Department of Electronics and Instrumentation Engineering

Minor Certificate Programme : Automation Engineering

Professional Core Courses (C)

Sl.No	Course Code	Course Title	Hours/ Week			C
			L	T	P	
1	18EIC001J	Instrument Transducers	2	0	2	3
2	18EIC002J	Process Control	2	0	2	3
3	18EIC003J	Programmable logic controller	2	0	2	3

Professional Elective Courses (E)

Sl.No	Course Code	Course Title	Hours/ Week			C
			L	T	P	
1	18EIE004J	SCADA and DCS	2	0	2	3
2	18EIE005J	Electro pneumatics and Hydraulics	2	0	2	3
3	18EIE006T	Building Automation System	3	0	0	3
4	18EIE007T	Industrial data communication	3	0	0	3
5	18EIE008T	Industrial Internet of Things	3	0	0	3
6	18EIE009T	Industrial Processes and Control	3	0	0	3
7	18EIE010T	Cyber Security for Industrial Automation	3	0	0	3
8	18EIE011T	Machine Learning	3	0	0	3
9	18EIE012T	Reliability and safety engineering	3	0	0	3

Course Code	18EIC001J	Course Name	INSTRUMENT TRANSDUCERS	Course Category	C	Professional Core	L	T	P	C
							2	0	2	3

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	*Measure & evaluate various types of errors in instruments*	3	80	80
CLO-2 :	*Develop a mathematical model for a given system and estimate the response*	3	85	80
CLO-3 :	*Devise a method for any applications to measure resistance.*	3	75	80
CLO-4 :	*Design a method for any applications to measure inductance & capacitance.*	3	85	80
CLO-5 :	*Construct a transducer based on MEMS, fiber optics, etc.,*	3	85	80
CLO-6 :	*Create any transducers for any industry applications*	3	85	80

Program Learning Outcomes (PLO)	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	13 PSO 1	14 PSO-2	15 PSO-3
CLO-1 :	H	H	L	M	-	-	L	M	L	L	-	M	M	H	H
CLO-2 :	H	H	H	M	-	-	L	M	M	L	-	M	M	H	H
CLO-3 :	H	H	H	M	-	-	L	M	M	M	-	M	M	H	H
CLO-4 :	H	H	H	M	-	-	L	M	L	M	-	M	M	H	H
CLO-5 :	H	M	H	M	-	-	L	M	H	M	-	M	M	H	H
CLO-6 :	H	L	H	H	H	-	L	M	H	M	-	M	M	H	H

		Science of Measurement	Characteristics of Transducers	Variable Resistance Transducers	Variable Inductance and Variable Capacitance	Miscellaneous Transducers
Duration (hour)		12	12	12	12	12
S-1	SLO-1	General configuration and description of measuring Instruments	General input-output configuration	Basic principle-Potentiometer-Loading effect	Principles of operation, construction details	Piezoelectric transducer
	SLO-2	Basic methods of measurement	Selection & classification of transducers–based on physical effect, physical quantity	Resolution-Linearity of potentiometers	Inductive sensor: common types- brief discussion with respect to material, construction and input output variable	Hall effect transducer, Analog & Digital Hall Effect sensor
S-2	SLO-1	Functional Elements of Measurement Systems	Characteristics of instruments: Static characteristics: Accuracy, precision, resolution, sensitivity	Resistance strain gauge	Magneto strictive type& Reluctance change type	Magneto elastic sensor
	SLO-2	Definition, principles of sensing and transduction	Characteristics of instruments: linearity, span and range, threshold, Hysteresis, Dead Time	Bonded type-Unbonded type strain gauge-Filament construction-	Mutual inductance change type, Transformer Type	Digital transducers
S-3	SLO-1	Lab1: Identifying the components of measuring instruments.	Lab 4: Characteristics of RTD	Lab 7: Loading effect of potentiometer	Lab 10: Characteristics of LVDT	Lab13: Characteristics of Hall effect transducer, photovoltaic, LDR
	SLO-2					
S-4	SLO-1					
	SLO-2					
S-5	SLO-1	Units and Standards	Dynamic characteristics – Mathematical model of transducer	Material of the filament wire-Base carrier material-	Construction, material, output input relationship, I/O curve, discussion.	Fiber optic sensors, IC sensor.
	SLO-2	Error: Classification of errors, Limiting error and probable error	Zero, first and second order transducers	strain gauge cement-Lead wire connection	RVDT: Construction, material	Photo emissive cell types, Light Dependent Resistor
S-6	SLO-1	Static analysis of random error	Response to impulse, step inputs	Resistance Thermometers-Introduction-	Synchros, Microsyn	Photovoltaic cells, Photodiodes

