ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

(Syllabi for Mechatronics Engineering Programme Courses)
(Revised on August 2024)



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Engineering Science Course

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course	21MHS201T	Course	THEDMODYNAMICS AND HEAT TRANSFER	Course	c	ENCINEEDING SCIENCE	L	Т	Р	С
Code	211011132011	Name	THERMODYNAMICS AND HEAT TRANSFER	Category	3	ENGINEERING SCIENCE	3	0	0	3

Pre-requisite Courses	N	Co- requisite Courses	Nil Progressi Courses	е	Nil
Course Offeria	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR): The purpose of learning this course is to:	11	4			Progr	<mark>am O</mark> u	ıtcome	es (PO)					ograr	
CLR-1:	evaluate the internal energy, work done and analyze the Coefficient of performance of heat engine, refrigerator and heat pump	1	2	3	4	5	6	7	8	9	10	11	12	Specifi Outcom		
CLR-2:	analyze the different properties of air using psychrometry chart and the working principle of different air conditioning and refrigeration systems			1	/	X		oility								
CLR-3:	apply the basic concepts of heat transfer and evaluate the conduction and convection heat transfer in plane wall, cylinder and sphere	Engineering Knowledge		development of s	ions of	Э	society	Sustainability	N.	Work		Finance	_			
CLR-4:	R-4: analyze the heat transfer effects in different electronics components				tigat	Usage	and	Su	١, ١	Team	_	Fin	rning			ĺ
CLR-5:	R-5: study the mathematical modelling of different thermal systems and different cooling techniques of transformer and electric motor				t investigations x problems	Tool	engineer a	Environment 8	•	య	Communication	Mgt. &	Lea			
		gine	Problem	sign/ ution	Conduct i	Modern	eu	viron	Ethics	Individual	mm	Project	Life Long	PSO-1	PS0-2	PSO-3
Course C	utcomes (CO): At the end of this course, learners will be able to:	п	P	Sole	2 8	Mo	The	En	E	pu	Ŝ	Prc	Life	PS	PS	PS
CO-1:	define and apply the concep <mark>ts of firs</mark> t law and second law of thermodynamics in different real systems	1	2	12	15	-	=) - I		-	-	-	-	-	-	-
CO-2:	define the psychrometry properties and evaluate the performance of refrigeration and air conditioning systems using psychrometry chart	1	2	GE!	3	1	-	-	- 5	-	-	-	-	-	-	-
CO-3:	recap the basics of heat tran <mark>sfer and</mark> demonstrate the application of conduction, convection and radiation in different real time systems		2		-	1	(\cdot)	-	-	-	-	ı	ı	-	-	-
CO-4:	estimate the amount of heat generation in different electronic components and select the suitable cooling system		2	-	-	3		-		-	-	-	ı	-	-	-
CO-5:	gain the knowledge of thermal system design modelling and different cooling methods of electrimachines			-	-/	3	7	-	÷.,	-	-	-	-	-	-	

Unit-1 - Fundamentals of Thermodynamics

9 Houi

Thermodynamic concepts and definitions – System, Surroundings, Cycle, process, path and point function, Mechanical, thermal, chemical and thermodynamic Equilibrium - Laws of thermodynamics – Zeroth law, first law and second law – Application of first law of thermodynamics to non-flow process - Application of first law of thermodynamics of thermodynamics – Application of second law of thermodynamics in heat engine, refrigerator and heat pump - Entropy – Change in entropy for isobaric process, isochoric process and isentropic process

Unit-2 - Psychrometry and Applications in Refrigeration and Air Conditioning

9 Hour

Psychrometry properties definition – Psychrometry chart – Psychrometry process – sensible heating, sensible cooling, humidification and dehumidification process – cooling and humidification, cooling and dehumidification, Heating and humidification, Heating and humidification - mixing of air streams - Refrigeration and air conditioning system – Fundamentals of refrigeration – vapour compression refrigeration and vapour absorption refrigeration system – types and working principle of window, split and centralized air conditioning system

Unit-3 - Fundamentals of Heat Transfer

9 Hour

Modes of heat transfer – conduction, convection and radiation – one dimensional steady state heat conduction – heat transfer in plane wall, cylinder and spherical shell - heat transfer in composite wall, cylinder and spherical shell – Free convection and forced convection – Free convection over a horizontal plate - Free convection over a vertical plate, cylinder - Free convection over an inclined surface

Unit-4 - Application of Heat Transfer in Electronics Systems

9 Hour

Heat generation in active devices – CMOS device – JFET – MOSFET, Heat generation in passive devices – Resistor – capacitor – Thermal Management system design for electronic systems – Cooling of electronic components with heat pipes

Unit-5 – Application of Heat Transfer in Mechanical and Electrical Systems

9 Hour

Elements of IC engine – analysis of heat transfer in IC engine – elements of refrigeration system – modes of heat transfer in refrigeration system – thermos-electric effect – Seeback effect – Peltier effect – Thomson effect – thermoelectric cooler and heat pumps- cooling system and methods in transformer and electric motors – modelling of heat transfer systems

Learning Resources

- 1. Yunus A Cengel Michael A Boles, Thermodynamics, 8th ed., Tata McGraw-Hill, 2017
- 2. Nag.P.K., Engineering Thermodynamics, 6th ed., Tata McGraw-Hill, 2017
- 3. Yunus A. Cengel, Afshin J. Ghajar, Heat and Mass Transfer Fundamentals and Applications | 6th Edition, 2020
- 4. Upadhyay, K.G, Design of Electrical Machines, New Age International Publishers, 1st edition, 2018
- 5. Ralph Remsburg, Advanced thermal design of electronic equipment, Springer, 1998th edition, 2012
- 6. Dhar P.L, Thermal System Design and Simulation, Academic Press Inc., 2016

Learning Assessmen	t /		A HOLE W	**						
			Continuous Learning	g Assessment (CLA)		Cumn	nativo			
	Bloom's Level of Th <mark>inking</mark>	CLA-1 Avera	Formative Life-Long Learning CLA-1 Average of unit test CLA-2 (50%) (10%)			Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	the first the second state of	15%		15%	-			
Level 2	Understand	25%	108 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		25%	-			
Level 3	Apply	30%	All 1971 1971	25%		30%	-			
Level 4	Analyze	30%	171 172 174	25%		30%	-			
Level 5	Evaluate		14 Table 1	15%	3	-	-			
Level 6	Create	47, -2-	The same will be	200		-	-			
	Total	100	0 %	100	0 %	100) %			

Course Designers	William William	/ ∀ ⊋ / / / / / / / / / /
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Gopinath, Intel Technology India Pvt Ltd.,	1. Dr. M. Baskaran, Associate Professor, KSR College of Technology	1. Dr. S. Senth <mark>ilraja, SR</mark> MIST
2. Mr. S. Senthilkumar, Grundfos Pumps India Pvt. Ltd.,	2. Dr. P. Ravichandran, Associate Professor, Kongu Engineering College	e 2. Mr. M. Thi <mark>rugnanam</mark> , SRMIST

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21MHC201T	Course Name	ELECTRICAL ACTUA	TORS AND DRIVES		ourse tegory	C			F	PROF	ESSIO	NAL (CORE			L 3		C 3
Pre-requis		Nil	Co- requisite Courses	21MHC202J		Progr	essiv Irses						211	лнЕ40)3T				
Course O	ffering Departme	ent	Mechatronics Engineering	Data Book / Codes / Stan	dards		-	-e,	1				Nil						
Course Lea	ırning Rationale ((CLR):	The purpose of learning this cour	se is to:	\Box				<u> </u>	Progra	m Oı	ıtcome	s (PO)				Program	
CLR-1:	outline the concep	ots of DC an	d AC Electrica <mark>l M</mark> ac <mark>hines</mark>	1.30	_	1	2	3	4	5	6	7	8	9	10	11	12	Specific Outcomes	
CLR-2:	gain knowledge o	n Stepper, S	Servo, BLD <mark>C M</mark> otors and their applica	tions		ge	1	of	SI		٠,			Work		8			
CLR-3:	familiarize the diff	erent Power	Electro <mark>nic Devic</mark> es and Converters	- 10 m 3 ft s		Knowledge	(C)	development of	investigations ex problems	Usage	ъ			πW		nance	βL		
CLR-4:	illustrate the work	ing of differe	ent D <mark>C Electric</mark> al Drives	Alle	iv.	Kno	Analysis	ldo	estig	l Us	r and	∞ >		Team	io	& Fin	.earning		
CLR-5:	acquire the knowl	ledge on AC	Ele <mark>ctrical D</mark> rives	100		ering	η Ana	deve	olex p	Tool	gineer	ment ability		al &	ınication	Mgt.	ng Le		

Course (Outcomes (CO): At the end of this course, learners will be able to:	nginee	roblem	esign/	onduc	lodern	he eng	nviron ustain	thics	ndividu	nmmo	roject	ife Lon	SO-1	SO-2	SO-3
CO-1:	examine the fundamentals of DC and AC Machines	3	3	2	-		<u>⊢ </u>	<u>-</u>	Щ.	-	-	-	-	<u> </u>		2
CO-2:	apply the Special Machines for different actuations	3	2	2		- 7	-	-		-	-	-	-	-	-	2
CO-3:	describe the working principle of Rectifiers, Choppers and Inverters	3	2	2		- (-	ė	-	-	-	-	-	2	-
CO-4:	summarize the working of E <mark>lectrical</mark> Drives	-3	2	2	-	-	-	-		-	-	-	-	-	-	-
CO-5:	disseminate the latest trends in applications of Electrical Drives	3	3	2	-	- 5		-		-	-	-	-	-	-	-

Unit-1 - DC and AC Electrical Actuators

9 Hour Overview of DC Machines, Single Phase Transformers, Three phase Induction Motors, Single Phase Induction Motors, Synchronous Motors, Characteristics, Speed Control, Starting and Braking of DC and AC Machines

Unit-2 - Special Machines and Actuators

9 Hour

Overview of PMDC, Stepper, BLDC and Servo Motors, Robotic grippers, MEMS actuators, Introduction to solenoids, Solenoid operated fuel injection systems

Unit-3 - Power Electronic Devices and Converters

9 Hour

Power semiconductor devices and their working -Power Diode, Power BJT, MOSFET, IGBT, SCR, Power Converters-Single Phase and Three Phase Rectifiers, Choppers, Buck, Boost and Buck boost converters, Three Phase Voltage Source Inverters, Voltage regulators, Cycloconverters

Unit-4 - DC Electric Drives

9 Hour

Introduction to Electric Drives, Choice of electric drives - Status of DC and AC drives, Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation, Control of Electrical Drives, Speed Control methods - Armature Voltage Control and Ward Leonard Drives, Controlled Rectifier fed DC Drives, Chopper, Controlled DC drives, Traction Drives, Problems

