-	2	-

Duration (hour)		Models for Identification	Parameter Estimation Methods	Plant Model Identification in Open Loop	Plant model identification in closed loop	Applications in process industries
		9	9	9	9	9
S-1	SLO-1	Introduction to system identification	Introduction to discrete time system models	Introduction to plant model identification	Introduction	Introduction to application in process industries
	SLO-2	Introduction to dynamic systems Static, Dynamic, Time invariant and time variant system	Recursive and Non recursive system	Identification methods	Identifiability	Case study: Modeling And Identification Of Heat Exchanger
S-2	SLO-1	Types of model	ARX models,	Least square method	Approaches to closed loop identification	Experimental Design
	SLO-2	System identification procedure	Design Example of ARX models	Design using Least square method	Direct approach	Case study: Identification of distillation column
S-3	SLO-1	System identification methods	AR Model, MA Model	Recursive Least Squares	Indirect approach	Experimental Design
	SLO-2	Parametric and Nonparametric method	Design Example of AR Model, MA Model	Design using Recursive Least square	Joint input output approach	Case Study: System Identification Modeling for Flight Control Design
S-4	SLO-1	Models of LTI system	ARMA Model	Extended Least Squares	Closed loop identification methods	Experimental Design
	SLO-2	Linear model	Design Example of ARMA Model	Design using Extended Least Squares	Closed loop output error algorithm	Case-study :System identification based on selective sensitivity analysis:
S-5	SLO-1	state space models	ARMAX model	Generalized Least Squares	Design of closed loop output error algorithm	Experimental Design
	SLO-2	Numerical Problems	Design Example of ARMAX Model	Design using Generalized Least Squares	Closed loop output error algorithm with adjustable predictor	System identification tool box

S-6	**SLO-1**	*OE model,*	*NARMAX model*	*Need for iteration*	*Design of Closed loop output error algorithm with adjustable predictor*	*Estimating Transfer Function Models for a Heat Exchanger*
	SLO-2	*Deterministic model, stochastic model*	*Hammerstein model*	*Choice of model structure*	*Filtered closed loop error algorithm*	*Programming using system identification toolbox*
S-7	**SLO-1**	*Models with nonlinearity*	*Wiener model*	*Mode L Structure Selection Based on Preliminary Data Analysis*	*Design of Filtered closed loop error algorithm*	*Glass Tube Manufacturing Process*
	SLO-2	*Types of nonlinearity*	*bilinear parametric model*	*Model Order Selection*	*Filtered open loop error algorithm*	*Programming using system identification toolbox*
S-8	**SLO-1**	*Model sets*	*Problems using ARX, ARMAX Model*	*Model Validation in open loop*	*Model validation in closed loop*	*Identifying nonlinear ARX models*
	SLO-2	*Predictive model, probabilistic model*	*Linear model selection*	*Whiteness Test*	*Whiteness Test*	*Programming using system identification toolbox*
S-9	**SLO-1**	*Fuzzy model*	*Pseudo Random Binary Signal (PRBS)*	*correlation Test*	*correlation Test*	*Validating Hammerstein-Wiener Models*
	SLO-2	*Black Box Model*	*Selection of PRBS*	*Uncorrelation Test*	*Uncorrelation Test*	*Programming using system identification toolbox*

Learning Resources	*1. Arun K thangirila , Principles of* System Identification*: Theory and Practice, CRC Press,2018.* *2. Lennart Ljung, "System Identification", PTR Prentice Hall, Englewood Cliff, New Jersey, 1999.* *3. Karel J. Keesman, "System Identification, an introduction", Springer, 2011.*	*4. NPTEL video lecture series on"SystemIdentification" , by Prof. Dr.Arun K. Tangirala,, IIT Madras.* *5. S. Bittanti, L. Piroddi, "Nonlinear identification and control of a heat exchanger: A neural network approach", Journal of the Franklin Institute, Volume 334, Issue 1, January 1997, pp 135–153..*

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. Deepak, ONGC, Mumbai, Dsingh39@slb.com	*1.* Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	*1.* ***Dr.A.A.Asuntha****, SRMIST*
2. M.Neelakandan, Cognizant Techno Solutions,Chennai., *pymani2010@yahoo.com*	*2.* **Dr.I.Thirunavukkarasu, Mlanipal Institute of Technology, Karnataka, itarasu1881@gmail.com**	*2.Dr.A.Vimala Juliet, SRMIST*

Course Code	18EIE407T	Course Name	MACHINE VISION SYSTEMS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Provide the basic knowledge in Machine vision	Blooms Level (1-6)
CLR-2 :	Understand the concept of Image acquisition and conversion	
CLR-3 :	Know the basic knowledge in image processing decision making	
CLR-4 :	Introduce the three-dimensional machine vision techniques	
CLR-5 :	Provide the adequate information in the implementation of machine vision in industry	
CLR-6 :	Impart the overall practical concept of machine vision	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning	Program Outcomes (PO)												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
			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	PSO – 1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze &Research
CO-1 :	Understand the fundamentals of machine vision.	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Develop any application based on Image acquisition and conversion	1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-3 :	Implement the evolution of decision making in image processing	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Analyze the ***three-dimensional machine vision techniques***	4	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	Evaluate the machine vision concept in various industries.	3	-	-	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-6 :	Apply machine vision based automation system used in industries ranging from discrete, continuous process to hybrid processes	2	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-

Duration (hour)		INTRODUCTION TO MACHINE VISION	IMAGE ACQUISITION AND CONVERSION	DECISION MAKING IN IMAGE PROCESSING	THREE-DIMENSIONAL MACHINE VISION TECHNIQUES	APPLICATIONS IN INDUSTRY
		9	9	9	9	9
S-1	SLO-1	Machine Vision: Introduction	Image Acquisition: Introductory Concepts	Image Processing: Enhancement/Preprocessing	Various approaches to obtaining three-dimensional data.	Introduction: Semiconductor industry
	SLO-2	A Data Acquisition System	Application Features	Segmentation	Stereo, Stereopsis	
S-2	SLO-1	Relationships to Other Fields	Contrast and Resolution	Coding/Feature Extraction		Electronic Manufacturing
	SLO-2	Role of Knowledge	Lighting- Light	Image Analysis/Classification/Interpretation	Active Imaging	
S-3	SLO-1	Image Geometry	Wavelength	Pixel Transformations	Simple Triangulation Range Finding	Bareboard inspection system offered by AOI Systems
	SLO-2		Polarization	Problems		
S-4	SLO-1	Perspective Projection	Geometry of Propagation	Scaling- Global Transformations	Range from Focusing	Automated Optical Inspection system
	SLO-2	Coordinate Systems	Incandescent Light Bulb	Neighborhood Transformations		
S-5	SLO-1	Sampling and Quantization	Discharge Tube	Spatial Filters, IIR filters	Time-of-Flight Range Finders	Automotive Industry
	SLO-2	Problems	Illumination Optics	Problems		Automotive Industry
S-6	SLO-1	Image Processing Introduction	Interaction of Objects with Light	Localized Thresholding	Active Triangulation Range Finder	Taxonomy of Machine Vision Applications in the Auto Industry