	SLO-2	Error analysis– Statistical methods	Response to ramp and sinusoidal inputs	Construction Details of Resistance thermometer-RTD Circuits	magneto-strictive transducers, proximity sensors	MEMS & NEMS sensors
S-7	**SLO-1**	Lab2: Determining the transfer function of a first order transducer	Lab5: Dynamic characteristics of Thermistor	Lab 8: Determination of gage factor	Lab 11: Characteristics of Synchro	Lab14 : Displacement measurement using LABVIEW and DAQ Hardware
	SLO-2					
S-8	**SLO-1**					
	SLO-2					
S-9	**SLO-1**	Problems in Statistical methods- mean, median mode, variance	Example for zero order system	Causes for Self Heating error and its mathematical expression	Capacitive Transducers: Principle of operation, construction details and characteristics Variable distance-parallel plate type	Biosensors, SMART
	SLO-2	Problems in Statistical methods- standard deviation, probable error of one reading	Principle of operation of thermistor	Advantages of wire resistance Thermometers	Variable area- parallel plate, cylindrical type, variable dielectric constant type	Displacement measurement using LABVIEW and DAQ Hardware
S-10	**SLO-1**	Classification of standards	Practical example for first order system	Sensitivity analysis of strain gauge bridges	Capacitive Transducers: calculation of sensitivity. Stretched diaphragm type	Fundamentals of Fiber optic sensors and its Applications
	SLO-2	Standards of calibration	Practical example for second order system	Compare quarter, half and full bridges using strain gages	Capacitor Microphone, response characteristics	Film sensors
S-11	**SLO-1**	Lab3: Statistical Error analysis- Mean, SD, variance for an open loop response of thermocouple	Lab6: Demonstration of the dynamic characteristics of second order system.	Lab 9: Experiment on quarter, half and full bridges	Lab 12: Characteristics of capacitive transducer	Lab 15: A mini project on MEMS / Nano/ smart/fiber optics sensor using any software / fabrication
S-12	**SLO-2**					

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

Learning Assessment

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

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

Course Designers

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

Course Code	18EIC002J	Course Name	PROCESS CONTROL	Course Category	C	Professional Core	L	T	P	C
							2	0	2	3

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	Analyze and mathematically model the process systems	3	80	75	H	-	-	-	-	H	M	M	H	-	-	H	H	L	H
CLO-2 :	Demonstrate the working and application of different type of actuators and control valves	3	80	70	H	H	H	H	-	H	M	M	H	-	-	H	H	L	H
CLO-3 :	Analyze various control schemes and recommend the right control scheme for a given application.	3	75	70	H	M	M	_	M	H	M	H	H	-	-	H	H	L	H
CLO-4 :	Select and optimize the appropriate tuning of a controller	3	80	75	H	M	M	_	M	H	M	H	H	-	-	H	H	L	H
CLO-5 :	Analyze the various advanced control schemes	3	80	70	H	-	M	-	H	H	H	H	H	H	-	H	H	L	H
CLO-6 :	Choose the right choice of control strategy for a given process	3	80	70	H	-	-	-	-	H	M	L	H	-	-	H	H	L	H

Duration (hour)		Process Dynamics	Final Control Elements	Control Action	Tuning of controllers	Advanced Control Schemes
		12	12	12	12	12
S-1	SLO-1	Need for process control	Need for final control elements	Basic control actions	PID controller Tuning	Multi-loop Control Schemes
	SLO-2	Process Variables and dynamics	Signal converters	Continuous and Discontinuous modes of controllers	Need for controller tuning	Cascade control.
S-2	SLO-1	Objectives and requirements of process control	I/P and P/I converter	Characteristics of ON- OFF controllers	Evaluation criteria	Split-range control
	SLO-2	Hardware elements of process control	Pneumatic and electric actuators	Characteristics of Single speed floating controllers	PID controller Tuning	Feed-forward control
S 3-4	SLO-1	Lab1: Identify the components of the process control loop.	Lab4: Determine the characteristics of I/P and P/I converter	Lab 7: Design the on-off, P,PI and PID controller for the Pressure Process	Lab 10: Tune the PID Controller for mathematically described process using ZN method	Lab13: Case study: Cascade control in various processing units
	SLO-2					
S-5	SLO-1	Servo and Regulatory operation	Control Valves	Basic control schemes	Tuning – Process reaction curve method	Inferential control
	SLO-2	Continuous and batch processes	Types of control valves	P,I,D modes	Z-N open loop tuning technique	Ratio control
S-6	SLO-1	Mathematical model of level processes	Characteristic of Control Valves	Composite modes	Z-N closed loop tuning technique	Smith predictor control scheme
	SLO-2	Interacting and non-interacting systems	Valve Positioner and its importance	P+I, P+D and P+I+D control modes	Damped oscillation method	Internal model control (IMC)
S 7-8	SLO-1	Lab 2 : Determine the characteristics of interacting system	Lab 5: Determine the characteristics of Pneumatically Actuated Control Valve	Lab 8: Design the on-off control, P,PI and PID controller for the flow Process	Lab 11: Tune the PID Controller for mathematically described process using ZN open loop method	Lab14: Case study:Feed forward control in various processing units
	SLO-2					