Unit-5 - AC Electric Drives

9 Hour

Speed Control of Three phase Induction Motors - Stator Voltage Control, Variable frequency Control, Voltage source inverter (VSI) Control, Cycloconverter control, Rotor Resistance Control and Slip Power recovery schemes, Problems, BLDC motor Drives, Stepper Motor Drives and Battery powered Drives, Applications of Drives

	Bhimbra. Dr.P.S., "Power Electronics", Khanna Publishers, 2012. Dubey.G.K., "Fundamentals of Electrical Drives", Narosa publishing house 2001.	 Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, Hughes Electrical and Electronics Technology, Pearson Education, 12th ed., 2016.
Learning Resources	3. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, New Delhi, 2003.	 B. L Theraja, A. K. Theraja, A text book of Electrical Technology, Volume II, S.Chand Publications, 2008 S. K. Bhattacharya, S. Chatterjee, Industrial Electronics and Control, TTTI, Chandigarh, Vol.II, 2017

	Bloom's Level of Thinking	CLA-1 Aver	Continuous Learning mative rage of unit test 50%)	Life-Lon C	g Learning LA-2 10%)	Summative Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	20 E 10 E 10	15%	(P) ()	15%	-		
Level 2	Understand	25%	100 to 2777	20%		25%	-		
Level 3	Apply	30%		25%	(-4,	30%	-		
Level 4	Analyze	30%		25%		30%	-		
Level 5	Evaluate	-	Carlot Page 10 miles	10%		-	-		
Level 6	Create		A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5%		9 -	-		
	Total	1	00 %	10	00 %	100) %		
				人工机场		1			

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
1. Dr. N. Gunavardhini, TANGEDCO, Salem,	1. Dr.K.Sujatha, Dr.MGR Educational and Research Institute, 1. Dr. M. Santhosh Rani, SRMIST
gunatneb1990@gmail.com	sujatha.eee@drmgrdu.ac.in
2. Ms.Joyce Sumathi, CMWSSB,	2. Dr.G.R.Kanagachidambaresan, Vel Tech, 2. Dr.R.Gangadevi, SRMIST
sumathijoyce1968@gmail.com	kanagachidambaresan@gmail.com

Course	21MHC2021 Course	ANALOG AND DIGITAL ELECTRONICS	Course	PROFESSIONAL CORE	L	Τ	Р	С
Code	Name	ANALOG AND DIGITAL ELECTRONICS	Category	PROFESSIONAL CORE	2	0	2	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L	Learning Rationale (CLR): The purpose of learning this course is to:		Program Outcomes (PO)											_	ogram	
CLR-1:	outline the concepts of various semiconductor devices	1	2	- 3	4	5	6	7	8	9	10	11	12		pecific tcome	
CLR-2:	illustrate the working of amplifiers biasing and significance of amplifier for various wave shaping circuits	ge	-	of	SL			N.		ork		Se				
CLR-3:	gain knowledge on operational ampli <mark>fiers and i</mark> ts applications	Knowledge	S	evelopment of	stigations oblems	Usage	ъ			N N		Finance	р			
CLR-4:	familiarize the concepts of digital circuits	중	Analysis	udo	estig	l Us	er and	∞ ×		Team	ion	∞ŏ	arning			
CLR-5:	acquire the knowledge on seque <mark>ntial circu</mark> its	ering	_	gn/deve	ot inve	Tool	enginee	ronment ainability	N	al &	ommunication	Mgt.	Long Le			
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Engine	Problem	Design	Conduct of compl	Modern	The er	Envirol Sustair	Ethics	Individual	Comm	Project	Life Lo	PS0-1	PS0-2	PSO-3
CO-1:	analyze the characteristics of special semiconductor devices	3	1	1	-	7	7	-	-	-	-	-	-	-	2	-
CO-2:	analyze different types of am <mark>plifiers,</mark> oscillators and multivibrator circuits	3	3	3	-	- 4		-	-	-	-	-	-	-	2	-
CO-3:	design linear and non-linear applications of Op-amps	3	2	2		-		-		-	-	-	-	-	2	-
CO-4:	design various combination <mark>al digital</mark> circuits using logic gates	-3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	understand the concepts and applications of various sequential circuits	3	3	3	-	-		-		-	-	-	-	-	2	-

Unit-1 - Applications of PN Junctions

12 Hour

Operation and Vi Characteristics - Tunnel Diode, Varactor Diode, Photo Diode, Light Emitting Diode and Laser Diode, UJT. Diode Applications – Clippers, Clampers, Half Wave, Full Wave and Bridge Rectifier, with and without filter. Transistor Biasing – Overview (Concepts) of Fixed Bias, Emitter Bias with and without Emitter Resistance. Analysis and Design Experiments:

1. Characteristics of Half Wave and Full Wave Rectifier With and Without Filter. 2. Characteristics of UJT

Unit-2 - Feedback Amplifiers, Oscillators and Multivibrators

12 Hour

Feedback Amplifiers: Concepts of Feedback – Classification of Feedback Amplifiers – General Characteristics of Negative Feedback Amplifiers – Effect of Feedback on Amplifier Characteristics – Voltage Series, Voltage Shunt, Current Series and Current Shunt Feedback Configurations – Simple Problems. Oscillators: Barkhausen Criterion for Oscillation – Types of Oscillators. Construction and Working Principle of RC and LC Oscillators. Multivibrators: Construction and Working Principle of Astable, Bistable and Monostable Multivibrator.

Experiments:

1. Design of Astable Multivibrator. 2. Design of RC Phase Shift Oscillator

Unit-3 - Operational Amplifier Applications

12 Hour

Basic Information About Op-Amps – Ideal Operational Amplifier – General Operational Amplifier Stages -And Internal Circuit Diagrams of IC 741, DC and AC Performance Characteristics, Slew Rate, Open and Closed Loop Configurations, Inverting and Non-Inverting Amplifier, Differential Amplifier, Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I And I-to-V Converters, Adder, Subtractor, Integrator, Differentiator, Logarithmic Amplifier, Antilogarithmic Amplifier, Comparators, Zero Crossing Detector, Schmitt Trigger, Precision Rectifier, Peak Detector, Clipper and Clamper.

Experiments:

1. Inverting and Non-Inverting Amplifiers Using Op-Amp. 2. Study of Half Wave and Full Wave Precision Rectifier

Unit-4 - Combinational Logic Circuits

12 Hour

Introduction to minterms and maxterms, Minimization of Boolean Expressions Using K – Map, Combinational Circuits -Design steps - Adder and Subtractor, Multiplexer and De-Multiplexer, Encoder and Decoder, Logic Diagram of Parallel Binary Adder/Subtractor, Code Converters, Magnitude Comparator. Programmable Logic Devices - PLA, PAL, Complex PLD Experiments:

1. Realization of Logic Circuits of Multiplexer and De-Multiplexer. 2. Realization of Logic Circuits of Encoder and Decoder. 3. Design of Code Converters

Unit-5 - Sequential Logic Circuits

12 Hour

Introduction to Latches and Flip-Flop, Triggering of Flip Flops, Truth Table, Characteristic Table, Excitation Table and Equations for Flip Flops, Conversion of Flip Flops, Master – Slave Flip-Flop, Design of Sequential Circuits - Synchronous and Asynchronous counters, Shift Registers - Serial in Serial Out, Serial In Parallel Out, Parallel In Serial Out and Parallel In Parallel Out

Experiments:

1. Study of Flip Flop – SR, JK, T and D. 2. Design of Shift Registers using Flip-Flops. 3. Design of Synchronous Counter

Learning Resources

- Robert L. Boylestad and Louis Nasheresky, Electronic devices and circuit theory, Tenth edition, Pearson, 2013.
- D Roy Choudhury and Shail Bala Jain, Linear Integrated Circuits, Fifth edition, new age International 2017.
- Sergio Franco, Design with operational amplifiers and analog integrated circuits, Fourth edition, McGraw Hill, 2017.
- 4. M. Morris Mano and Michael D.Ciletti, Digital design, Pearson education, 2008.
- 5. Thomas L. Floyd, Digital Fundamentals, Tenth edition, Pearson education, 2011.
- 6. David A.Bell, Electronic Devices and Circuits, Fifth edition, Oxford University Press, 2008.
- 7. Adel S. Sedra and Kenneth C. smith, Microelectronic Circuits theory and applications, sixth edition, Oxford University Press, 2010.
- 8. Jacob Millman, Microelectronics, McGraw Hill, 2nd Edition, Reprinted, 2009.

Learning Assessment		100	V	State of the Land William	S		0	
			1000	Continuous Learning	Assessment (CLA)		Cum	motivo
	Blo <mark>om's</mark> Level of <mark>Thinkin</mark> g	4	CLA-1 Avera	native age of unit test 5%)	CL	Learning A-2 5%)	Final Exa	mative amination eightage)
			Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember		15%		1	15%	15%	-
Level 2	Understand	-	25%	10 - Mari	· ·	20%	25%	-
Level 3	Apply		15%	- 1	-	25%	30%	-
Level 4	Analyze	. 4		- 1111	-	25%	30%	-
Level 5	Evaluate		7 7 -	- /3/6	-	10%	-	-
Level 6	Create		-			5%	-	-
	Total	9 7	= 10	0 %	100	0%	10	0 %

Course Designers	-/>\mu_m_, real. Falls -	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Subramani K.P,CTO, vTitan Corporation Pvt. Ltd.	1. Dr.R.Thiyagarajan, Indian Institute of Technology ,Tirupati, thiyagu@iittp.ac.in	1. Dr.V.Krithika, SRMIST
2. T.S.Srikanth, Principal Chief Engineer, CREAT UNO Minda	2. Dr.Sreejith.S, National Institute of Technology, Silchar(NITS), Assam,	2. Dr.S.Vasanth, SRMIST
Group	sreejith@ee.nits.ac.in	

Course	21MHC203J	Course	FLUID POWER SYSTEM AND AUTOMATION	Course	_	PROFESSIONAL CORE	L	T	Р	С	
Code	2 11011 102000	Name	FLUID FOWER STSTEM AND AUTOMATION	Category	C	FROFESSIONAL CORE	2	0	2	3	

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offeri	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil	