	SLO-2	*Levels of Computation*	*Geometric Parameters*	*Edge Segmentation*		*Specific Applications of Machine Vision in the Automotive Industry*
S-7	SLO-1	*Point Level*	*Shape or Profile of Object*	*Morphology, Coding/Feature Extraction*	*Surface Measurement Using Shading Data*	
	SLO-2		*Image Formation by Lensing*	*Thermal image in machine vision applications*		*Machine Vision Systems in the Container Market*
S-8	SLO-1	*Local Level*	*Conventional Imaging*		*Depth from Texture Gradient*	*Glassware Inspection*
	SLO-2	*Global Level*	*Image Scanning*	*Miscellaneous Scalar Features*		
S-9	SLO-1	*Object Level*	*Image Conversion*	*Three-Dimensional Machine Vision Techniques*	*Applications*	*List of Applications in Pharmaceuticals*
	SLO-2	*Road Map*	*Capturing Techniques*			

Learning Resources	1. *Nellazuech, 'Understanding & applying machine vision' Marceldekker Inc. 2000.* 2. *Alexander Hornberg , "Handbook of Machine and Computer Vision: The Guide for Developers and Users", 2nd Edition, Wiley Publisher, 2017.* 3. *E. R. Davies, 'Computer and Machine Vision' Academic Press, 4rth Edition, 2012.* 4. *Beyererj,'Machine Vision Automated Visual Inspection Theory Practice And Applications' Springer, 2015.* 5. *Snyder Wesley E., Qi Hairong, Wesley E. Snyder, 'Machine Vision' Cambridge University Press, 2010.* 6. *NPTEL Video Lecture notes on," Computer Vision" by Prof. JayantaMukhopadhyay, 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	*50%*	-	*20%*	-	*20 %*	-	*50%*	-	*20%*	-
Level 2	Understand	*50%*	-	*40%*	-	*20 %*	-	*50%*	-	*30%*	-
Level 3	Apply		-	*40%*	-	*20 %*	-	-	-	*30%*	-
Level 4	Analyze			40-		*40 %*	-			2 *20%*	
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.SanthoshEswaran, VR Savvy, info@vrsavvy.co	*1. Dr.J.Prakash, Professor, MIT, Chennai, prakaiit@gmail.com*	*1. **Dr.S.UmaMaheswari**, SRMIST, umamahes3@srmist.edu.in*
2. Mr. Neelakandan Mani, Senior Director, CTS, pymani2010@yahoo.com	*2. Dr. B.Chittibabu, IIITDM, Kancheepuram, bcbabu@iiitdm.ac.in*	*2. **Dr. A. Vimala Juliet**, SRMIST, hod.eie.ktr@srmist.edu.in*

Course Code	18EIE408T	Course Name	NON-LINEAR CONTROL DESIGN	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Introduce basic concepts of phase plane analysis and limit cycles.	Blooms level (1-6)
CLR-2 :	Know and understand the describing functions in nonlinear systems	
CLR-3 :	Introduce the concepts of lyapunov theory for stability analysis of system	
CLR-4 :	Impart the knowledge of control design for non-linear systems – simple lower order system	
CLR-5 :	Impart the knowledge of control design for non-linear systems – complex system	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Explain the need and process of implementing the phase plane analysis method.	2
CO-2 :	Examine the describing function analysis in controller design.	3
CO-3 :	Infer the stability of Non-Linear system using Lyapunov Theory	4
CO-4 :	Analyze the non-linear control system using lyapunov theory for simple lower order practical applications	4
CO-5 :	Model the non-linear control system using lyapunov theory for higher order complex practical applications	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
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	Utilize PLC & DCS for control of systems	Effective management skills in the implementation
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	-	-	-	-	-	-	-	-	-	3	-	-

Duration (hour)		Phase Plane Method	Describing Function Method	Fundaments of Lyapunov Theory	Non-Linear Control System Design	Adaptive and Sliding Mode Control Design
		9	9	9	9	9
S-1	SLO-1	Introduction	Describing Function Fundamentals	Nonlinear systems and Equilibrium points	Non-Linear Control Problems	Feedback Linearization
	SLO-2	Need for Non-Linear Control	Applications of Describing Functions	Autonomous and Non-Autonomous Systems	Stabilization Problems	Input-State Linearization
S-2	SLO-1	Non-Linear Systems Analysis	Basic Assumptions	Concepts of Stability	Asymptotic Stabilization Problem	Input-Output Linearization
	SLO-2	***Phase Plane Analysis***	Describing Function Representation	Stability and Instability	***Tracking Problems***	***Internal Dynamics of Linear Systems***
S-3	SLO-1	Phase Portraits	Nonlinearities in Control Systems	Asymptotic and Exponential Stability	Asymptotic Tracking Problems	Mathematical Tools
	SLO-2	Singular points	Continuous and Dis-Continuous Non-Linearities	Local and Global Stability	Relationship between Stabilization and Tracking	Lie Derivatives
S-4	SLO-1	Symmetry in Phase Plane Portraits	Saturation, On-Off Nonlinearity	Linearization and Local Stability	Specifying Desired Behavior	Lie Brackets
	SLO-2	Constructing Phase Portraits	Deadzone, Backlash	Lyapunov's Linearization Method	Stability, Accuracy	Sliding Control
S-5	SLO-1	Analytical Method	Hysteresis	Lyapunov's Direct Method	Speed of Response, Robustness	Sliding surfaces
	SLO-2	Method of Isoclines	Describing Functions of Non-Linearities	Positive Definite Functions and Lyapunov's Functions	Cost	Switching control laws
S-6	SLO-1	Determining Time from Phase Portraits	Saturation, Deadzone	Equilibrium Points Theorems	Issues in Constructing Nonlinear Controllers	Basic concepts of Adaptive Control

	SLO-2	*Phase Plane Analysis of Linear System*	*Backlash*	*Lyapunov Theorem for Local Stability*	*Procedure for Control Design*	*Design of Adaptive Controllers*
S-7	**SLO-1**	*Phase Portraits of Linear System*	*Describing Function Analysis of Non-Linear Systems*	*Lyapunov Theorem for Global Stability*	*Modeling Non-Linear systems*	*Adaptive control of first order systems*
	SLO-2	*Stable, Unstable Node, Saddle Point*	*Nyquist Criterion*	*System Analysis based on Lyapunov's Direct Method*	*Feedback and Feedforward*	*Full state feedback*
S-8	**SLO-1**	*Phase Plane Analysis of Non- Linear System*	*Existence of Limit Cycles*	*LTI System Analysis*	*Methods of Non-Linear Control Design*	*Output feedback*
	SLO-2	*Existence of Limit Cycles*	*Detection of Limit Cycles*	*Krasovskii's Method*	*Feedback Linearization*	*Adaptive control of non-linear systems*
S-9	**SLO-1**	Stable, Unstable, Semi-stable limit cycles	*Stability of Limit Cycles*	*Variable Gradient Method*	*Robust Control, Adaptive Control*	*Robustness of adaptive control*
	SLO-2	*Poincare Theorem, Bendixon Theorem*	*Reliability of Describing Function Analysis*	*Case Study – Lyapunov Control Design*	*Case Study – Non-Linear Control Design Applications*	*On-line parameter estimation*

Learning Resources	*1. Michal Piorek, Analysis of Chaotic Behavior in Non-Linear Dynamical Systems, Springer., 2019* *2. Mourad B, Nonlinear Control Systems using Matlabv, CRC Press, 2019.* *3. Shuli Guo, Stability and Control of Nonlinear Time Varying Systems, Springer, 2018.*	*4. Martin Guay, Robust and Adaptive Model Predictive Control of Nonlinear Systems, IET Control Robotics and Sensors Series, 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	*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.T.A.Balaji, Robert Bosch, Coimbatore, Balaji.TAnanthanpillai@in.bosch.com	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. **Dr.G.Y. Rajaa Vikhram**, SRMIST*
2. 2. Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com	***2. Dr.S.Latha, TCE, Madurai, sleee@tce.edu***	