S-9	**SLO-1**	Mathematical models of pressure processes	Control valve sizing	Reset windup and anti-reset windup techniques	Stability analysis using tuning methods	Survey of features available in commercially available control schemes
	SLO-2	Mathematical models of thermal processes	Guidelines for control valve sizing	Auto/manual transfer	Controller tuning with one quarter decay ratio	
S-10	**SLO-1**	Degrees of freedom	Cavitation and flashing	Practical forms of PID Controller	Problem solving	Piping and Instrumentation Diagram and its significance- Technical talk by industrial person.
	SLO-2	Self-regulation	Selection criteria	PID Implementation Issues	Problem solving	
S 11-12	**SLO-1**	Lab3: Determine the characteristics of noninteracting system	Lab 6: Determine the characteristics of Pneumatically Actuated Control Valve (with and without Positioner)	Lab 9: Design on-off control, P,PI and PID controller for the level Process	Lab 12: Compare the responses of simple and cascade control system using MATLAB	Lab15: Case study: Control valve selection and sizing for a particular process.
	SLO-2					

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	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. *Srinath, Design Engineer Instrumentation,VATECH WABAG,, srinath.vigneshwar@gmail.com*	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	**2.** *Mrs. A.Asuntha, SRMIST*

Course Code	18EIC003J	Course Name	PROGRAMMABLE LOGIC CONTROLLER	Course Category	C	*Professional Core*	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Introduce the hardware components of Programmable Logic Controller*			
CLR-2 :	*Understand the PLC of programming language*			
CLR-3 :	*Know the ladder logic program for control application*			
CLR-4 :	*Impart the knowledge of timers and countries in process automation*			
CLR-5 :	*Know the malfunctions and troubleshooting various types of error in Programmable Logic Controller*			
CLR-6 :	*Provide the knowledge of Commissioning, Maintenance and their importance on industry*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	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	PSO - 2	PSO - 3
CLO-1 :	*Illustrate and select the appropriate architecture, hardware components of Programmable Logic Controller*	*3*	*80*	*75*	*H*	*L*	-	-	-	-	*L*	*M*	*M*	*H*	*M*	*M*	*H*	*M*	*M*
CLO-2 :	*Select* the *appropriate* transducer for the given control application	*3*	*80*	*70*	*H*	*H*	-	*M*	-	*L*	*L*	*M*	*M*	*H*	*M*	*M*	*H*	*M*	*M*
CLO-3 :	*Develop the logic program for control application*	*3*	*75*	*70*	*H*	*H*	*M*	*M*	*M*	*L*	*M*	*M*	*M*	*H*	*M*	*M*	*H*	*M*	*M*
CLO-4 :	*Select the appropriate Timers and counter for the given problem statement.*	*3*	*80*	*75*	*H*	*H*	*H*	*M*	-	*L*	*M*	*M*	*M*	*H*	*M*	*M*	*H*	*M*	*M*
CLO-5 :	*Validate and Troubleshoot the I/O malfunctions in PLC*	*3*	*80*	*70*	*H*	*H*	*H*	*M*	*M*	*L*	*M*	*M*	*H*	*H*	*M*	*M*	*H*	*M*	*M*
CLO-6 :	*Evaluate the* appropriate *PLC for the given application*	*3*	*80*	*70*	*H*	*H*	-	*M*	-	*L*	*M*	*M*	*M*	*H*	*M*	*M*	*H*	*M*	*M*