Course L	ourse Learning Rationale (CLR): The purpose of learning this course is to:					Program Outcomes (PO)										ograr	
CLR-1:	get exposed to the fundamer	ntals of fluid po <mark>wer principle</mark> s and fluid power components	1	2	- 3	4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	explore various control valve	ge		of	SL					S. Y.		8					
CLR-3:	realize sequencing control of	fluid po <mark>wer actua</mark> tors for an application	wlec	Knowledge		ation	age	ъ			Μ		Finance	Б			
CLR-4:	apply positioning control of fl	uid po <mark>wer actu</mark> ators		nalysi	elopment	vestigations problems	-S	er and	∞ ×		Team	ion	⊗ F	arning			
CLR-5:	acquire knowledge on role of	PL <mark>C in fluid</mark> power system automation	neering	<	deve	t inv	T ₀₀	enginee ety	nment		<u>a</u>	ommunication	Project Mgt.	ong Le			
				roblem	/ugis	onpr	Jern	enç iety	iron tain	S	ndividual	nu	ect		-	0-2	50-3
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Eng	Po	Des	डि इ	Mo	Soc The	Env Sus	Eth	lpd	Š	Pro	Life	PS(PSO.	PS(
CO-1:	select fluid power system so	u <mark>rces and</mark> actuators for an application	3	١٠.	-		Ŧ	7	-		-	-	-	-	-	3	-
CO-2:	demonstrate competency in	choice of control valves and logics based on application	3	1	100	14	- 4		-	1	-	-	-	-	-	3	-
CO-3:	design and implement any se	equencing of actuations based on the application requirements	7.85	2	3		1		-	ė	-	-	-	-	-	1	2
CO-4:	implement positioning contro <mark>l of cylin</mark> ders using servo valve				3	-	1	-	-		-	-	-	-	-	1	2
CO-5:	develop PLC ladder logic pro	evelop PLC ladder logic programming control for fluid power circuits				-	1		- 1		-	-	-	-	-	1	2

Unit-1 - Fluid Power Sources and Actuators

12 Hour

Introduction to fluid power system – Types, Advantages and Applications - Physics of fluid power - Pneumatic sources – Compressors and its types – Working principle, design and selection criteria - Hydraulic sources – Pumps and its types – Working principle, design and selection criteria - Types of fluid power actuators - Special cylinders – Design and selection criteria.

1. Study experiment on pneumatic components and their symbolic representation, 2. Experiment on direct and indirect control of fluid power actuators

Unit-2 - Control Valves in Fluid Power Systems

12 Hour

Direction control valves – Types, actuation techniques and neutral positions - Continuous reciprocation of single-acting and double-acting cylinder - Flow control valves, their needs and types-Speed control circuits - Pressure control valves, their needs and types - Logic valves – Actuator control with logic valves - Time delay valve, and Quick exhaust valve.

1. Experiment on continuous reciprocation of fluid power actuators, 2. Experiment on speed control circuits

Unit-3 - Design and Implementation of Fluid Power Circuits

12 Hour

Two-cylinder and three-cylinder sequencing – Pneumatic and electro-pneumatic implementation - Two-cylinder and three-cylinder sequencing with signal conflict – Pneumatic and electro-pneumatic cascading implementation - Timer and counter-based control of fluid power actuators.

- 1. Experiment on pneumatic and electro-pneumatic implementation of multiple actuator sequencing control with and without signal conflict
- 2. Experiment on timer and counter-based control of pneumatic actuators

Unit-4 - Position Control of Fluid Power Actuators

12 Hour

Synchronization circuits - Accumulators and application circuits - Need for positioning control of fluid power actuators - Proportional valves – working, types and applications - Servo valves – working, types and applications - Servo pneumatic/Servo hydraulic positioning system - Application case studies.

1. Experiment on synchronization circuits, 2. Experiment on servo pneumatic position control

Unit-5 - Applications of PLC in Fluid Power Systems

12 Hour

Introduction to programmable logic controllers - Architecture and advantages of PLC - Ladder logic programming – Logic gates, start/stop operation with latching - Timers and counters - Interlocking - Continuous reciprocation circuit and sequential circuit implementation using PLC.

- 1. Experiment on basic ladder logic programming of PLC and continuous reciprocation of fluid power actuator using PLC
- 2. Experiment on multiple actuator sequencing control using PLC

Learning Resources

- 1. Anthony Esposito, "Fluid Power with applications", Prentice Hall International, 7th edition, 2014.
- Majumdar .S.R., "Oil Hydraulics: Principle and Maintenance", Tata McGraw Hill Education, 2012.
- 3. Werner Deppert, Kurt Stoll, "Pneumatic Application", Vogel verlag, 1986

- 4. James L. Johnson, "Introduction to Fluid Power", Prentice Hall, 2004.
- 5. Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, 2003.
- 6. G. Dunning, "Introduction to Programmable Logic Controllers", Cengage Learning.

	Bloom's Level of Thi <mark>nking</mark>	CLA-1 Avera	Continuous Learning native ge of unit test %)	g Assessment (CLA) Life-Long CL/ (15	4-2	Summative Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	5%	A Page 1	14 W. T.	10%	5%	-		
Level 2	Understand	15%	A 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- 14	10%	15%	-		
Level 3	Apply	15%	William Commence of the	8. 1 30 77	10%	15%	-		
Level 4	Analyze	15%	Mar. 1985 1997	7 17 17 17 17 17	20%	15%	-		
Level 5	Evaluate	27 77 31		"一世也为'从安石'。		-	-		
Level 6	Create		4. 70.2	10.00	-	-	-		
	T <mark>otal T</mark>	- 10)%	100	%	100	0 %		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. C. Elan Chezhian, Keyence Engineering, Chennai	1. Dr. D. Saravanakumar, VIT University, Chennai	1. Dr. T. Muthur <mark>amalinga</mark> m, SRMIST
2. Mr. K. Elango, Sealed Air Company, Chennai	2. Dr. V. Mugendiran , MIT, Anna University, Chennai	2. Mrs. G. Mad <mark>humitha,</mark> SRMIST

Course Code	21MHC204L	Course Name	ELEC1	TRICAL ACTUA	FORS AND DRIVES LAB	ORATORY	Cou Cate		С				PROF	ESSIC	NAL (CORE			L 0	T 0	P 2	C 1
Pre-requis		Nil		Co- requisite Courses	21MHC	C201T	F	Progre)						Nil						
	ourse Offering Department Mechatronics Engineering Data Book / Codes / Standards									٠.,					Nil							
						EENL	C 200				۳.											
Course Lea	arning Rational	e (CLR):	The purpos	se o <mark>f learning th</mark>	is course is to:	LEAN					F	rogra	<mark>m</mark> Ou	tcome	s (PO)					ograr oecifi	
CLR-1:	apply the basic	concepts of L	DC motor		A 30			-1	2	- 3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	analyze the bas	sic concepts c	of BLDC m <mark>oto</mark> i	*///				lge	7	of	SL			7		ork		Se.				
CLR-3:	demonstrate th	eir ability in se	electing <mark>motor</mark>	<mark>s for</mark> particular a	pplication			wlec	S	nent	atior	age	p			Λ		nan	βL			
CLR-4:	implement char	acteristics of	semic <mark>onducto</mark>	r devices and co	onverters			ξ S	alysi	lopi	estig	Š	r an	∞ _		Геаг	ion	& Fi	arni			
CLR-5:	illustrate the ba	sic concepts	of power conv	rerters	/ £.	10 350		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment Sustainability		ndividual & Team Work	Communication	Project Mgt. & Finance	ife Long Learning			
		•				2000 (F) 19	4	nee	lem	Design/dasolutions	duct	e .	eng ety	ronraina	S	idus	ımur	ect N	Lon	7	7-7	က္
Course Ou	tcomes (CO):		At the end	of this course,	learners will be able to:	AMERICA PORT	294	Engi	Prop	Desi	Con	Mod	The en society	Envi Sust	Ethics	ndi	Con	Proje	⊏ife	PS0-1	PS0-2	PSO-3
CO-1:	implement the	functionality o	of <mark>DC mo</mark> tors		- A 27 1	AN DEST	18	3	2	2	- 1		-	-	1	-	-	1	-	-	-	-
CO-2:	apply the know	ledge on bas <mark>i</mark>	<mark>ic conce</mark> pts in	operating BLDC	motors	1 450 No. 188.		3	2	2	4	- 1	-	-		-	-	-	-	-	-	-
CO-3:	analyze the Pe	rformance Ch	naracteristics o	f drives		SE SEE T		3	2	2	-4	- (-	-	-	-	-	-	-	-	-
CO-4:	apply the know	ledge in sele <mark>d</mark>	<mark>cting mo</mark> tors fo	r different applic	ations	F 47 4	11.3	3	2	2	-		-	-		-	-	-	-	-	-	-
CO-5:	illustrate charac	cteristics of se	<mark>emi</mark> conductor (devices and pow	er converters	2 × 10	1. 3	3	2	2	-	- 5		-		-	-	-	-	-	-	-
Unit-1							-£						_		i						6.1	Hour
1. Control o	f DC motor			-		ii na						-6	-	-							0 1	ioui
	f stepper motor.			-C		1.76																
Unit-2					1	1111					F .	. I	7	7 .							6 1	Hour
	f servomotor					_ 4530A																
Unit-3	f BLDC motor												\rightarrow								6.1	Hour
5.Light dimr	mer control				7 to u a R Y	V . I 19	4 15				+	7		-							0 1	Ioui
	sed control circuit				Thum	A Late	M'		F A	(I)												
Unit-4					_						_ ا		1 /								6 1	Hour
7. Rectifier-b																						
8. Chopper- Unit-5	based control																				6 1	Hour
	verter based contr	rol						_													0 1	ioul
	ons of DC,Steppe		motors																			
	ment of a convert			rives			4 4 5															

Learning Resources	 Bhimbra. Dr.P.S. "Power Electronics", Khanna Publishers, 2012. Dubey.G.K. "Fundamentals of Electrical Drives", Narosa publishing house 2001. 	 Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, Hughes Electrical and Electronics Technology, Pearson Education, 12th ed., 2016 Lab Manuals.