Course Code	18EIE409T	Course Name	BIO-OPTICAL INSTRUMENTATION	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Impart basic knowledge on optical properties of the Tissues.	
CLR-2 :	Understand the types of interaction between light and tissue	
CLR-3 :	Introduce different types of Instruments for measurement, fibers, polarizers, detectors	
CLR-4 :	Know various applications of laser in Surgical and Therapy in medicine field	
CLR-5 :	Understand the Hazards in using Lasers	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1 :	Summarize the optical properties of tissue and its numerical approach.	2
CO-2 :	Illustrate different types of Interactions between light and tissue	4
CO-3 :	Select appropriate source, fibers and detectors for experimental and practical applications.	4
CO-4 :	Classify the lasers used for surgery or therapy.	4
CO-5 :	Infer the risks involved in handling the laser sources.	4

Program Outcomes (PO)												PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team	Communication	Project Mgt. & Finance	Life Long Learning	Automatic control for	Utilize PLC & DCS for	Effective management
3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		Optical Properties of Tissue	Light – Tissue Interaction	Basic Instrumentation in Photonics	Medical Applications	Hazards & Safety
		9	9	9	9	9
S-1	SLO-1	Introduction	Introduction	**Basic Spectrometer** – Apparatus	Introduction, **Lasers in Ophthalmology**	Introduction - **Laser Hazards**
	SLO-2	**Fundamental Optical Properties -** Refraction	**Light Interaction with a strongly Scattering Tissue**	Instrumentation for Absorption Measurement		Radiation, chemical, Electrical
S-2	SLO-1	Scattering and Absorption	Continuous Wave Light	Instrumentation for Scattering Measurement	**Lasers in Dentistry**	**Eye Hazards**
	SLO-2	**Light transport in Tissues** – Preliminary to RTT	Short Light Pulses	Instrumentation for Emission Measurement		Optical radiation
S-3	SLO-1	Radiation Transport Therapy	Diffuse Photon – Density Waves	**Instrumentation Components**	**Lasers in Gynecology**	**Skin Hazards**
	SLO-2	Approach& Limiting Cases	**Polarized Light Interaction**	**Excitation Light Sources** – High Pressure ARC Lamps		
S-4	SLO-1	**Numerical approach:**Monte Carlo Simulation	Tissue structure and Anisotropy	Low Pressure Vapor Lamps, Incandescent Lamps	**Lasers in Urology**	**Associated Hazards from High Power Lasers**
	SLO-2		Polarized Light Description	Solid State Light Sources, Lasers		
S-5	SLO-1	Kubelka-Munk Model	Single Scattering and Quasi ordered Tissue	**Optical Fibers and Dispersive Devices** – Optical Filters	**Lasers in Neurosurgery**	**Laser Safety Standards**
	SLO-2		Vector Radiative Transfer Theory	Prism Monochromators, Grating Monochromators, Tunable Filters		
S-6	SLO-1	Effective Index of Refraction	**Opto-Thermal Interaction**	**Optical Fibers**	**Lasers in Angioplasty and Cardiology**	**Hazard Classification**

	SLO-2	*Time resolved propagation of light pulses*	*Temperature Rise and Tissue Damage*			
S-7	**SLO-1**	***Tissue Properties***	*Opto-Thermal and Optoacoustic Effects*	***Polarizers***	***Lasers in Orthopedics***	***Viewing Laser Radiation***
	SLO-2	*Refractive Index*	*Acoustooptical Interaction*			
S-8	**SLO-1**	*Scattering Properties*	*Sonoluminescence*	***Detectors** – Single Channel Detectors,*	***Lasers in Dermatology and Cosmetics***	***Eye Protection***
	SLO-2	*Absorption properties*	*Refractive Index and Controlling of Light Interaction with Tissue*	*Multichannel Detectors*		
S-9	**SLO-1**	***Summary***	***Fluorescence** – Fundamentals and Methods*	***Detection Methods** – DC Techniques, AC Techniques,*	***Lasers in Gastroentology***	***Laser Beam Calculations***
	SLO-2		*Multiphoton Fluorescence*	*Digital Photon Counting Technique, Time resolved & Phase Resolved,*		

Learning Resources	1. *Tuan Vo-Dinh, "Biomedical Photonics Handbook" Volume – I, CRC Press, Second Edition – 2015* 2. *Markolf H. Niemz, "Laser-Tissue Interactions: Fundamentals and Applications", Springer, Fourth Edition – 2019* 3. *R Splinter and B A Hooper, "An Introduction to Biomedical Optics", CRC Press – 2007*	4. *Paras N. Prasad, " Introduction to Biophotonics", John Wiley & Sons Inc., publications – 2003* 5. *Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press - 2006*

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 and Conf. Paper etc.

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Neelakandan Mani, Senor Director, CTS	*Dr. J Prakash, MIT, Chennai*	*Mr.C. Likith Kumar, SRMIST*
Mr. Vijayarajeswaran, MD Vi micro system Pvt.Ltd	*Dr. E. Paul Braineard, IIIT Sricity*	*Dr. P A Sridhar, SRMIST*

Course Code	18EIE410T	Course Name	BIO - MECHATRONICS	Course Category	E	Professional Elective	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:	Learning
CLR-1 :	Impart basic knowledge on Physiological System and Bio-Mechatronic System	Blooms level (1-6)
CLR-2 :	Gain knowledge on design aspects of Hearing Implants	
CLR-3 :	Understand various design aspects of Visual Implants	
CLR-4 :	Provide insights on working of Heart & Respiratory Aiding System	
CLR-5 :	Explore the various mechanism suitable for designing Prosthetic Limbs	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning
CLO-1 :	Summarize the concepts for replacing physiological system by Bio-mechatronic System	2
CLO-2 :	Illustrate the working of hearing implants	4
CLO-3 :	Classify Visual Prosthetics based on their nature of working	4
CLO-4 :	Analyze the working of heart and respiratory aiding system	4
CLO-5 :	Analyze the working mechanism of the prosthetic limbs	4

Program Outcomes (PO)												PSO		
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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	Utilize PLC & DCS for control of systems	Effective management skills
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	-	2	-	-	-	-	-	-	-	-	1	-	-