Duration (hour)		PLC Hardware Components	PLC Programming	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	Timer Instructions- On-delay timer instruction	Data manipulation	PLC Enclosures PLC mounting
	SLO-2	Architecture of a PLC	Developing logic circuit from Boolean expression	Off-delay timer instruction	Data transfer operations	Electrical noise
S-2	**SLO-1**	Principles of Operations	Converting Relay Schematics into PLC Ladder programs	Retentive timer	Data compare instructions	Leaky inputs and outputs
	SLO-2	PLC size and application	Electromagnetic control relays	Cascading timer- Programs	Data manipulation program	Grounding, Surge control
S 3-4	**SLO-1** / **SLO-2**	***Lab1:*** *PLC control panel wiring.*	***Lab 4:*** *Demonstration of traffic light control sequence.*	***Lab 7:*** *Development of control logic for DC motor speed control*	***Lab10:*** *Development of control logic for Lift control*	***Lab13:*** Control of a double-acting cylinder (DAC) with Impulse valve
S-5	**SLO-1**	Discrete input modules	Seal-in circuits, Program Scan	*Up counter*	Math instructions	Commissioning, Programming and Monitoring
	SLO-2	Discrete output modules	Electrical Interlocking circuits	Down counter	Addition instructions	Preventive maintenance
S-6	**SLO-1**	Sinking I/O	switches	Cascading Counter- Programs	Subtraction Instruction	Troubleshooting PLC software
	SLO-2	Sourcing I/O	Proximity sensor	Combining counter and timer functions	Multiplication Instruction	Troubleshooting PLC hardware
S 7-8	**SLO-1** / **SLO-2**	***Lab 2 :*** *Development of control logic for filling and draining of liquid in a single tank*	***Lab 5:*** *Development of control logic for Automatic Bottle filling process*	***Lab 8:*** *Development of control logic for Flow control*	***Lab11*** *Development of control logic for Car parking*	***Lab14:*** Development of control for Sequential control of 2 double-acting

S-9	**SLO-1**	Analog Input module	Magnetic Reed switch	High speed Counters	Division Instruction	Input malfunctions
	SLO-2	Analog Output module	velocity and position sensor	Programs	Other world level math instructions	Output malfunctions
S-10	**SLO-1**	Special I/O modules	Output control devices	RS function block	FBD equivalents to LL	Comparative study of PLCs in Lab
	SLO-2	I/O specifications	Human machine interface	SR function block	FBD programming	Comparative study of Industrial PLCs
S 11-12	**SLO-1**	***Lab3:*** *Development of control logic for Material handling*	***Lab 6:*** *Development of control logic for Temperature control*	***Lab 9:*** *Development of control logic for Stamping machine control*	***Lab12:*** Development of control for Slow-speed extension, rapid retraction of a SAC	***Lab15:*** *A mini project using PLCs.*
	SLO-2					

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 Series on "Industrial Automation and Control "by Prof. S. Mukhapadhyay, IIT Kharagpur*

Learning Assessment

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

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

Course Designers

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

Course Code	18EIE004J	Course Name	SCADA AND DCS	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		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Give basic knowledge in SCADA in the field of automation			
CLR-2 :	Understand the communication modules used in SCADA			
CLR-3 :	Give basic knowledge in different architectures of DCS			
CLR-4 :	Explore the local control unit of distributed control system			
CLR-5 :	Impart adequate information in the interfaces used in DCS			
CLR-6 :	Know the applications of DCS in process industries			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Classify the various elements of SCADA system	2	80	70
CLO-2 :	Develop any application based on SCADA along with GUI using SCADA software.	3	80	70
CLO-3 :	Understand evolution and architecture of DCS and hierarchical control in DCS	2	80	70
CLO-4 :	Develop interfacing of hardware and software of computer-based automation system.	3	80	70
CLO-5 :	Select and use the most appropriate automation technologies for a given application	3	80	70
CLO-6 :	Evaluate computer-based automation system used in industries ranging from discrete, continuous process to hybrid processes.	3	90	80

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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	PSO – 2	PSO –3
H	-	-	M	H	-	-	-	-	H	-	H	M	H	M
H	M	H	M	H	M	M	-	-	H	H	H	H	H	H
H	H	M	H	M	-	-	M	M	H	H	H	H	H	H
H	H	H	H	M	M	M	M	H	H	H	H	M	H	H
H	M	H	H	H	M	-	H	H	H	H	H	M	H	H
H	M	H	H	H	H	M	H	H	H	H	H	H	H	H