		Continuous Learning Assessment (CLA)									
	Bloom's Level of Thinking	exper	ge of first cycle riments 0%)	cycle exp	ge of second periments (%)		eightage)	Final Examination (0% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	- /	15%	-	15%	1/-)	15%	-	-		
Level 2	Understand		25%	- A A	20%	7	25%	-	-		
Level 3	Apply		30%	Activities	25%	-	30%	-	-		
Level 4	Analyze	274.7	30%	Grand Control	25%	_	30%	-	-		
Level 5	Evaluate			1. J. M. 777	10%	- 1	-	-	-		
Level 6	Create	~- A	with the first	1.500	-5%	- \	C 4-	-	-		
	Total	10	0 %	100)%	10	0%		-		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Exp <mark>erts</mark>
1. Dr.N.Gunavardhini, TANGEDCO, S <mark>alem, g</mark> unatneb1990@	Ogmail.com 1. Dr.K.Sujatha,Dr.MGR Educational and Research Institute, sujatha.eee@drmgrdu.ac.in	1. Dr. M. S <mark>anthosh</mark> Rani, SRMIST
2. Ms.Joyce Sumathi, MWSSB, sumathijoyce1968@gmail.co	om. 2. Dr.G.R.Kanagachidambaresan, Vel Tech,	2. Mr. A. La <mark>kshmi S</mark> rinivas, SRMIST
	kanagachidambaresan@gmail.com	

Course Code	ode Name MICROCONTROLLER AND EMBEDDED SYSTEMS requisite Co- requisite 21MHC2071					ourse tegory	C				PROF	ESSIC)NAL (CORE			L 3	. T	P 0
Pre-requi		Nil	Co- requisite Courses	21MHC207L	•••	Progr	essiv Irses						211	мнЕ41	12T				
Course	Offering Departm	ent	Mechatronics Engineering	Data Book / Codes / Sta	ndards			Ţ÷,					Nil						
Course Le	arning Rationale	(CLR):	The purpose of learning th	is course is to:	\bigcirc				. 1	rogra	ım Oı	ıtcome	s (PO)					gram
CLR-1:						1	2	-3	4	5	6	7	8	9	10	11	12		ecific come
CLR-2:	acquire knowledg	ge of microcor	ntroller pr <mark>ogrammin</mark> g in Mech	atronics systems		dge		of	SL			1		ork		9			
CLR-3:	realize the fundamentals of embedded system design with real time systems					Knowlec	S	velopment of	vestigations x problems	age	р			\geq		Finance	рu		
CLR-4:	assimilate the way to create and optimize programs						ınalysis	udol	estig	ool Usa	ır and	۸ ×		Team	ation	& FI	arning		
~ ~ ~	in a second to the first and a second of the					ρ	Ĕ	18	l ≥ U	0	eer	iity		∞	77	₹	Φ		

CLR-5:	incorporate the fundamentals of embedded systems design with real time system		erin	m A	ns ns	ict in iplex	5	ngin€ /	nme nabi		nal	iun	t Mg	l gu			
Course C	Outcomes (CO): At the end of this course, learners will be able to:	139	Engine	Proble	Design solutio	Condu of corr	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Project	Life Lc	PS0-1	PS0-2	PSO-3
CO-1:	evaluate and compare various embedded processors		3	}- 1	- 1	-	1	7	-	-	-	-	-	-	-	1	-
CO-2:	implement the concepts of microcontroller to Mechatronics systems	7	3	-	2		2 -		-	Ė	-	-	-	-	-	-	2
CO-3:	apply the fundamentals of embedded system design with real time systems		3	7	1	4	1	-7	-	- 1	-	-	-	-	-	-	2
CO-4:	appreciate the way program <mark>s are cre</mark> ated and optimized	113	-3	7	r- (-	- 1	-	-	-	-	-	-	-	-	1	-
CO-5:	build simple embedded appl <mark>ications</mark>	- 4	3		1	-	-	_	-	-	-	-	-	-	-	_	2

Unit-1 - Microprocessor and Microcontrollers

9 Hour

8-bit and 16-bit microprocessor - architecture - instruction set- addressing mode, Instruction cycle, 8-bit microcontroller - architecture - special function registers - instruction set - addressing mode, - interrupt handling

Unit-2 - ARM Controller 9 Hour

ARM Controller - Architecture - Functional description - ARM state instruction - Thumb state instruction - Addressing modes - Operating modes

Unit-3 - Introduction to Embedded System

9 Hour

Embedded System - Definition, Key Elements- Design Metric Challenges - Design technology - IC technology - Processor technology, Introduction to Arduino - Hardware interfacing - controlling embedded system based devices using Arduino - Arduino IDE - Introduction to Raspberry pi

Unit-4 - Embedded System - Debugging & Development Environment

9 Hour

Debugging Techniques/ Challenges - Program Design and Analysis - Components for Embedded systems- Model of programs - DFG and CDFG - Assembly, linking and loading - Basic compilation techniques optimization, Interrupts - Interrupt Latency, Embedded software architectures

Unit-5 - RTOS Based Embedded System Design

9 Hour

Introduction to basic concepts of RTOS, Task, process & threads - Task management and scheduling - Interrupt servicing - Multiprocessing and Multitasking - Inter task Communication and data exchange -Synchronization between processes: Semaphores - Memory management - Issues in real-time system design - Design of Embedded Systems - Development of IoT Applications

	1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller	and 5. Andrew N Sloss, D. Symes, C. Wright, "Arm System Developers Guide", Morgai
	Embedded Systems", Pearson Education, Second Edition, 2014.	Kauffman/ Elsevier, 2006.
	2. Douglas V Hall, "Microprocessors and Interfacing", McGraw Hill Education, 3rd Edition (\$	IE), 6. Michael McRoberts, "Beginning Arduino", Apress, Year: 2010
Learning	2017	7. Massimo Banzi, "Getting Started with Arduino: The Open Source", Shroff Publishers
Resources	3. Frank Vahid and Tony Givargis, "Embedded system design: A unified hardware softw	
	approach", Pearson Education Asia, 3rd edition, 2009	8. M. A. Mazidi, S. Naimi, S. Naimi, The AVR Microcontroller and Embedded Systems
	4. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System De	sign Usin <mark>g Assembly and C</mark> , Pearson, 2015

(The Morgan Kaufmann Series in Computer Architecture and Design)", 5th Edition, 2022

- Kauffman/ Elsevier, 2006. (SIE),

 - 6. Michael McRoberts, "Beginning Arduino", Apress, Year: 2010
 7. Massimo Banzi, "Getting Started with Arduino: The Open Source", Shroff Publishers & Distributors Pvt Ltd, 2014
 - 8. M. A. Mazidi, S. Naimi, S. Naimi, The AVR Microcontroller and Embedded Systems Using Assembly and C, Pearson, 2015

			Continuous Learning	g Assessment (CLA)		C	
	Bloom's Level of Thinki <mark>ng</mark>	Format CLA-1 Average (50%	of unit test	Life-Long CL/ (10	4-2	Sumn Final Exa (40% we	mination
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%		THE PERSON NAMED IN	(-/,	15%	-
Level 2	Understand	25%		100000		25%	-
Level 3	Apply	30%	No. of Page 1	50%		30%	-
Level 4	Analyze	30%	Section 18 Acres	50%		30%	-
Level 5	Evaluate	A - 3.1	21 of 1 same 10 h	Sec. 1 32 75		-	-
Level 6	Create	3 Jan 1777	De State State	The state of the s	- C	-	-
	Total	100 %	6	100) %	100) %

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
 Mr.N.Ravi,L&T GeoStructure Private Limited, 	1. Dr.BamaSrinivasan, Anna University, Guindy, Chennai,bama@annauniv.edu 1. Mrs.T.S.Rajalakshmi, SRMIST
Ravinagarajan@Intecc.com	
2. Mr. SathiyaMoorthi, Broadcom Inc,	2. Dr.Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in 2. Mrs.M.Nandhini, SRMIST
sathiyamoorthi.chinnappan@broadcom.com	

Course	21MHC206T	Course	MECHANICS OF SOLIDS AND FLUIDS	Course		DDOEESSIONAL CODE	L	Τ	Р	С
Code	21MHC2061	Name	MECHANICS OF SOLIDS AND FLOIDS	Category	C	PROFESSIONAL CORE	3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	21MHC208L	Progressive Courses	Nil
Course Offering D	Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

THE RESERVE

Course L	earning Rationale (CLR):	The purpose of learning	g this course is to:	TAKE A		Program Outcomes (PO)						Pr	ograr	n					
CLR-1:	understand the behavior and behavior of fluids using the con-		Inder external loading conditions,	and Analyze the	1	2	3	4	5	6	7	8	9	10	11	12		pecific tcom	
CLR-2:	analyze the beams and shafts ι	under pu <mark>re bending</mark> and to	orsion, Analyze the columns using t	he buckling effect	dge	- 14	of	JS			1		Work		ce				
CLR-3:	identify types of beams and und	derstan <mark>d their de</mark> flection u	nder different types of load	R Miles	Knowledge	ဟ	nent	ation	Usage	р					Finan	р			
CLR-4:	understand the applications of E	Bern <mark>oulli's eq</mark> uation		3.46573	ering Kno	Analysis	velopment	vestigations x problems	US	er and	× ×		Team	tion	∞ర	aming			
CLR-5:	_R-5: summarize the various losses in pipes						deve	.⊨ ഒ	<u>S</u>	engineer a	nability		ndividual &	Sommunication	Mgt.	g Le			
						roblem	fign/	comp	eru	et G	ron Tain	SS	/idu	mı	roject	Long	7	7-2	က္
Course C	Course Outcomes (CO): At the end of this course, learners will be able to:							Conduct of comple	Modern	The	Environme Sustainab	Ethics	Indi	Corr	Proj	Life	PSO	PS0-2	PS0-3
CO-1:	estimate the different types of s	<mark>tress in</mark> duced in materials			3	3	3	4	-	-	-	1	-		-	-	-	-	-
CO-2:								-	-7		-	-	-	-	-	-	-	-	-
CO-3:	-3: calculate the maximum shear stress and bending moment at the critical section						3	-	-3		-	1	-	1	-	-	-	-	-
CO-4:	D-4: determine the coefficient of discharge of different devices					3	2	-	-	-	-	1	-	1	-	-	-	-	-
CO-5:	5: estimate losses in pipes				3	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Mechanics of Materials and Fluids

9 Hour

Introduction-Stress, Strain and Displacement, Fundamental equations deformable body mechanics, Equilibrium, Determination of Internal Resultant Forces by Method of Joints and Method of Sections, Stress-strain relationship, Axially Loaded Bars, Elastic Constants, Poisson's Ratio, Stress-strain diagrams- Tension Test, Compression test, Mechanical properties of materials. Introduction- Fluid Properties, Types of Fluids, Types of Flow, Pressure and its measurement, Pressure measurement devices – Different types of manometers

Unit-2 - Pure Bending, Torsion and Columns

9 Hour

Pure Bending-Bending equation and its assumptions, Moment of Inertia for different cross sections, Bending Stress in beams- Torsion- Torsion Equation and its assumptions, Polar moment of inertia, Torsion in stepped and composite shafts- Columns-Buckling of slender column, Critical load, critical stress and effective length for a Column with pinned end, Column Fixed at the Base and Free at the Top, Column with Both Ends Fixed Against Rotation, Column Fixed at the Base and Pinned at the top.

Unit-3 - Beams and Shafts 9 Hour

Beams - Types of beams - cantilever, simply supported, fixed and continuous beam Types of loads, Sign conventions, Shear force and bending moment diagram – cantilever, simply supported and over hanging beams. Shafts- Equivalent twisting moment-Shaft with pulley and gear.