Duration (hour)		Introduction to Bio-Mechatronics	Hearing Aids & Implants	Visual Prostheses	Heart & Respiratory Aid	Active & Prosthetic Limbs
		9	9	9	9	9
S-1	SLO-1	***Introduction***	*Introduction*	***Introduction***	*Introduction* ***Heart as a Pump***	*Introduction to prosthetics*
	SLO-2	***Overview of Physiological Systems***	***Sound –*** *Characteristics Impedance*	*Anatomy and physiology of the visual path way, causes of Blindness*	*Heart Valves, Pump cycle, cardiac Output, Pressure Regulation, Heart Disease*	***Structure of the ARM***
S-2	SLO-1	*Biochemical System*	*Sound Pressure, Sound Intensity*	***Optical Prosthetics –*** *Lasses, Thermal Images*	*Bio mechatronics Perspective*	***Kinematic Model of ARM***
	SLO-2	*Nervous System*	***Hearing Works****– Outer Ear, Middle Ear*	*Night Vision*	***Artificial Hearts***	
S-3	SLO-1	*Cardiovascular System*	*Inner Ear and Hearing Statistics*	***Sonar Based System****– Existing Systems*	***Ventricular Assist Devices***	***Structure of the Leg***
	SLO-2	*Respiratory System*	***Hearing Loss –*** *Causes, Diagnosis*	*Issues with Sonar*	*Types of Generations in VAD's*	
S-4	SLO-1	*Musculoskeletal System*	*Treatment*	***Laser Based System***	***Engineering in Heart Assist Devices***	***Kinematic Model of Leg***
	SLO-2	*Feedback Elements*	***Hearing Aid****– Hearing Aid Operation*		*Fluid Dynamics in Pulsatile LVADs, centrifugal & Axial LVADs*	
S-5	SLO-1	***Overview of Bio Mechatronics System***	***Bone Conduction Devices***	***Visual Neuroprostheses***	*Estimation and Control of Blood Flow*	***Kinematics of Limb Movements***
	SLO-2	*Human Subject*	***Middle Ear Implants***	*History*	*Introduction to* ***Respiratory Aids***	*Center of Mass and Moment of Inertia of Limb Segment*
S-6	SLO-1	***Stimulus or Actuation***	*PZT Devices, Electromagnetic Hearing Devices*	*Potential Sites for V N*	***Mechanics of Respiration -*** *Physical Properties, Lung Elasticity*	*Angular Acceleration*
	SLO-2	*Transducer and Sensors*	*Issues with Implantable Middle Ear Devices*	*Components & Research Activity*	*Frictional Forces, Inertia*	*Center of Mass and Moment of Inertia of complete Limb Segment*

S-7	**SLO-1**	*Signal Processing Elements*	***Direct Acoustic Cochlear Stimulatory Devices***	*Sub retinal Implants*	***Energy Required for Breathing***	***Passive Prosthetics*** *– Actuation and Control*
	SLO-2	*Recording and Display*	*Actuator Design*	*Epi retinal Implants*	***Lung Characteristics***	*Walking Dynamics, Knee Prosthetics*
S-8	**SLO-1**	*Future of Bio mechatronics System*	***Cochlear Implants -*** *Working, Installation of Electrodes*	*Alternative Implants*	***Mechanical Ventilation***	*Foot Prosthetics*
	SLO-2	***Applications***	*Processing, Stimulation and Strategies*	*Optic Nerve Stimulation*	***External Negative Pressure Ventilation***	***Active Prosthetics –*** *ARM & Hand Mechanism*
S-9	**SLO-1**	***Applications***	***Auditory Brainstem Implants***	*Visual Cortex Implants*	***External Positive Pressure Ventilation***	*Hand Research & Applications*
	SLO-2	***summary***	*Electrodes and Stimulus Mapping*	*Applications & Future Scope*	*Applications*	*Control of Prosthetic ARM and Hands & Leg Mechanism*

Learning Resources	1. "Hand Book of Bio Mechatronics", by Jacob Segil. Academic Press publications, 2019 (Academic Press is an imprint of Elsevier). 2. "Introduction to Bio Mechatronics", by Graham M. Brooker. SciTech publication, 2012. 3. "Bio Mechanics in Medical Rehabilitation", by Shane Xie · Wei Meng. Springer International Publishing AG, 2017.	4."Bio Mechatronics in Medical and Health Care", by Raymond Tong. Pan Stanford Publishing Pte. Ltd. 2011. 5."Wearable Robots - Bio mechatronic Exoskeletons", by Jose L. Pons. John Wiley & Sons Ltd, 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, Certification and Conf. Paper etc.

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Neelakandan Mani, Senor Director, CTS	*Dr. J. Prakash, MIT, Chennai*	***Mr.C. Likith Kumar****, SRMIST*
Mr. Vijayarajeswaran, MD Vi micro Pvt.Ltd	***Dr. E Paul Braineard, IIIT Sricity***	*Dr. P A Sridhar, SRMIST*

Course Code	18EIO131J	Course Name	VIRTUAL INSTRUMENTATION	Course Category	O	Open Elective	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:	Learning
CLR-1 :	Study the concepts of Virtual instrumentation and to learn the programming concepts in VI.	
CLR-2 :	Study about the various real time data acquisition methods.	
CLR-3 :	Study about the various Instrument Interfacing concepts.	
CLR-4 :	study the programming techniques for various control techniques using VI software	
CLR-5 :	Study various analysis tools for Process control applications.	
CLR-6 :	study various real time measurement systems	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	understand the purpose of virtual instrumentation and understand the construction of VI	2	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-2 :	Apply various data acquisition methods.	3	2	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-3 :	implement the available interfacing instruments	3	2	-	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-4 :	implement various control techniques using VI software	4	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5 :	Develop a program for an engineering application.	6	3	-	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-6 :	implement various measurement systems	3	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		12	12	12	12	12
S-1	SLO-1	Historical perspective, Need of VI, Advantages of VI, Virtual Instruments versus Traditional Instruments	A/D Converters, Organization of the DAQ VI system -	Introduction to PC Buses	Introduction to Non continuous controllers in LabVIEW	PC based digital storage oscilloscope
	SLO-2	Review of software in Virtual Instrumentation ,Software environment Architecture of VI, Introduction to the block diagram and Front panel Pallets	D/A Converters, Types of D/A	Local Buses-ISA, PCI,	Introduction to continuous controllers in LabVIEW	Sensor Technology
S-2	SLO-1	Creating and saving a VI, Front Panel Tool Bar, Block diagram Tool Bar, Palettes	plug-in Analog Input/output cards - Digital Input and Output Cards,	RS232, RS422	Design of ON/OFF controller	Applications of sensor Technology
	SLO-2	Creating sub VI, Creating an ICON, Building a connector pane, Displaying VI'S, Placing and Saving Sub VI'S on block diagram, Example of full adder circuit using half adder circuit	Organization of the DAQ VI system -	RS485	Proportional controller for a mathematically described processes using VI software	Signal processing Techniques
S-3	SLO-1	Front Panel controls and Indicator	Measurement of diode I-V characteristics using LabVIEW	Load cell Data acquisition using RS232	On-off temperature controller using LabVIEW	Design of DSO
	SLO-2	Verification of Arithmetic Operations	Measurement of diode I-V characteristics using LabVIEW	Load cell Data acquisition using RS232	On-off temperature controller using LabVIEW	Design of DSO
S-4	SLO-1	Verification of Half Adder	Temperature measurement using LabVIEW and DAQ hardware.	Load cell Data acquisition using RS422	Continuous Control of temperature using LabVIEW	Analysis of different signal Filters using LabVIEW
	SLO-2	Verification of Full adder.	Temperature measurementusing LabVIEW and DAQ hardware.	Load Data acquisition using RS422	Continuous Control of temperature using LabVIEW	Analysis of different signal Filters using LabVIEW
S-5	SLO-1	Loops-For Loop,	Opto Isolation need	Interface Buses-USB,PXI	Modeling of level process	Spectrum Analyzer