Duration (hour)		SCADA Elements	Communication	DCS Architecture	Operator interface	DCS Application
		15	15	15	15	15
S-1	SLO-1	SCADA basics introduction	SCADA communication introduction	DCS - basics	DCS operator interfaces- introduction	DCS Application in Power plant
	SLO-2	Elements of SCADA	Communication system components	Evolution of Distributed Control System	Operator Interface Requirements	Automation strategy
S-2	SLO-1	Functionality of SCADA	Structure of a SCADA Communications Protocol	DCS Architecture	Low-level Operator Interface	Distributed system structure
	SLO-2	Process example	Field/RTU communication	Local control unit	Continuous control station	Application functions
S 3-4	SLO-1 / SLO-2	Lab1: SCADA Development for the level process control training plant	Lab 4: Study of AI,AO,DI,DO Interface modules of DCS	Lab 7: To design a running LED logic using functional block in DCS	Lab10: Interfacing temperature transmitter to a DCS	Lab13:To design a Cement plant logic using functional block in DCS
S-5	SLO-1	Key features	RTU/MTU communication	Architectural parameters	Smart annunciators	DCS Application in iron plant
	SLO-2	Real time systems	System components	Types of architecture	High level Operator interface	System architecture
S-6	SLO-1	Analog signals measurement	Communication Protocols	CPU, Memory	Architectural Models	DCS Application in steel plant
	SLO-2	Control techniques	Operator interface	Local control unit languages, Functional blocks	Hardware Elements, Operator displays	System architecture
S 7-8	SLO-1 / SLO-2	Lab 2 : SCADA Development for the temperature process control training plant	Lab 5: Installation and Configuration of I/O modules	Lab 8: To design a single LED blinking logic using functional block in DCS	Lab11: Interfacing level transmitter to a DCS	Lab14:On line monitoring and control of level process using DCS

S-9	**SLO-1**	Remote terminal unit	Control interfacing	Problem-oriented languages	Engineering interface- Introduction, System configuration requirements	DCS Application in petroleum-refining industry
	SLO-2	Analog and Discrete control		High-level languages	Diagnosis of System Problems	
S-10	**SLO-1**	Monitoring signals	Parallel operator interface	Process interfacing issues	Low-level engineering interface	DCS Application in oil and gas processing industry.
	SLO-2	Master terminal unit	SCADA Development for any one typical application	Security design issues, Remote I/O and communication modules	High-level engineering interface	
S 11-12	**SLO-1**	Lab3: SCADA Development for the flow process control training plant	Lab 6: DCS control panel wiring diagram and creating control panel layout	Lab 9: To design a Traffic light controller in SCADA screen using DCS	Lab12: Interfacing flow transmitter to a DCS	Lab15: Mini Project
	SLO-2					

Learning Resources	1.Stuart Boyer A, "*SCADA : Supervisory control and data Acquisition*", Fourth Edition, ISA-The Instrumentation, Systems, and Automation Society, 2010 2.Y. Jaganmohan Reddy, B.R. Mehta, *Industrial Process Automation Systems: Design and Implementation, 2014*	3. IDC Technologies, "*Practical Distributed Control Systems (DCS) for Engineers and Technicians*"2012. 4.Krishna Kant, Computer Based Industrial Control, 2nd Edition, Prentice Hall of India, New Delhi, 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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	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. Fawaz Hamad Mofdi, Damascus University, Syria,fawwazm@gmail.com	2. Mr. J. Sam Jebakumar, SRMIST

Course Code	18EIE005J	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:*
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 on industry.
CLR-6 :	*Know the malfunctions and troubleshooting various types of error.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	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	PSO - 2	PSO - 3
CLO-1 :	*Design the Structure of pneumatic control system.*	*3*	*80*	*75*	*H*	*H*	*H*	*M*	*L*	*L*	*L*	*M*	*M*	*H*	*L*	*M*	*L*	*L*	*L*
CLO-2 :	*Select the appropriate control components in pneumatic control systems.*	*3*	*80*	*70*	*H*	*H*	-	*L*	*L*	*L*	*L*	*M*	*M*	*H*	*M*	*M*	*L*	*L*	*L*
CLO-3 :	*Select the appropriate hydraulic pump for a fluid power system.*	*3*	*75*	*70*	*H*	*M*	*H*	*M*	*L*	*L*	*L*	*M*	*M*	*H*	*L*	*M*	*H*	*L*	*L*
CLO-4 :	*Design and develop electro pneumatic circuits and systems.*	*3*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	*L*	*L*	*M*	*H*	*H*	*L*	*H*	*H*	*L*	*L*
CLO-5 :	*Develop the appropriate fluid power system for the given application.*	*3*	*80*	*70*	*H*	*M*	*H*	*L*	*L*	*L*	*L*	*M*	*H*	*H*	*L*	*H*	*H*	*L*	*L*
CLO-6 :	*Evaluate the problems and troubles in fluid power systems.*	*3*	*80*	*70*	*H*	*H*	*L*	*H*	*H*	*L*	*L*	*M*	*H*	*H*	*L*	*H*	*H*	*L*	*L*