Unit-4 - Kinematics and Dynamics of Fluids

9 Hour

Fluid flow, Streamline-streak line-path line - stream function - Continuity equation and its application, Rate of flow, Derivation of Euler's equation, Bernoulli's equation and its assumptions, Application of Bernoulli's equation – Venturi meter, Orifice meter

Unit-5 - Flow Through Pipes

9 Hour

Introduction to losses in pipes, Types of losses, Darcy – Weisbach's equation, Friction factor, Analysis of Minor losses and Major losses in pipes- pipes in series and parallel, construction and working principle of centrifugal pump and reciprocating pump, Performance of pumps

Learning

1. R.K.Bansal, "Strength of Materials", 6th ed., Lakshmi Publications, 2022.

4. Bansal. R. K, "Fluid Mechanics and Hydraulic Machines", 11th ed., Laxmi publications (P)

Resources	2.	Ramamurtham S and Narayanan R, "Strength of Materials", 20th ed., Dhanpat Rai		Ltd., 2022.
		Pvt. Ltd., 2022.	5.	Kumar. K. L, "Engineering Fluid Mechanics", S Chand Publications, 2016.
	3.	Timoshenko. S. P., Gere .M. J, "Mechanics of Materials", 5th ed., Stanley Thornes	6.	John.M.Cimbala Yunus A.Cengel, "Fluid Mechanics: Fundamentals and Applications", 4th
		(PUB) Ltd, 1999.		ed. Mc Graw Hill Higher Education, 2019.
<u> </u>				

			Continuous Learnin	g Assessment (CLA)		C	mative				
	Bloom's Level of Thinking	CLA-1 Avera	native ge of unit test 0%)	Life-Long CL	g Le <mark>arning</mark> LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice Practice	Theory	Practice				
Level 1	Remember	15%		15%	2 - 1	15%	-				
Level 2	Understand	25%	ALC: U.S.	20%	7 h	25%	-				
Level 3	Apply	30%	2017 10 0	25%	1 1 1 T	30%	-				
Level 4	Analyze	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		30%	-				
Level 5	Evaluate			10%	6-4	-	-				
Level 6	Create	- /-	a de region d	5%		-	-				
	Tot <mark>al</mark>	10	0%	10	00 %	10	0 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.G.Gopinath, R&D Manager, ZF, Chennai, Email ID:	1. Dr. D. Madesh, Professor, Dept of Mechanical Engineering, AMET University,	1. Mr. M. Chandrasekaran, SRMIST
gopinath.gunasekaran@zf.com	Chennai, Email ID: madesh.d@ametuniv.ac.in.	
2. Mr. K.Maheshwaran, Assistant Manager, TAFE, Madurai, Email ID	2. Dr. L. Ranganathan, Professor and Head, Dept. of Mechanical Engineering, Agni	2. Ms. D. Gayathiri, SRMIST
maheshwaran@tafe.com	College of Technology, Chennai, Email ID: mechod@act.edu.in	

Course Code	21MHC207L	Course Name	DED SYSTEMS LABORATOR	/	ourse tegory	С				PROF	ESSIO	NAL (CORE			L 0	. T	P 2	C 1		
Pre-requ Course		Nil	Co- requi Courses	ite	21MHC205T			essive	9					211	ИНЕ41	2T					
Course	Offering Departn	nent	Mechatronics Engine	eri <mark>ng</mark>	Data Book / Codes / Stan	dards			٠.,					Nil							
					- OIEN					<u> </u>									_		
	earning Rationale		The purpose of learni				1		1	·	rogra	am Ou	itcome	s (PO)	1	1		Pr	ograr pecific	n
CLR-1:	familiarize with	the functiona	ality of micropr <mark>ocessors ar</mark>	d microcontro	llers		1 1	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	gain knowledge	of microcon	troller progr <mark>amm</mark> in <mark>g an</mark> d e	nbedded syst	em		lge		of	SL			1		ork		Se				
CLR-3:	assimilate the v	ay programs	s are to b <mark>e cre</mark> ated and op	imized	-0-00-		wlec		ent	ation	ge	-			Μu		nan	б			
CLR-4:	71 0										Nse	engineer and	∞ _		Team Work	.u o	& Fi	arnir			
CLR-5:		-	Is of embedded systems of		I time system		gui	Ana	eve	inve ex p	00	nee	nent bility		≪	icat	/gt.	Le			
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Course O	utcomes (CO):		At the end of this cou	se, learners	will be able to:	· b	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The en society	Environment 8 Sustainability	Ethics	ndividual &	Communication	Project Mgt. & Finance	Life Long Learning	PS0-1	PS0-2	PSO-3
CO-1:	1	mpare vario	u <mark>s embed</mark> ded processors		24 24 A A 25 T	17.	3	2	2	-	2	- 0)	-	Ţ.	-	-	-	-	-	1	٠.
CO-2:	analyze applica	tions of IoT ι	using Arduino	-			3	2	2	-	2	4	-		-	-	-	-	-	-	2
CO-3:	appreciate the v	vay program	s are created and optimiz	d			3	2	2	34	2	-	-	ī	-	-	-	-	-	-	-
CO-4:			aspberry Pi /open platforn			T")	-3	70	. r. '	-	-	-	- 1	-	-	-	-	-	-	-	2
CO-5:	design simple e	mbedded ap	pplications	143 N	24. (1) 2 3 3	11.5	3	, I	2	-		_	-		1	-	-	-	-	-	2
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	licroprocessor an										- 7									6 I	Hour
			og <mark>rammin</mark> g for basic oper		- NA 1977						. "	4									
			Mic <mark>roproce</mark> ssor and Micro roduction to Embedded							7	-		7 4							61	Hour
	perations in Arduin			bystem .	- 400				7		1									0 1	ioui
	ing of motors and								-	~ /											
			ng & De <mark>velopme</mark> nt Envir	nment		-				75	-	7								6 I	Hour
5. Interrup	t-based programs	in microproc	essor an <mark>d microco</mark> ntroller	//1	FARN-FF	A D	-	70.1	100	1			77								
	and actuator interi	facing with A	rduino contr <mark>olle</mark> r	1-1-1	The real of the		- 1	НJ	VU				/								
Unit-4 -	navetiene in ADM									<u> </u>		I ji								6 I	Hour
	perations in ARM of the ing of motors with		llor																		
	TOS Based Embe									. * *										6 /	Hour
			res of ARM controller.						. • •												
	pts handling in AF																				

	1.	Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 3. Andrew N Sloss, D. Symes, C. Wright, "Arm System Developers Guide", Morgan	1
Learning		Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014. Kauffman/ Elsevier, 2006.	
Resources	2.	Douglas V Hall, "Microprocessors and Interfacing", McGraw Hill Education, 3 rd Edition 4. Laboratory Manuals	
		(SIE), 2017	

		. • *	Co									
	Bloom's Level of Thinking	exper	ge of first cycle iments 0%)	cycle exp	ge of second periments 9%)		Examination eightage)	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember		15%		15%	7	15%	-	-			
Level 2	Understand		25%	DET FEET	25%	- 1	25%	-	-			
Level 3	Apply		30%	Professional Confession	30%	4	30%	-	-			
Level 4	Analyze		30%	LJ N 7777	30%	- 1	30%	-	-			
Level 5	Evaluate	- A	mark to a fill	7-885-5	A	-	C 4-	-	-			
Level 6	Create	- /-	2.50		100		V-C	-	-			
	Total	10	0 %		0 %	10	00%		-			

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
 Mr. N.Ravi, L&T GeoStructure Private Limited, 	1. Dr.BamaSrinivasan, Anna University, Guindy, Chennai,bama@annauniv.edu 1. Dr.M.Mohamed Rabik, SRMIST
Ravinagarajan@Intecc.com	
2. Mr. SathiyaMoorthi, Broadcom Inc,	2. Dr.Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in 2. Dr.Cross T Asha Wise, SRMIST
sathiyamoorthi.chinnappan@broadc <mark>om.com</mark>	

Course Code	21MHC208L	Course Name	ME	CHANICS OF SC	LIDS AND	FLUIDS LABORATOR)	urse egory	С			l	PROF	ESSIO	NAL (ORE			L 0	T 0	P 2	<u>C</u>
Pre-requisi Courses	te	Nil		Co- requisite Courses		21MHC206T		Progre		,						Nil						
Course Of	fering Departme	ent	Mechai	ronics Engin <mark>eerin</mark>	g	Data Book / Codes	s / Standards		-	" + _e					Nil							
		(OLD)	I				N_{C}			<u> </u>	<u> </u>				(5.0					_		
Course Leai	ning Rationale			ose of l <mark>earning t</mark>					-	_		Progra	am Ou	ıtcome	es (PO)	1	1			ograi ecifi	
CLR-1:	behavior of fluid	ls using the co	oncepts an	d equations		al loading conditions, a		1-4	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	analyze the bea effect	ams and shaf	fts under <mark>p</mark>	ure bending and	torsion, An	nalyze the columns usi	ng the buckling	age		o Jo	ns of	1	society			ork		ee				
CLR-3:	identify types of	beams and u	under <mark>stan</mark> d	their deflection u	nder differe	ent types of load		Mec	(0	ent	ation	ge	S			Μ		nan	βι			l
CLR-4:	understand the	applications o	of B <mark>ernoulli</mark>	's equation	7		STAN T	S S	llysis	lopi	stig	Usa	r and	∞ _	l la	Fear	.u	& Finance	arnir			ł
CLR-5:	summarize the			- 5				Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations complex problems	Modern Tool Usage	he engineer	Environment 8 Sustainability		ndividual & Team Work	Communication	Project Mgt.	ife Long Learning		01	_
Course Outo	comes (CO):		At the en	d of this course,	learners v	vill be able to:	100 -17	ngi	roble	Design	Conduct	lode	he el	nvirc	Ethics	divic	nmo	rojec	ife Lo	PS0-1	PS0-2	PSO-3
CO-1:											<u>-</u>	<u>-</u>										
CO-2:	7 - 3 - 3 - 3 - 3 - 3 - 3 - 3 - 3 - 3 -										-	-										
CO-3:				d bending momen				3	3	2		-	_	-		_	-	-	_	-	-	-
CO-4:				f different devices		241 100 6	10 m	3	3	2	_			-		-	_	_	-	_	-	-
CO-5:	estimate losses						-1	3	2	2	-	-5		-	-	-	-	-	-	-	-	-
					17 ,		Alban Alban												U U			
	ics of Mechanic		l <mark>s and Fl</mark> ui	ds			1002				/_		1								6 I	Hour
	of metallic materi st on simply supp																					
	e Bending, Tors		ımns	1	-	- 4	- 1					7			7						6 /	Hour
				nal test on mild st	eel rod						-		7								• • •	ioui
Double Shea	r test on metallic			<u> </u>	-	er v TVA:					٦ ١	-,										
Unit-3 - Bea	ms and Shafts			e, 7	/ 17	FAKN	LEAD		T 1 A	173				1							6 I	Hour
Fatigue test					- L	12.	COLUMN TO			MII		1										
	Iness test on me			A	-						_											
	e coefficient of d			eter																		J
	ematics and Dyr f Bernoulli's theo		uias																		b I	Hour
	e coefficient of d		enturi meta	or																		
	v Through Pipes		ontan mete																		6 /	Hour
			fittings. De	termination of pip	e friction fa	ctor															•	
	test on centrifug			r r																		