	SLO-2	While Loop	Performing analog input and analog output	VXI,	Basic control of level process in LabVIEW	Waveform Generator
S-6	SLO-1	Arrays,	Scanning multiple analog channels	SCXI	Modeling of Reactor Processes	Data visualization from multiple locations
	SLO-2	Clusters,plotting data	Issues involved in selection of Data acquisition cards	PCMCIA	Basic control of Reactor process in LabVIEW	Distributed monitoring and control
S-7	SLO-1	Program to find Addition of First n natural numbers using for loop	Flow measurement in water using LabVEW and DAQ hardware.	DC motor control using VXI	On-off Level controller using LabVIEW	Real time spectrum analysis using LabVIEW
	SLO-2	Program to find Addition of First n odd numbers using while loop.	Flow measurement in water using LabVEW and DAQ hardware.	DC motor control using VXI	On-off Level controller using LabVIEW	Real time spectrum analysis using LabVIEW
S-8	SLO-1	Implementation of Array functions.	Level measurement in water using LabVEW and DAQ hardware	GPIB with VISA functions	Continuous Control of pressure controller using LabVIEW	Arbitratory Waveform Generator using LabVIEW
	SLO-2	Calculation of BMI using cluster	Level measurement in water using LabVEW and DAQ hardware	GPIB with VISA functions	Continuous Control of pressure controller using LabVIEW	Arbitratory Waveform Generator using LabVIEW
S-9	SLO-1	Charts	Data acquisition modules with serial communication	Instrumentation Buses - Modbus and GPIB	Case studies on development of HMI in VI	Vision and Motion Control
	SLO-2	Graphs	Design of digital voltmeters with transducer input	Networked busses – ISO/OSI	Case studies on development of HMI in VI	Examples on Integrating Measurement with vision and motion
S-10	SLO-1	Case and Sequence Structures	Timers and Counters	Reference model,	Case studies on development of SCADA in VI	NI Motion control
	SLO-2	Formula nodes, String and File Input/Output.	Timers and Counters	Ethernet and TCP / IP Protocols	Case studies on development of SCADA in VI	Speed control system
S-11	SLO-1	Monitoring of temperature using Charts and Graphs	Design of digital voltmeters with transducer input using LabVIEW	Online temperature control using LabVIEW using TCP/IP	On-off pressure controller using LabVIEW	Minor Project
	SLO-2	Program for implementing Seven segment display..	Design of digital voltmeters with transducer input using LabVIEW	Online temperature control using LabVIEW using TCP/IP	On-off pressure controller using LabVIEW	Minor Project
S-12	SLO-1	Program to perform Traffic light control	Pressure measurement usingLabVEW and DAQ hardware DAQ.	Online temperature control using Webpublishing tool	Continuous Control of pressure controller using LabVIEW	Minor Project
	SLO-2	Program to perform Traffic light control	Pressure measurement usingLabVEW and DAQ hardware DAQ.	Online temperature control using Webpublishing tool	Continuous Control of pressure controller using LabVIEW	Minor Project

Learning Resources

1. *Nadovich, C., Synthetic Instruments Concepts and Applications, Elsevier, 2005*
2. *Bitter, R., Mohiuddin, T. and Nawrocki, M., Labview Advanced Programming Techniques, 2nd ed., CRC Press, 2007*
3. *Gupta, S. and Gupta, J. P., PC Interfacing for Data Acquisition and Process Control", 2nd ed., Instrument Society of America, 1994*
4. ***Jamal, R., Picklik, H., Labview – Applications and Solutions, National Instruments Release.***
5. ***Johnson, G., Labview Graphical programming, McGraw-Hill, 1997***
6. ***Wells, L.K., Travis, J., Labview for Everyone, Prentice Hall, 1997***
7. ***Buchanan, W., Computer Busses, CRC Press, 2000***

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. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	***1.** Dr. K. A. Sunitha**, SRMIST***
2. V. Venkateswaran, Instrumentation Consultant,vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	***2.** Mrs. A. Brindha**, SRMIST***

Course Code	18EIO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	Open Elective	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:	Learning
CLR-1:	Understand the principle and theory of analytical instruments	
CLR-2:	Understand the quantitative analysis of dissolved components	
CLR-3:	Study the concept of separation science and its applications	
CLR-4:	Study the various spectroscopic techniques and its instrumentation	
CLR-5:	Identify and solve engineering problems associated with Radiation Techniques	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1:	Apply the principles and theory of instrumental analysis	2
CO-2:	Apply the principles of various chemical analysis instruments in industries	3
CO-3:	Analyze and understand the operation of various radio chemical methods of analysis	3
CO-4:	analyze and understand the operation of instruments based on optical properties	4
CO-5:	identify and solve engineering problems associated with Radiation Techniques	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
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
3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
2	-	-	-	-	-	-	-	-	-	-	-	3	2	-
2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
		9	9	9	9	9
S-1	SLO-1	Introduction to Chemical instrumental analysis	Dissolved oxygen analyzer, Importance of measuring dissolved oxygen in Industry, Principle working	Chromatography, Importance, Basic working of Chromatography	Spectral methods of analysis- Properties or parameters of electromagnetic radiation	NMR spectrometers ,Importance and basic working of NMR Spectroscopy
	SLO-2	Spectral method of analysis	Working of Dissolved oxygen analyzer	Gas chromatography Instrumentation	Electromagnetic spectrum Types of spectrometers	Magnetic assembly, Probe unit, Instrument stabilization
S-2	SLO-1	Electro analytical and seperative methods	sodium analyzer, Importance of measuring sodium in Industry, Principle working	Basic parts of a gas chromatography	Beer's law UV-visible spectrophotometers Transmittance and absorbance	Types of NMR spectrometer, Minimal type
	SLO-2	Instrumental methods of analysis-basic components and their classification	Working of sodium analyzer	Carrier gas supply Sample injection system	Beer's law Application of beer's law	Multipurpose NMR,Wideline
S-3	SLO-1	Sampling systems	Silica analyzer, Importance of measuring Silica in Industry, Principle working	Chromatographic column, Selection of column	Derivations of beer's law	Applications of NMR Spectrometer
	SLO-2	Importance of Sampling system in chemical Industries and Safety aspects	Working of Silica Analyzer	Thermal compartment, Detection system, Recording system	Single beam and double beam instruments	Mass Spectrometers, Basic working and Importance
S-4	SLO-1	PH Measurement, Principle of PH measurement &Importance of PH measurement in Industries	Moisture measurement Importance of Moisture measurement	Liquid chromatography-Principles, types and applications	IR spectrophotometers Instruments of IR	Components of Mass Spectrometers
	SLO-2	Types of Electrodes, Reference Electrodes and types	Types of Moisture measurement	High pressure liquid chromatography	Types of IR Components required for three types of IR	Types of Mass spectrometers Magnetic Sector analyzer,Double focusing spectrometers
S-5	SLO-1	Secondary Electrodes and Types	Oxygen analyzer Methods of oxygen analyzers and importance	Instrumentation or basic component of HPLC	Instruments of dispersive instrument , IR Radiation Sources and types	Time of flight analyzers, Quadrupole Mass analyzers