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 Two-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%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	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	18EIE006T	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		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Give basic knowledge in intelligent building and building automation systems			
CLR-2 :	Gain Knowledge on *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 various elements of BAS Architecture*			
CLR-6 :	*Present an overview of different communication protocols*			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Summarize the need of intelligent buildings and develop automation systems*	*2*	*80*	*75*
CLO-2 :	*Measure the parameters and design of sensors*	*3*	*80*	*70*
CLO-3 :	*Design air handling units for different specifications.*	*3*	*75*	*70*
CLO-4 :	*Design terminal units for different specifications.*	*3*	*80*	*75*
CLO-5 :	*Experiment with the components of BAS architecture*	*2*	*80*	*70*
CLO-6 :	*Select the communication protocol for a particular application*	*3*	*80*	*70*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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:	PSO-2:	PSO-3:
H	*M*	-	-	-	*M*	*H*	-	-	-	-	*H*	*H*	*H*	*H*
H	*M*	*H*	*H*	*H*	*M*	*H*	-	*M*	-	*H*	*H*	*H*	*M*	*H*
H	*H*	*H*	*H*	*M*	*M*	*M*	*M*	*H*	-	*H*	*H*	*H*	*M*	*H*
H	*H*	*H*	*H*	*M*	*M*	*M*	*M*	*H*	-	*M*	*H*	*M*	*M*	*H*
H	*M*	*M*	*M*	*H*	*M*	*M*	*M*	*H*	-	*M*	*H*	*M*	*M*	*H*
H	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*H*	*M*	*H*	*H*	*M*	*H*

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	*50 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*50 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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, 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. Fawaz Hamad Mofdi, Damascus University, Syria,fawwazm@gmail.com	

Course Code	18EIE007T	Course Name	INDUSTRIAL DATA COMMUNICATION	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:*
CLR-1 :	*Understand the basic concepts of data networks*
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.*
CLR-6 :	*Understand the working of computer buses and protocols*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	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	PSO - 2	PSO - 3
CLO-1 :	*Represent the basic concepts of data networks*	*2*	*80*	*75*	*H*	*-*	*H*	*-*	*-*	*-*	*-*	*M*	*-*	*H*	*-*	*H*	*H*	*L*	*H*
CLO-2 :	*Establish the protocols and layers of HART and field bus*	*2*	*80*	*70*	*H*	*-*	*M*	*H*	*M*	*-*	*-*	*M*	*M*	*H*	*-*	*H*	*L*	*L*	*L*
CLO-3 :	*Infer the techniques of MODBUS, PROFIBUS and other communication protocol*	*3*	*75*	*70*	*H*	*-*	*M*	*H*	*M*	*-*	*-*	*M*	*M*	*H*	*-*	*H*	*L*	*L*	*L*
CLO-4 :	*Review and report the significance of industrial Ethernet along with its standards*	*2*	*80*	*75*	*H*	*H*	*M*	*-*	*M*	*-*	*-*	*M*	*H*	*H*	*-*	*H*	*L*	*L*	*H*
CLO-5 :	*Consider the techniques of wireless communication in Instrumentation systems*	*3*	*80*	*70*	*H*	*M*	*M*	*M*	*H*	*-*	*-*	*M*	*M*	*H*	*M*	*H*	*H*	*H*	*H*
CLO-6 :	*Infer the working of computer busses and protocols*	*3*	*80*	*70*	*H*	*M*	*M*	*M*	*-*	*H*	*-*	*L*	*-*	*H*	*H*	*H*	*H*	*L*	*H*

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	*60 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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	18EIE008T	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:
CLR-1 :	Understand the internet principles and various components of IoT
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 IoT application
CLR-6 :	Know the technological challenges and opportunities in Industrial IoT design and implementation