Learning 2. Ramamurtham S and Narayanan R, "Strength of Materials", 20th ed., Dhanpat Rai Pvt. (P) Ltd., 2022. Resources 5. Kumar. K. L, "Engineering Fluid Mechanics", S Chand Publications, 2016.	
Pasources 1 td 2022 5 Kumar K. L. "Engineering Fluid Machanics" S Chand Publications 2016	
1. Numar. N. E., Engineering Fluid Mechanics, 5 Oriand Fluid Michael M	
3. Strength of Material Lab Manual 6. Fluid Mechanics Lab Manual	

			Co									
	Bloom's Level of Thinking	exper	ge of first cycle iments 0%)	cycle exp	nge of second periments 0%)		Examination eightage)	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember		15%		15%	7	15%	-	-			
Level 2	Understand		25%	Definition of the second	25%	-	25%	-	-			
Level 3	Apply		30%	Grand Control	30%	4	30%	-	-			
Level 4	Analyze		30%	L J N - 777	30%	-	30%	-	-			
Level 5	Evaluate	- A	mark to a fill	V-5565 4	- A	-		-	-			
Level 6	Create		2.50	1879 F 1	1 Page 194		V-G-	-	-			
	Total Total	10	0 %	.10	0 %	10	00%		-			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Expe <mark>rts</mark>
1. Mr. G. Gopinath, R&D Manager, ZF <mark>, Chenn</mark> ai,	1. Dr. D. Madesh, Professor, AMET University, Chennai,	1. Mr. M. C <mark>handras</mark> ekaran, SRMIST
gopinath.gunasekaran@zf.com	madesh.d@ametuniv.ac.in.	
2. Mr. K. Maheshwaran, Assistant Manager, TAFE, Madurai,	2. Dr. L. Ranganathan, Professor and Head, Dept. of Mechanical Engineering,	2. Mr. G. B <mark>alakuma</mark> ran, SRMIST
Email ID: maheshwaran@tafe.com	Agni College of Technology, Chennai, Email ID: mechod@act.edu.in	

Course Code	21MHC209T	Course Name	PROJECT MANAGEMENT AN	ND INDUSTRIAL PRACTICES	Course Category	С		PF	ROFES	SIONA	AL COR	RE		_L	. T	P C 0 3
Pre-requisir Courses		Nil	Co- requisite Courses	Nil	Progre Cour						Nii	I				
Course Of	fering Departme	ent	Mechatronics Engineering	Data Book / Codes / Standa	rds		÷.			Nil						
				ORIGINA	Trans.											
Course Lear	rning Rationale ((CLR): T	he purpose of le <mark>arning this cou</mark> rse	is to:	111 1			Program C	utcom	es (PC	O)				Prog	
CLR-1:	introduce the con	cepts and c	components of <mark>Project Man</mark> agement	112	1 2	3	4	5 6	7	8	9	10	11	12	Spec Outco	

OLIN-3.	gain apply knowledge of time, cost and resource management	≥	ဟ	1 =	<u>a</u> <u>a</u>	ည်	O		L .	I ∈		.⊆	, ≌′			ı
CLR-4:	introduce the concepts of new product development, productivity, reliability and Quality	Α̈́	alysi	ndole	estig	l Us	a a	t &		Tea	tion	& F	arni			
CLR-5:	introduce modern industrial practice - digitization	ring	Ä	deve	t inv lex p	700	jine	ment ability	1.	<u>ه</u>	nica	Mgt.	g Le			
		nee	Jen -	gn/	duc	ern	eng ety	ron	SS	/jdu	חוו	ect	딜	7	-5	6
Course C	Outcomes (CO): At the end of this course, learners will be able to:	Eng	Pro	Desi	Con of α	Mod	The	Envi Sust	Ethi	lpdi	Con	Proj	Life	PSC	PSC	PSC
CO-1:	understand main aspects of project management: time, money and resources	7 -	1	1-1	1.	N-		-		-	-	3	-	_	-	-
CO-2:	design project scheduling us <mark>ing Gan</mark> t, CPM and PERT methods	. 1-	, i.e.,	40	24-13	-	4	1	-1	-	-	3	-	2	-	-
CO-3:	apply project management technique for managing time, cost and resources	1	g v rys	1.0	153	-	-	-	-	-	-	3	-	- 1	-	-
CO-4:	understand productivity and NPD in engineering	1 3	19.20	100	-	-	-	-	-	-	-	2	-	-	-	-
CO-5:	understand modern industrial practice system using digitization tools		4	1.54	74	2		-	- 5	-	-	2	-	-	-	-

Unit-1 - Project, Program, and Project Life Cycle

9 Hour

Project scope management, Work Breakdown Structure (WBS) and Responsibility Assignment Matrix (RAM), Project communications and documentation, Project evaluation: Benefit-Cost Ratio (BCR), Project performance and Earned Value Management (EVM), Professional project management organizations, Introduction to software project management

Unit-2 - Project Scheduling

CLR-2:

CI R-3.

9 Hour

Project scheduling - Terms, terminologies, and definitions, Gantt Chart, Activity On Arc (AOA), Activity On Node (AON), CPM, PERT, Examples

Unit-3 - Project Time, Costing, Budget, Crashing

9 Hour

Trade-offs in project-time and -cost, Project crashing with examples, Project cost estimation, budgeting, Actual Cost, Budgeted cost, Value of work done, Cost Performance Analysis (CPA), Resource constrained planning, Resource allocation, Resource loading, Resource levelling

Unit-4 - New Product Development (NPD) and Productivity

gain knowledge in the fundamentals project scheduling

gain apply knowledge of time, cost and resource management

9 Hour

New Product Development (NPD)— an industrial practice, Ideation, development, testing, launch and track — phases NPD, Value driven management, Innovation Driven management, Break-Even Analysis, Productivity, Reliability, Quality management, Process control, ISO9000.

Unit-5 - Digitization in Industry

9 Hour

Modern industrial practice, Digital transformation and exponential growth, Work styles, Product- to service-oriented model, Digitization solutions, IOT, Industry 4.0, 3D printing, VR & AR, Wearables, Blockchain, Digitization in Automotive industry, Digital twins

	1.	Pradeep Pai, Project management, I
Learning	2.	D.R.Kiran, Production planning and
Resources		pvt ltd-Elsevier, 2019
	_	

- Pearson India, 2019
- control A comprehensive approach, BSP books
- 3. Juran, Gryna, Quality Planning and Analysis, McGraw-Hill, New York, 1993.
- Lewis, R., Project Management, McGraw-Hill, 2006, ISBN 0-07-147160-X
 Uwe Winkelhake, The digital transformation of the automotive industry- Catalysts, Roadmap, Practice, Springer, 2022
 6. Phillips, J., PMP Project Management Professional Study Guide, McGraw- Hill, 2003.

	Bloom's Level of Thinking	CLA-1 Aver	Continuous Learnin mative age of unit test 50%)	CI	g Learning LA-2 0%)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	AND A			2 - 1	20%	-			
Level 2	Understand	55%	14.5	50%	- 0	30%	-			
Level 3	Apply	45%	42.50	50%	(P)	50%	-			
Level 4	Analyze	~ ·	Sec. 200	** CT'-		-	-			
Level 5	Evaluate			- A	- 4	-	-			
Level 6	Create		10 TH WHAT I I	100.00		-	-			
	Tot <mark>al</mark>	1	00 %	10	00 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr Venkat Perumal, Ph.D., Sr. Principal Engineer, R&D,	1. Dr VeeraRagavan, Senior Lecturer, Monash University (Malaysia campus),	1. Dr Mad <mark>havan S</mark> hanmugavel, SRMIST
Stryker	Malaysia	
2. Mr Koteswaran Srinivasan, Director, HCL Technologies	2. Elango Natarajan, Associate Professor, Faculty of Engineering, Technology and	2. Dr Sen <mark>thilnatha</mark> n, SRMIST
Ltd, Chennai	Built Environment,, UCSI University, 56000 Cheras, Kuala Lumpur, Malaysia	

Course 21MHC30	Ourse Course	SYSTEM DYNAMICS AND CONTROL	Course	DDOEESSIONIAL CODE	L	ı	Р	C
Code	Name	STSTEIN DTNAINIGS AND CONTROL	Category	PROFESSIONAL CORE	3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	21MHC304L	Progressive Courses	21MHE414T
Course Offerin	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	1	7			Progr	<mark>am</mark> Ou	tcome	s (PO))				Prog	
CLR-1:	model the electrical, mechai	nical, and electromechanical dynamic systems	1	2	- 3	4	5	6	7	8	9	10	11	12	Spec Outco	
CLR-2: analyze a dynamic system using procedural methods					of	SL	1	-	N		ork		8			
CLR-3:	construct the control system	s in the t <mark>ime domai</mark> n	Knowledge	S	nent	vestigations problems	age	ъ			Μ		nance	ng		
CLR-4: analyze control systems in the frequency domain					ldo	estig	Usage	rand	∞ > >		Team	io	≪	arni		
CLR-5:	CLR-5: develop a state space model			. An	gn/development of	ĕ ±.	20	engineer stv	ironment tainability	N	<u>8</u>	ommunication	Mgt.	ig Le		
			ineering	Problem	/ugi	onduct	Modern	et e	iron	SS	ndividual	F F	roject	Long	7 2	7 5
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Prof	Des	of Sol	Moc	The	Environi Sustaina	Ethics	Indi	Sol	Proj	Life	PSO-1	PSO-3
CO-1:	construct the basic dynamic	s <mark>ystems</mark>	3	2	-	-	Ŧ	-	-	-	-	-	-	-	3 -	. -
CO-2:	design a conventional contro	o <mark>ller for a</mark> dynamic system	3	2	177	-	- /	-	-	-	-	-	-	-	3 -	. -
CO-3:	CO-3: analyze a controller based on time domain specifications				3		- 1		-	-	-	-	-	-	3 -	. 2
CO-4:	CO-4: apply the procedure of frequ <mark>ency re</mark> sponse plot to design a compensator				3	-	-	-	-		-	-	-	-	3 -	. 2
CO-5:					3	_	_		- 1	-	_	_	-	-	3 -	. 2

Unit-1 - Modeling of Systems

Introduction to signals and their properties- Elementary Signals-Introduction to systems and properties- LTI system- Solving differential equation using Laplace transform -Transfer function/System function, poles and zeros-Modeling of mechanical, electrical, and electromechanical dynamic systems, and numerical examples on modeling.