	SLO-2	*Indicator electrodes*	*Paramagnetic oxygen analyzer* *Electro analytical method*	*Solvent reservoir and its treatment system*	*Importance of Monochromators and types of Monochromators*	*Application of mass spectrophotometers*
S-6	**SLO-1**	*pH meters* *direct reading type pH meter* *null detector type pH meter*	*CO monitor,Importance of measuring CO*	*Pumping system, Types of working systems and Importance*	*Samples And Sample Cells* *detectors*	*nuclear radiation detectors, importance of measurement*
	SLO-2	*ion selective electrodes* *Types of ion selective electrodes* *Glass membrane electrodes* *Liquid membrane electrodes* *Solid membrane Electrodes*	*Types of CO monitor*	*Pulse dampers*	*FTIR spectrometers* *Main components* *Advantages* *disadvantages*	*GM counter*
S-7	**SLO-1**	*Biosensors* *Features of Biosensor* *Block diagram of bio sensor*	*NO2 analyzer, Importance of NO_2 measurement*	*Sample injection system and types*	*Types of sources* *Selection factors*	*Working setup, advantages of GM Counter*
	SLO-2	*Applications of Biosensors in industries*	*Types of NO_2 measurement*	*Liquid chromatographic column working , Types of Column thermostats*	*Types of detectors* *Selection factors*	*proportional counter, Basic Principle*
S-8	**SLO-1**	*conductivity meters ,Importance in Chemical Industries*	*H_2S analyzer, Importance of H_2 S Measurement*	*Detection system types*	*atomic absorption spectrophotometer instruments for atomic absorption spectroscopy*	*Working setup, advantages of GM Counter*
	SLO-2	*Types of Conductivity meters*	*Types of H_2S measurement*	*Types of Recording system*	*radiation source* *chopper*	*solid state detectors, Basic Principle*
S-9	**SLO-1**	*Air pollution Monitoring Instruments*	*Dust and smoke measurement-* *dust measurement and Importance* *Types of dust measurement*	*Application of HPLC, Advantages of HPLC over gas chromatography*	*production of atomic vapor by flame, Parts by flame photometer* *Emission system*	*Working setup, advantages of Solid state detectors*
	SLO-2	*Estimation of Air pollution*	*Thermal analyzer , Importance of Thermal analyzers, Types of Thermal analyzer*	*Detectors types, Factors Influencing the Selection of Detectors*	*Monochromators* *And types, Types of Detectors and recording systems and their selection criteria*	*scintillation counter, Basic principle*

Learning Resources	1. *Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006* 2. *Bella. G, Liptak, "Process Measurement and analysis"., CRC press LLC.,2003.* 3. *Francis Rousseau and AnnickRouesssac "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley& sons Ltd.2007.*	4. *James W.Robinson,"Undergraduate Instrumental Analysis", Marcel Dekker., 2005.* 5. *Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.*

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	-	-	*60 %*	-	*40 %*	-	*30 %*	-	*40 %*	-
Level 4	Analyze	-	-		-	*20%*	-	*30 %*	-	*20 %*	-
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, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Dr. K.A.Sunitha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant,vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs.A.Brindha,SRMIST*

Course Code	18EIO133T	Course Name	INDUSTRIAL AUTOMATION SYSTEMS	Course Category	O	Open Elective	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:	Learning
CLR-1:	Study the basic components of PLC	
CLR-2:	Identify the use of timers and counters in process automation	
CLR-3:	Understand the DCS architecture	
CLR-4:	Gain knowledge on operator and engineering interface in DCS	
CLR-5:	Impart the knowledge on various elements in SCADA	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)
CO-1:	Summarize the I/O modules in PLC for process control	2
CO-2:	Apply timers and counters in process automation	3
CO-3:	Use the knowledge of DCS in LCU selection	3
CO-4:	Analyze data in operator displays for industrial automation	4
CO-5:	Illustrate the remote terminal unit and master terminal unit in SCADA.	3

Program Outcomes (PO)														
1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
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
3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
2	-	-	-	-	-	-	-	-	-	-	-	3	2	-
2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Programmable logic controllers	PLC Programming Languages	Evolution of DCS	Operator Interfaces Requirements	SCADA basics introduction
	SLO-2	PLC vs Computer	Ladder Diagram	Hybrid System Architecture	Process Monitoring	Elements of SCADA
S-2	SLO-1	Parts of a PLC	Functional block	Central Computer system Architecture	Process Control	Functionality of SCADA
	SLO-2	Architecture	Sequential Function Chart	DCS Architecture	Process Diagnostics	Process example
S-3	SLO-1	PLC size and Application.	Instruction List	Comparison of Architecture	Process Record Keeping	Key features
	SLO-2	Fixed and Modular I/O	Structured Text	Local Control Unit Architecture	Low Level Operator Interface	Real time systems
S-4	SLO-1	Discrete Input Modules	Wiring Diagram	Architectural Parameters	High Level Operator Interface	Analog signals measurement
	SLO-2	Discrete Output Modules	Ladder logic Program	Comparison Of LCU Architecture	Hardware Elements In The Operator Interface	Control techniques
S-5	SLO-1	Analog Input Modules	On-Delay Timer Instruction	LCU Language Requirements	Operator Input And Output Devices	Remote terminal unit
	SLO-2	Analog Output Modules	Off-Delay Timer Instruction	Function Blocks	Operator Display Hierarchy	Analog and Discrete control
S-6	SLO-1	Special I/O Modules	Retentive Timer	Function Block Libraries	Plant-Level Display	Monitoring signals
	SLO-2	High Speed Counter Module	Cascading Timer	Problem-Oriented Language	Area- Level Display	Master terminal unit
S-7	SLO-1	Power Supplies	Up-Counter	LCU Process Interfacing Issues	Group- Level Display	RTU/MTU communication
	SLO-2	Isolators	Down-Counter	Security Requirements	Loop- Level Display	System components
S-8	SLO-1	Input/output Devices: Switches	Cascading Counters	Security Design Approach	Engineering Interface Requirements	

	SLO-2	*sensors*	*Combining Counter and Timer Functions*	*On-Line Diagnostics*	*Requirement For Operator Interface Configuration*	Communication Protocols
S-9	**SLO-1**	*Relays*	*Math Operation*	*Redundant Controller Design*	*Low Level Engineering Interface,*	Operator interface
	SLO-2	*Solenoid valve*	*Program*	*One-On-One, One-On-Many Redundancy*	*High Level Engineering Interfaces*	

Learning Resources	1. Frank D. Petruzella, Programmable Logic Controller, Tata McGraw Hill Fifth Edition, 2017 2. Bolton. W, Programmable Logic Controllers,6th Edition, Elsevier Newnes, Sixth Edition 2016. 3. Krishna Kant, Computer Based Industrial Control, Second edition, Prentice Hall of India, New Delhi,2015	4. Bowten, R HART Application Guide, HART Communication foundation, 2015. 5. Berge, J, Field Busses for process control: Engineering, operation, maintenance, ISA press,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	*40 %*	-	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-
Level 2	Understand	*60 %*	-	20 %	-	20 %	-	20 %	-	20 %	-
Level 3	Apply	-	-	*60 %*	-	*40 %*	-	*30 %*	-	*40 %*	-
Level 4	Analyze	-	-		-	*20%*	-	*30 %*	-	*20 %*	-
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, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mr.J. Sam Jeba Kumar, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant,vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. G.Joselin Retna Kumar, SRMIST*

Course Code	18EIO136J	Course Name	PLC FOR INDUSTRIAL AUTOMATION	Course Category	O	Open Elective	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:	Learning
CLR-1 :	Study the hardware components of Programmable Logic Controller	Blooms level (1-6)
CLR-2 :	Understand the need of programming languages for PLC	
CLR-3 :	Explore the ladder logic program for control application	
CLR-4 :	Identify applications of timers and counters in process automation	
CLR-5 :	Locate the malfunctions and troubleshooting various types of errors in Programmable Logic Controller	
CLR-6 :	Provide the knowledge of Commissioning, Maintenance and their importance in industry.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Learning
CO-1 :	Summarize the I/O modules in PLC for process control	2
CO-2 :	Apply logical principles in ladder logic program for control applications	3
CO-3 :	Use timers and counters function blocks in PLC programming for process automation	3
CO-4 :	Use data manipulation instruction in PLC programming	3
CO-5 :	Analyze the input and output malfunctions in PLC	4
CO-6 :	Develop a logical program for a given sequence of control problem	6

Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PS O2	PS O3
	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 :	2	-	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-2 :	2	2	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-3 :	2	-	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-4 :	2	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO-5 :	2	2	-	--	-	-	-	-	-	-	-	-	2	3	-
CO-6 :	2	-	-	-	-	-	-	-	-	-	-	-	3	3	-

Duration (hour)		PLC Hardware Components	PLC Programming and Wiring	Timers and Counters	Data manipulation and Math instructions	Troubleshooting
		12	12	12	12	12
S-1	SLO-1	Evolution of Programmable logic controllers	PLC programming languages-Ladder Logic	Timer Instructions	Data manipulation	Electrical Noise
	SLO-2	Architecture of a PLC	Function Block Diagram, Instruction List	On-Delay timer instruction	Data transfer operations	Leaky Inputs and Outputs
S-2	SLO-1	Principles of Operation	Instruction Addressing	Off-delay timer instruction	Data compare instructions	Grounding
	SLO-2	PLCs versus Computers	Branch Instructions	Retentive Timer	Data manipulation programs	Voltage Variations and Surges
S 3-4	SLO-1 SLO-2	***Lab1: PLC Wiring***	***Lab 4: Traffic light control system***	***Lab 7: HMI Programming***	***Lab10: Lift control***	***Lab13: Electro pneumatic direction control***
S-5	SLO-1	PLC size and application	Electromagnetic Control Relays	Cascading Timers	Numerical Data I/O Interfaces	Program Editing and Commissioning
	SLO-2	Discrete I/O modules	Contactors	Up-Counter	Closed-Loop Control	Preventive Maintenance
S-6	SLO-1	Sinking and sourcing	Manually Operated Switches	One-Shot Instruction	Math Instructions	Troubleshooting
	SLO-2	Analog I/O modules	Mechanically Operated Switches	Down-Counter	Addition Instruction	Processor Module
S 7-8	SLO-1 SLO-2	***Lab 2 :***Water level control system	***Lab 5:*** Sequential operation of motor	***Lab 8: DC motor speed control system***	***Lab11:*** Car parking system	***Lab14:*** Stamping machine control

S-9	**SLO-1**	*Special I/O modules*	*Proximity Sensor, Magnetic Reed Switch*	*Cascading Counters*	*Subtraction Instruction*	*Input Malfunctions*
	SLO-2	*I/O Specifications*	*Light Sensors, Velocity and Position Sensors*	*Combining Counter and Timer Functions*	*Multiplication Instruction*	*Output Malfunctions*
S-10	**SLO-1**	*Human Machine Interfaces (HMIs)*	*Output Control Devices, Seal-In Circuits, Electrical Interlocking Circuits*	*High-Speed Counters*	*Division Instruction*	*Comparative study of Industrial PLCs.*
	SLO-2	*Alarms, Graphics Library*	*Converting Relay Schematics into PLC Ladder Programs*	*Problems*	*Other Word-Level Math Instructions*	
S 11-12	**SLO-1** **SLO-2**	***Lab3:*** *Material handling system*	***Lab 6: Bottle filling system***	***Lab 9:*** *Temperature control system*	***Lab12: Flow control system***	***Lab15: Servo controller programming***

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. *John W. Webb, Ronald A. Reis, "Programmable Logic Controllers", Principles and Applications, Prentice Hall, 5th Edition, 2011*	4. *Gary Dunning, "Programmable Logic Controllers", Cengage Learning, 3rdEdition, 2009.* 5. *John R. Hackworth, "Programmable logic controllers Programming Methods and Applications", Pearson, 1stEdition, 2006* 6. *NPTEL Video Lecture Notes 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 %*	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. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	1. Mr. J. Sam Jebakumar, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	2. Dr. G. Joselin Retna Kumar, SRMIST

Project Work, Seminar, Internship in Industry / Higher Technical Institutions (P)

Course Code	18EIP101L / 18EIP104L	Course Name	MASSIVE OPEN ONLINE COURSE I / II	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As exposed to during the duration of training		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Improve Student Academic Characteristics and learning goals through forums, discussion groups, and blogs	
CLR-2 :	Improve Student Personal Characteristics through self-learning habits	
CLR-3 :	Characterize self-learning environment that includes pedagogy, tools, tasks, duration, feedback and assessments	
CLR-4 :	Improve lifelong learning habits and Learning process	
CLR-5 :	Characterize learning engagement methods and activities	
CLR-6 :	Inculcate self-learning behavior and lifelong learning tendency	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Inculcate student characteristics: prior-knowledge, prior-experience, expertise, academic achievement and matriculation	2	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-2 :	Inculcate self-motivation, self-confidence, intrinsic motivation, participation, social economic statute, and task-orientation	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-3 :	Enhance self-learning through peer learning, learning groups, positive collaboration	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-4 :	*Explore different learning styles and activities, identify self-learning pace, difficulties and remedial measures*	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-5 :	Identify ways of students' engagement, achievement, and attrition	4	3	-	2	-	-	-	-	-	3	3	-	-	-	-	-
CO-6 :	Identify ethical practices in self-learning and practice both individual and group learning dynamics	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-

MOOC Course Selection : List of MOOC Courses that are Approved to be learned by the student in the respective semester will be displayed by the Department MOOC Committee. Student can pick any course from that list.

Learning Assessment	
MOOC Certification Obtained (80% weightage	Final Presentation (20% weightage)

Note : Final Presentation by the student would be evaluated by the Department MOOC Committee

Course Code	18EIP102L / 18EIP105L	Course Name	Industrial Training I / II	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As exposed to during the duration of training		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Train oneself in finding the aspects in real-time work environment and prepare them to join the workforce in the future	
CLR-2 :	Gain Exposure to the actual working conditions including rules, regulations and safety practices	
CLR-3 :	Enhance and supplement the knowledge and skills of the students	
CLR-4 :	Develop the students in terms of ability, competence and interpersonal relationship	
CLR-5 :	Enhance students' knowledge in one particular technology	
CLR-6 :	Provide learning platform that can enhance their employ ability skills	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO) 1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Apply knowledge of Mathematics, Science, and Engineering Fundamentals in the real world of work	2	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-2 :	Demonstrate competency in relevant engineering fields through problem identification, formulation and solution	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-3 :	Effectively implement skills in professional communication, technical writing and using multimedia tools	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-4 :	Develop ability to work as an individual and in a group as an effective team member	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-5 :	Master the professional and ethical responsibilities of an engineer	4	3	-	2	-	-	-	-	-	3	3	-	-	-	-	-
CO-6 :	Generate a report based on the experiences and projects carried out in a real-world work environment	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-

Industrial Training Selection: List of Industries for Industrial Training for students would be finalized by the Department Internship/Industrial Training Committee.