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Apply the knowledge of Internet principles and protocols to understand the architecture and specifications of a given network	2	80	75
CLO-2 :	Design simple IoT applications using prototyping boards	3	80	70
CLO-3 :	Select the appropriate protocol for a specific network implementation	3	75	70
CLO-4 :	Identify the security level needed for a particular industrial IoT application	2	80	75
CLO-5 :	Analyze and Interpret the process data using cloud-based process data management tools	3	80	70
CLO-6 :	Categorize the technological challenges and opportunities in Industrial IoT design and implementation	3	80	70

	Program Learning Outcomes (PLO) 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	13 PSO -1	14 PSO-2	15 PSO-3
CLO-1 :	H	M	M	M	H	H	M	M	H	H	H	H	H	H	H
CLO-2 :	H	M	H	H	H	M	H	M	H	H	H	H	H	H	H
CLO-3 :	H	H	M	H	M	H	M	M	M	H	H	H	H	M	H
CLO-4 :	H	H	M	H	M	M	M	M	H	H	M	H	M	M	H
CLO-5 :	H	H	M	H	H	M	M	M	H	H	M	H	H	M	H
CLO-6 :	H	H	H	H	H	H	M	M	M	H	M	H	H	M	H

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.Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", 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 Understand	*50 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*50 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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	18EIE009T	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		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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 Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	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	PSO - 2	PSO - 3
CLO-1 :	Describe the process and instrumentation involved in petrochemical industries.	2	80	75	H	-	-	-	-	M	H	M	-	-	-	H	M	H	H
CLO-2 :	Represent the control methodologies used for various process in petrochemical industries.	2	80	70	H	-	-	-	-	-	H	M	-	-	-	H	H	H	-
CLO-3 :	Review and report the different processes involved in iron and steel industries.	2	75	70	H	H	L	H	-	M	H	M	-	-	-	H	M	H	H
CLO-4 :	Interpret and compare the control methodologies involved in iron and steel industrial processes.	3	80	75	H	H	L	H	-	-	H	M	H	H	-	H	H	H	-
CLO-5 :	Explain and relate the computer applications in the control processes through case studies.	2	80	70	H	-	-	-	H	-	H	M	H	H	-	H	H	H	-
CLO-6 :	Formulate the instrumentation and control for real time applications in various processes involved in the industries.	3	80	70	H	-	-	H	-	H	H	M	H	H	-	H	H	H	H

Duration (hour)		Introduction to Petroleum Industry Processes	Control applications in Petroleum Industry	Process Involved in Iron and Steel Industry	Control applications in Iron & Steel Industry	Computer Applications in Industrial Control
		9	9	9	9	9
S-1	SLO-1	Petroleum Exploration	Temperature Control, Pressure control,	Introduction to Iron and Steel Industries	Control system in the Iron and Steel	Evolution of computer applications in the
	SLO-2		Feed control of. distillation column		Industry	industry
S-2	SLO-1	Production and Refining	Reflux Control	Description of the process -I	Blast Furnace stove Combustion Control	Review of data logging, SCADA, DDC and
	SLO-2		Reboiler Control		system	DCS
S-3	SLO-1	Refining, Refining Capacity in India,	Temperature Control of chemical reactors	Description of the process -II	Gas Controls in BOF Furnaces	Case study: Water treatment control using
	SLO-2	Consumption of Petroleum products in India.				SCADA
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	Iron making Blast furnaces	Control system involved in level	Case study: Control of chemical reactor
	SLO-2		and Vaporizers - Cascade Control,		measurement	using SCADA
S-6	SLO-1	Vacuum Distillation Process	Steam Heaters, Condensers, Reboilers	Raw Steel making	Strand Casting mold Level Control	Analysis on the Control of chemical reactor
	SLO-2		and Vaporizers - Feed forward Control.			using SCADA
S-7	SLO-1	Thermal Conversion process	Centrifugal Pumps, Rotary Pumps and	The basic oxygen Furnace	Ingot Weight Measuring System	Case Study: Boiler control
	SLO-2		Reciprocating Pumps			
S-8	SLO-1	Evaporators	Pumps: On-Off level control, Pressure	The Electric Furnace	Steel rolling mill Control	Utilities management with computer
	SLO-2					

			control,			system
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 Batch Annealing	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 %*	-	*50 %*	-	*20 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*60 %*	-	*50 %*	-	*30 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	*50 %*	-	*30 %*	-	*30%*	-
	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	18EIE010T	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:
CLR-1 :	Introduce the basic knowledge in industrial automation and control systems
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
CLR-6 :	Impart the knowledge of cyber security for critical infrastructure protection