Unit-2 - Time Domain Specifications and Controllers

9 Hour

9 Hour

Introduction to open loop and closed loop control system, -Block diagram and signal flow graph reduction techniques, Response of I and II order systems and their time domain specifications- Steady state error constant of the system for type numbers and inputs-PID control-Analytical design for PD, PI, PID control systems- Design of PID controller using Model-based /Zeigler Nichols method

Unit-3 - Concept of stability and Design

9 Hour

Stability of system- Routh-Hurwitz stability criterion- Root locus method, steps in obtaining a root-locus-Design of controllers using root-locus-Introduction to compensator - Compensator design using root locus-Cascade Lead, lag, and lag-lead compensation

Unit-4 - Frequency Response Analysis and Design

9 Hour

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Construction of Bode Plots and Polar Plots - Compensator design using Bode Plots - Cascade Lead, lag, and lag-lead compensation.

Unit-5 - State Space Analysis and Design

9 Hour

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Full state feedback controller design-Full order observer design-Design examples.

Learning Resources	B P Lathi, Principles of Linear Systems and Signals, 2nd edition, Oxford University Press, 2009. J Nagrath, M Gopal, Control Systems Engineering, 5th Edition, New Age International, 2007.	

Norman S Nise, Control Systems Engineering, 7th edition, Wiley, 2015.
 Roland S. Burns, Advanced Control Engineering, Butterworth- Heinemann, First edition, 2001

			Continuous Learning	g Assessment (CLA)		Summative				
	Bloom's Level of Thinking	CI A-1 Average of unit test			g Learning .A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice Practice	Theory	Practice			
Level 1	Remember	15%	-	15%	/) -	15%	-			
Level 2	Understand	25%		25%	2 - 1	25%	-			
Level 3	Apply	30%	AST SEE	30%	1/2	30%	-			
Level 4	Analyze	30%	44.75	30%	() () () () () ()	30%	-			
Level 5	Evaluate	7V- /	1 N. J. M. 177			• -	-			
Level 6	Create			100		-	-			
	Total	100 %	6	10	0 %	100	1%			

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
1. Dr. K. Karthikeyan Ph.D.,R &D Team Manager, Power	1. Dr.M.Mythili, Assistant Professor, Department of Electronics and Instrumentation 1. Dr.M.Mohamed Rabik, AP, SRMIST
Quality Products, Hitachi Energy, B <mark>angalore</mark>	Engineering, Anna University, Chennai - 600025.Email - mythilym@annauniv.edu
2. Mr. Emmanuel Thangiah Director-Operations, E73 Al	2. Dr. P. Karthikeyan, Assistant Professor, Department of Production Technology, MIT 2. Ms.D.Sasikala , AP, SRMIST
Innovations Pvt Ltd Email – emmanuel@73.ai	Campus, Anna University, Chennai- 600044. Email id:pkrthikeyan@mit.edu

Course	21MHC302J	Course	DESIGN AND ANALYSIS OF MACHINE ELEMENTS	Course	_	PROFESSIONAL CORF	L	Τ	Р	С	
Code	Z TIVII ICOUZU	Name	DESIGN AND ANALYSIS OF MACHINE ELEMENTS	Category	C	FROFESSIONAL CORE	2	0	2	3	

Pre-requisite Courses	Nii	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR):	The purpose of learning this course is to:	#H	4		٠, ١	Progra	am Ou	itcom	es (PC))					rograi	
CLR-1:	formulate, design, and ident	ify torque elem <mark>ents</mark>	1	2	3	4	5	6	7	8	9	10	11	12		pecifi ıtcom	
CLR-2:	estimate the life of sliding ar	dg.	5	of	SC					ا ملا		8					
CLR-3:	analyze the gear failure mod	des, and <mark>evaluate fo</mark> rces and stresses within a gear system	Knowledge	alvsis	nent	tigations	зде	p			×		Finance	р			
CLR-4:	4: construct flexible drive systems and design for light, medium, and heavy-duty applications				elopme	estig	Us	ar an	∞ >		Tea	ţi	∞	arning			
CLR-5:	summarize the basics of fini	te ele <mark>ment for</mark> mulation	ering	, A	deve	ex r	T ₀ 0	jinee	ment ability		<u>8</u>	mmunication	Mgt.	ıg Le			
		AMERICAN SE	ğ	j	/ugit	onpe	dern	enç ietv	iron	S	dividu	nuu.	Project	Long	5-1	0-5	53
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Fno	Pro	Des	Sol Sol	Mo	The	Env Sus	Ethic	Indi	Cor	Pro	9JI T	PSO	PSO.	PSO
CO-1:	design suitable shafts and c	o <mark>upling fo</mark> r particular engineering applications	3	3	2	2	3	-	-		-	-	-	•	2	2	-
CO-2:	analyze and select bearings and lubricants for various engineering applications				2	2	3	_=	-	1	-	-	-	-	2	2	-
CO-3:	design and analyze various simple gear trains for various power transmission applications				2	2	3		-	i-	-	-	-	-	2	2	-
CO-4:	design and select suitable flexible drive systems for power transmission applications				2	2	3	-	-		-	-	-	-	2	2	-
CO-5:	apply finite element formulations to solve one-dimensional and two-dimensional Problems				2	2	3	-	-	2	-	-	-	-	2	2	-

Unit-1 - Design of Power Transmission and Energy Storing Elements

9 Hour

Introduction to the design process, factors influencing machine design, selection of materials based on mechanical properties, Preferred numbers, fits, and tolerances. Design of rigid and flexible couplings, Keys, keyways, and splines, Various types of springs; design and optimization of helical springs; design of power screws.

Experiments:

Modeling of basic mechanical components using Solid Works Coupling and spring Modeling and Analysis (Solid works & Ansys)

Unit-2 - Design of Bearings

9 Hour

Design of Bearings (Ball Bearing, Roller Bearing & Sliding Contact Bearing) Sliding contact and rolling contact bearings – Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, Selection of Rolling Contact bearings.

Experiments:

screw jack Modeling Simulation and Analysis (Solid works & Ansys)

Plummer Block Modeling Simulation and Analysis (Solid works & Ansys)

Unit-3 - Design of Gears and Gear Trains

9 Hour

Types of Gears, Gear materials, Gear Nomenclature, Design of spur gear based on Lewis and Buckingham equations: Helical Gear Nomenclature, Design of helical gear based on modified Lewis equations: Bevel Gear Nomenclature, Design of bevel gear based on Lewis and Buckingham equations. Gears and Gear trains, Design of Gears using Gear Life: Design of Gearbox.

Experiments:

Universal Coupling Modeling Simulation and Analysis (Solid works & Ansys)

Modeling, Simulation, and Analysis of Mechanisms (Four bar, Slider crank Mechanisms)

Unit-4 - Design of Flexible Drives 9 Hour

Types of Flexible Drives, Belt Materials and Constructions, Design of Flat Belt Drive & V- Belt Drive, Chain Drive: Types, Failures, Designation Selection of Chain Drive, Chain Lubrication Wire Rope - Types, Construction, Lays of Wire Rope, Selection of Wire Rope, Stresses in Wire Rope, Design of a Wire Rope Drive.

Experiments:

Mode thermal analysis of Composite material Frequency analysis, Harmonic Analysis

Unit-5 - Finite Element Method

9 Hour

Finite element method: Introduction, types of elements, shape function, types of forces, elemental stiffness matrix, elemental force matrix, assembly, truss, introduction to 2-dimensional finite element method. Experiments:

Modeling, Simulation, and Analysis of a robotic arm

Learning	
Resources	

- Bhandari.V.B, "Design of Machine Elements", 3rd ed., Tata McGraw- Hill, 2010.
 Robert L. Norton, "Machine Design: An Integrated Approach", 5th ed., Prentice
- Merhyle Franklin Spotts, Terry E. Shoup and Hornberger.L.E, "Design of Machine Elements", 8th ed.,, Prentice Hall, 2003
- 4. Joseph Shigley and Charles Mischke, "Standard Handbook of Machine Design", 3rd ed., Tata McGraw Hill, 2004.
- 5. Richard G.Budynas, J.KeithNisbett, "Shigley's Mechanical Engineering Design", 10th ed., Tata McGraw-Hill, 2015.
- 6. PSG, "Design Data" [Data Book Of Engineers], Kalaikathir Achagam, 2016.
- 7. CAD Laboratory Manual.

Learning Assessme	ent		1 P. 18	A 1/4/2 A 1/4/						
	Bloom's Level of Thinking	CLA-1 Avera	Continuous Learning native ge of unit test %)	CL	Learning A-2 %)	Summative Final Examination (40% weightage)				
	0	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	10%		For the Park of th	20%	15%	-			
Level 2	Understand	30%			20%	25%	-			
Level 3	Apply	30%		A Park S	20%	30%	-			
Level 4	Analyze	30%	- N//	,	40%	30%	-			
Level 5	Evaluate	ala I	- 1				-			
Level 6	Create		- 1		7 -V	9 / -	-			
	Total	100	%	100	%	100	%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R. Nirmal, Caterpillar India, Chennai	1. Dr. R Arvindraj, VIT vellore	1. Mr.G.Bal <mark>akumaran</mark> ,SRMIST
2. Mr. R. DhineshBabu, Technofit, Malaysia	2. Dr. R. Senthilkumar, Mohamed Sathak A.J.College of Engineering	2. Mr.S.M. Vignesh SRMIST

Course	21MHC303J	Course	MEASUREMENT SENSORS AND INTEREACES	Course	_	DDOEESSIONAL CODE	L	Т	Р	С
Code	2 11011 103033	Name	IVIEASUREIVIENT, SENSORS AND INTERFACES	Category	C	PROFESSIONAL CORE	2	0	2	3

Pre-requisite Courses	Nii	Co- requisite Courses	Nil	Progressive Courses	21MHE401T, 21MHE410T
Course Offering	g Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