Learning Assessment	
Industrial Training Certification Obtained (80% weightage)	Final Presentation (20% weightage)

Note : Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department

Course Code	18EIP103L / 18EIP106L	Course Name	Seminar I / II	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Utilize fundamental principles, generalizations, or theories and ability to present the same	
CLR-2 :	Increase self-motivation, personal responsibility, understand one's role of being an informed participant	
CLR-3 :	Create an environment that helps the student establish healthy relationships and support networks	
CLR-4 :	State and explain some specific skills, competencies, and points of view	
CLR-5 :	Identify, apply appropriate note-taking, test-taking, and time-management strategies to the academic studies	
CLR-6 :	Develop critical thinking, information literacy, Interdisciplinary Inquiry, Engaging with Big Questions and Major Works	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Gaining factual knowledge (terminology, classifications, methods, trends)	2	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-2 :	Relate to their interests, abilities, career choices, and personal development	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-3 :	Develop a plan that demonstrates their responsibility for their own education	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-4 :	Explain the role of self-efficacy, personal goals, and motivation in improving academic life	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-
CO-5 :	Describe the behaviors and characteristics of an effective learner	4	3	-	2	-	-	-	-	-	3	3	-	-	-	-	-
CO-6 :	Improve the Presentation Skills, Discussion Skills, Listening Skills, Argumentative Skills, Critical Thinking, Questioning	4	3	2	-	-	-	-	-	-	3	3	-	-	-	-	-

Seminar Selection: List of Seminar Topics that are Approved to be learned by the student in the respective semester will be displayed by the Department Seminar Selection/Evaluation Committee. Student can pick any topic from that list.

Learning Assessment	
Seminar Preparation Materials & Report (80% weightage)	Final Presentation (20% weightage)

Note : Final Presentation Evaluation would be done by the Seminar Evaluation Committee formed by the Department.

Course Code	18EIP107L	Course Name	MINOR PROJECT	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	6	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As required for the project work		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Learn responsible and professional way of working	
CLR-2 :	Practice development-oriented approach to work	
CLR-3 :	Enhance students' knowledge in one particular technology	
CLR-4 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer	
CLR-5 :	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.	
CLR-6 :	Learn project management.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Develop capability to acquire and apply fundamental principles of engineering	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-2 :	Become updated with all the latest changes in technological world	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-3 :	Make deep connections between ideas	4	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-4 :	*Learn to take creative risks*	5	3	2	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-5 :	Be ready for the creative economy also engage in iterative thinking and divergent thinking	5	3	-	2	-	-	-	-	-	3	3	3	2	-	-	-
CO-6 :	Identify, formulate and model problems and find engineering solution based on a systems approach	6	3	2	3	-	-	-	-	-	3	3	3	2	-	-	-

Project Work Selection : Project Work Titles for students would be finalized by the Department Project Work Evaluation Committee.

Learning Assessment	
Project Report(80% weightage)	Final Presentation (20% weightage)

Note : Final Presentation Evaluation would be done by the Department Project Work Evaluation Committee formed by the Department.

Course Code	18EIP108L	Course Name	Internship	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	6	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As exposed to during the duration of internship		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Understanding of industry/organization customs and practices	
CLR-2 :	Demonstrate professional skills that pertain directly to the internship experience	
CLR-3 :	Demonstrate effective verbal and written communication skills, Allocate time effectively	
CLR-4 :	Demonstrate effective listening skills	
CLR-5 :	Participate well as a team member and build professional network	
CLR-6 :	Build a record of work experience, Develop work habits and attitudes necessary for job success	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Adapt effectively to changing conditions	2	3	-	-	-	-	-	-	-	3	3	2	-	-	-	-
CO-2 :	Demonstrate appropriate workplace attitudes	3	3	-	-	-	-	-	-	-	3	3	2	-	-	-	-
CO-3 :	Demonstrate individual responsibility	3	3	-	-	-	-	-	-	-	3	3	2	-	-	-	-
CO-4 :	Demonstrate effective management of personal behavior, ethics and attitudes	4	3	2	-	-	-	-	-	-	3	3	2	-	-	-	-
CO-5 :	Practice ethical standards appropriate to the internship site	4	3	-	2	-	-	-	-	-	3	3	2	-	-	-	-
CO-6 :	Explore career alternatives prior to graduation, Integrate theory and practice	4	3	2	-	-	-	-	-	-	3	3	2	-	-	-	-

Internship Training Selection : List of Industries / Research Centre's for Internship Training for students would be finalized by the Department Internship/Industrial Training Committee.

Learning Assessment	
Internship Certification Obtained (80% weightage)	Final Presentation (20% weightage)

Note : Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.

Course Code	18EIP109L	Course Name	PROJECT	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	20	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As required for the project work		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Learn responsible and professional way of working	
CLR-2 :	Practice development-oriented approach to work	
CLR-3 :	Enhance students' knowledge in one particular technology	
CLR-4 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer	
CLR-5 :	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.	
CLR-6 :	Learn project management.	

Course Outcomes (CO):	At the end of this course, learners will be able to:	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 digesta	PSO2 Utilize PLC & DCS for control of systems	PSO3 Effective management skills
CO-1 :	Develop capability to acquire and apply fundamental principles of engineering	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-2 :	Become updated with all the latest changes in technological world	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-3 :	Make deep connections between ideas	4	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-4 :	Learn to take creative risks	5	3	2	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-5 :	Be ready for the creative economy also engage in iterative thinking and divergent thinking	5	3	-	2	-	-	-	-	-	3	3	3	2	-	-	-
CO-6 :	Identify, formulate and model problems and find engineering solution based on a systems approach	6	3	2	3-	-	-	-	-	-	3	3	3	2	-	-	-

Learning Assessment					
Continuous Learning Assessment	Assessment tool	Review I	Review II	Review III	Total
	Weightage	5%	20%	25%	50%
Final Evaluation	Assessment tool	Project Report	Viva Voce *		Total
	Weightage	20%	30%		50%

* Student has to be present for the viva voce for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'

Course Code	18EIP110L	Course Name	SEMESTER INTERNSHIP	Course Category	P	Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)	L	T	P	C
							0	0	20	10

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes/Standards	As required for the project work		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Become job ready along with real corporate exposure	
CLR-2 :	Increase self-confidence and helps in finding their own proficiency	
CLR-3 :	Cultivate leadership ability and responsibility to perform or execute the given task	
CLR-4 :	Inculcate learners hands on practice within a real job situation	
CLR-5 :	Create awareness of the social, cultural, global and environmental responsibility as an engineer	
CLR-6 :	Become able to identify, formulate and model problems and find engineering solution based on a systems approach	

Course Outcomes (CO):	At the end of this course, learners will be able to:	Blooms level (1-6)	Program Outcomes (PO)														
			1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
			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	Utilize PLC & DCS for control of systems	Effective management skills
CO-1 :	Enhance capability to acquire and apply fundamental principles of engineering	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-2 :	Become master in one's specialized technology	3	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-3 :	Become updated with all the latest changes in technological world	4	3	-	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-4 :	Demonstrate hands on practice within a real job situation	5	3	2	-	-	-	-	-	-	3	3	3	2	-	-	-
CO-5 :	Inculcate self-improvement through continuous professional development and life-long learning	5	3	-	2	-	-	-	-	-	3	3	3	2	-	-	-
CO-6 :	Be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurship skills	6	3	2	3-	-	-	-	-	-	3	3	3	2	-	-	-

Learning Assessment					
Continuous Learning Assessment	Assessment tool	Review I	Review II	Review III	Total
	Weightage	5%	20%	25%	50%
Final Evaluation	Assessment tool	Project Report	Viva Voce *		Total
	Weightage	20%	30%		50%

* Student has to be present for the viva voce for assessment. Otherwise it will be treated as non-appearance for the examination with final grade as 'Ab'