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Describe the basic concepts of industrial automation and control systems	2	80	75
CLO-2 :	Illustrate any application with add-on security features in industrial control systems	2	80	70
CLO-3 :	Devise the software with IT paradigms for IACS	2	75	70
CLO-4 :	Evaluate the risk management approach for IACS	3	80	75
CLO-5 :	Develop the security methodologies for industrial systems	3	80	70
CLO-6 :	Develop the cyber security algorithms for critical infrastructure applications.	3	80	70

Program Learning Outcomes (PLO)	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	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	H	L	L	L	L	L	L	M	M	M	L	H	H	M	M
CLO-2 :	H	L	H	H	M	L	L	M	M	M	L	H	H	M	M
CLO-3 :	H	H	H	H	M	L	L	M	M	M	L	H	H	M	M
CLO-4 :	H	H	H	H	M	L	L	M	M	M	L	H	H	M	M
CLO-5 :	H	H	H	H	M	L	L	M	M	M	L	H	H	M	M
CLO-6 :	H	H	H	H	M	H	L	M	M	M	L	H	H	M	M

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	*50 %*	-	*50 %*	-	*50 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*50 %*	-	*50 %*	-	*50 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	*30 %*	-	*30%*	-
	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	18EIE011T	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:
CLR-1 :	Know the basic knowledge about machine learning
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
CLR-6 :	Impart the applications of Machine learning in industry

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	Report the fundamental concepts and methods of machine learning	2	80	75	H	H	-	-	-	-	-	M	H	M	-	H	H	L	L
CLO-2 :	Analyze and design any application based on data preprocessing and supervised learning	3	80	70	H	H	L	H	H	-	-	M	M	M	-	H	L	L	H
CLO-3 :	Estimate the architecture of un supervised learning and Bayesian network	2	75	70	H	H	-	M	M	-	-	M	M	M	-	H	H	L	H
CLO-4 :	Design the neural network architecture for industrial applications	3	80	75	H	H	M	H	M	-	-	M	H	H	H	H	L	H	H
CLO-5 :	Illustrate the working of various learning algorithms of Neural network and apply its application in machine learning	3	80	70	H	H	M	M	H	-	-	M	M	M	H	H	L	H	H
CLO-6 :	Design and perform experiments on real life problems using various algorithms in machine learning	3	80	70	H	H	M	H	H	-	-	H	H	H	-	H	L	L	H

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 Machine Learning-Supervised Learning-Unsupervised Learning	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	Logistic Regression	Types of inference	Batch Normalization and Dropouts	Spectral clustering

	SLO-2	Evaluation	Radial Basis Function Network		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	*60%*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	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	18EIE012T	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		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Introduce concepts of reliability failure models.			
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.			
CLR-6 :	Provide the various concepts of reliability and safety engineering used in instruments.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:				Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					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	PSO - 2	PSO - 3
CLO-1 :	Illustrate the fundamental concepts of Reliability test and analyze the performance of reliability failure models.	2	80%	80%	H	H	M	H	H	M	H	H	-	M	-	H	H	H	H
CLO-2 :	Interpret the methods used for sustained redundancy and maintenance.	2	80%	80%	H	H	M	H	H	M	H	H	-	M	-	H	M	H	H
CLO-3 :	Adapt the knowledge of various techniques used in Maintainability	3	80%	80%	H	H	M	M	H	H	H	H	-	M	-	H	H	H	H
CLO-4 :	Enumerate the various reliability tests and Evaluate the significance of Reliability tests.	3	80%	80%	H	H	M	H	H	M	H	H	M	-	-	H	H	H	H
CLO-5 :	Develop and infer the various safety measures to prevent accidents.	3	80%	80%	H	H	H	H	H	H	H	H	H	-	-	H	H	H	H
CLO-6 :	Validate the techniques of reliability and Safety engineering in various instruments.	3	80%	80%	H	H	H	H	H	H	H	H	H	-	-	H	H	H	H

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 MILI 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.Bikas Badhury & 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*

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	Analyze										
Level 3	Evaluate	-	-	*20 %*	-	*30 %*	-	*30 %*	-	*30%*	-
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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.Fawaz Mofdi, Head of Electronics and Telecommunication Engineering, Damascus University, Syria.	2. Mrs. A. Brindha, SRMIST