THE RESERVE

Course L	earning Rationale (CLR): The purpose of learning this course is to:					orogra	ım Ou	tcome	s (PO))				Pı	rogran	n
CLR-1:	perceive the fundamental understanding of design, calibration, characterization and analysis of measuring systems and data acquisition	11	2	3	4	5	6	7	8	9	10	11	12	_	pecific tcome	
CLR-2:	gain knowledge of the working principle of sensors used for force and displacement measurement	d)			ф Т		ciety			~						
CLR-3:	acquire the knowledge of the working principle of sensors for measurement of position, distance and acceleration		က္ဆ	ment of	stigations lems	age	S			m Work		& Finance	ng			
CLR-4:	explore the basic principles of pressure, flow, and temperature sensors	Knowle	Analysis	ldol	vestig	Tool Usage	ar and	t &		Team	tion		earning			
CLR-5:	comprehend different interfacing standards for sensors and their physical applications	Ingineering	oblem An	sign/development	uct in	ım Too	angineer	Environme <mark>nt.</mark> S <mark>ustainabilit</mark> y	(0	vidual &	ommunication	Project Mgt.	ong Le	_	2	က
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engir	Probl	Desig	길은	Моде	The	Envir S <mark>usta</mark>	Ethica	Indivi	Comi	Proje	Life L	PSO-	PSO-	PSO-
CO-1:	implement the physical principles applied in measurement systems and data acquisition systems	3	2	100	-	- /	-	-	-	-	-	-	-	1	-	-
CO-2:	analyze the sensors and their selection criteria for the measurement of force and displacement	3	ياء روا	2	-	- (-		-	-	-	-	-	-	-
CO-3:	evaluate the sensors for the measurement of position, distance and acceleration based on selection criteria	3	175	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-4:	analyze the sensors and their selection criteria for the measurement of pressure, flow and temperature	3	λ÷	2	-	ا - ا	-	-		-	-	-	-	-	-	-
CO-5:	acquire knowledge about different sensor interfaces and their real time applications	3	2	-	-	- 5		-	÷	-	-	-	-	-	-	-

Unit-1 - Sensor Based Measurement Systems and Data Acquisition

12 Hour

Sensor Classification - Static and Dynamic Characteristics of Measurement Systems - Errors in Measurement - Statistical Evaluation of Measured Data - Standard and Calibration - Amplification and Signal Conditioning - Digital Conversion - Elements of Data Acquisition Systems - Time Division and Space Division Channeling in Data Acquisition Systems

Experiments:

1. Design of instrumentation amplifiers. 2. Design of active filters

Unit-2 - Sensors for Force and Displacement Measurement

12 Hour

Potentiometric Sensors - Capacitive Sensors - Working Principle of Strain Gauges - Quarter Bridge, Half Bridge and Full Bridge Configuration of Load Cell - Magnetic and Inductive Proximity Sensors - Working Principle and Applications of LVDT and RVDT - Tactile Sensors

Experiments:

1. Study of characteristics of load cell. 2. Study of characteristics of LVDT

Unit-3 - Sensors for Position, Distance and Acceleration Measurement

12 Hour

Working Principle of Eddy Current Sensors - Hall Effect Sensors - Distance Measurement using IR and Ultrasonic Sensors - SONAR, RADAR, Optical Sensors - LIDAR - Optical Encoders - IMU Experiments:

1. Distance measurement using IR. 2. Distance measurement using optical encoder

Unit-4 - Sensors for Temperature, Pressure and Flow Measurement

12 Hour

Piezoresistive Sensors - Working Principle and Applications of Bourdon Tube, Bellows and Diaphragm - Thermoresistive Sensors: Thermistor - RTD - Thermoelectric contact sensors: Thermocouple - Thermal Transport Sensors: Hot wire Anemometer Experiments:

1. Study of characteristics of pressure sensors. 2. Study of characteristics of temperature sensors

Unit-5 - Sensor Interfacing

12 Hour

Smart Sensor Systems – Role of sensors in IOT - Multichannel Sensor Interfacing - Standards - Integrated Circuit Bus (I2C) - Serial Peripheral Interface (SPI) - Controller Area Network (CAN) Bus - Universal Transducer Interface (UTI) - Case studies related to different Interfacing Standards Experiments:

1. Interfacing temperature sensor with data acquisition system. 2. Interfacing ultrasonic sensor with data acquisition system.

Learning Resources

- Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
- 2. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press. Florida.
- Kirianaki N.V., Yurish S.Y., Shpak N.O., Deynega V.P., Data Acquisition and Signal Processing for Smart Sensors, John Wiley & Sons, Chichester, UK, 2002.
- 4. Ramon Pallas-Areny and John G Webster, Sensors and Signal Conditioning, 2012, 2nd ed., Wiley India Pvt. Ltd.
- 5. John Park and Steve Mackay, Practical Data acquisition for Instrumentation and Control, 2011, 1st ed., Newness publishers, Oxford, UK.
- 6. Paul P.L Regtien, "Sensors for Mechatronics", Elsevier publications, 1st edition, 2012.

Learning Assessm	ent			PAR Supplied			
	Bloo <mark>m's</mark> Level of <mark>Thinkin</mark> g	CLA-1 Avera	Continuous Learning mative age of unit test 5%)	y Assessment (CLA) Life-Long (CLA (15%	1-2	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%		() () () () () () () () () ()	15%	15%	-
Level 2	Understand	25%	The second second second	the state of the s	25%	25%	-
Level 3	Apply	30%		The second	30%	30%	-
Level 4	Analyze	30%		/ shake 3	30%	30%	-
Level 5	Evaluate		- N/A/	-	-40	-	-
Level 6	Create	P/4 1-	- 1.9	-		-	-
	Total	10	0 %	100	%	10	0 %

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
Dr.S. Shaffath Hussain Shakir, Project lead, VIASAT	Dr.R.Thiyagarajan, Assistant Professor, Department of Mechanical Engineering, IIT, Tirupati. Dr. S.Fouziya Sulthana, SRMIST
2. Mr.T.Sathish, Lead Engineer-Systems Engineering	2. Dr K. Navin sam, Assistant Professor, Department of Electrical and 2. Mr. J. Thiyagarajan, SRMIST
GE Power conversion.	Electronics Engineering, NIT, Puducherry

Course Code	21MHC304L	Course Name	M	ODELLING AND	CONTRO	L LABORATORY		ourse tegory	С			l	PROF	ESSIO	NAL C	ORE			L 0	T 0	P 2	<u>C</u>
Pre-requi		Nil	(Co- requisite Courses		21MHC301T	******	Progr	essive)					21 <i>N</i>	1HE41	4T					
	Offering Departm	nent	Mechatron	ics Engineering		Data Book / Cod	es / Standards	000	1303	٠.					Nil							
	<u> </u>			Ĭ.			TAL STO				٠.											
Course Le	earning Rationale	(CLR):	The purpose	of <mark>learning thi</mark> s	course is	to:					ı	rogra	ım Ou	itcome	s (PO)					ograi oecifi	
CLR-1:	model the electr	ical, mechar	nical, and electro	<mark>mechanical</mark> dyna	amic syster	ns		1	2	3	4	5	6	7	8	9	10	11	12		tcom	-
CLR-2:	analyze a dynan	nic system u	using proce <mark>dural</mark>	<mark>metho</mark> ds	O.			ge	7	of	SI					ork		99				
CLR-3:	construct the co	ntrol system	ns in the t <mark>ime dor</mark>	<mark>nai</mark> n	>		an talken a	wlec	(A)	nent	ation	age	ъ			ΜM		nan	Б			
CLR-4:	analyze a contro	ol systems in	n the fre <mark>quency</mark> d	lomain				X S	alysi	ldol	estig robl	NS:	ran	∞ >		Теа	ion	& Fi	arni			
CLR-5:	develop a state	space mode	el			- F	Santa Maria	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment 8 Sustainability	N	Individual & Team Work	Communication	Project Mgt. & Finance	ife Long Learning			
	-						1	inee	lem	Design/desolutions	duct	lern	eng etv	ronr	SS	/idu	ımı	ect I	<u>P</u>	-1	-5)-3
Course O	utcomes (CO):		At th <mark>e e</mark> nd o	f this course, lea	arners will	be able to:		Eng	Prot	Des solu	Con of a	ооМ	The soci	Env. Sus	Ethics	Indi	Con	Proj	Life	PS0-1	PS0-2	PS0-3
CO-1:	construct the ba	sic dynamic	s <mark>ystems</mark>	_		B SW W	Carry HILL	2	2	3	-	2	*	-		-	-	-	-	3	-	,
CO-2:	design a conven	ntional contro	o <mark>ller for a</mark> dynam	ic system	1	William Control	18 Mar. 1	2	2	3	1 -	2		-	1	-	-	-	-	3	-	-
CO-3:	analyze a contro	oller based o	o <mark>n time d</mark> omain s	pecification	9.37	No.		2	2	3	4-	2		-	1	-	-	-	-	3	-	2
CO-4:	apply the proced	dure of frequ	u <mark>enc</mark> y <mark>re</mark> sponse p	olot to design a co	ompensato	r	47 (17)	-2	2	3	-	2	-	-	1	-	-	-	-	3	-	2
CO-5:	develop a contro	oller using st	t <mark>ate spac</mark> e appro	ach	1. 25	The second second	V. F. 11.2	2	2	3	-	2	-	- 1	1	-	-	-	-	3	-	2
	1				$T_{ij}^{\prime}(T_{ij})$			18-	4			- 1		1							I	
	odeling of Syster		1.4			1.6.	11.					-0		4							61	Hour
	ng of electrical and ng of electromecha					liation soπware.	17017					-	1									
Unit-2 - Ti	me Domain Spec	ifications a	and Controllers		r contraro.						7	77		7 :							6 1	Hour
	ne the time domai						6.10			- 74					7							
	ance comparison oncept of Stabilit			sed loop system	with a PID	controller.	7 - 7 - 7	_	-		- 4		4		Ĭ						6 1	Hour
	entation of root lo			ion, and stability	analysis.	ARN.	FIDA D					> -									0 1	ioui
2. Design of	of compensators u	ising the roo	ot locus meth <mark>od.</mark>		114	TI ATT A	LEAP	-	E^{\prime}	(1)		1		/								
	requency Domain					" 11			4.22		<u> </u>										6 1	Hour
	entation on Bode _l of compensators u			ain, <mark>and phase</mark> m	nargins witi	n a suitable examp	ole.															
Unit-5 - St	ate Space Analys	sis and Des	sign									7									6 1	Hour
1. Experim	ent on state space	e representa	ation of a system	, conversions bet	tween trans	<mark>sfer function and s</mark>	tate space appro	aches.		• • •												
2. Design (of full state feedba	ck controller	ers with a suitable	example using L	JC servo n	notor																
Learning						h- Heinemann, Fir on, New Age Interi		3.	Labor	atory I	Nanuai	s for C	Qube s	servo, a	and co	mpens	sation (circuit	kits.			
Resources	2 . J Na	igratii, ivi G0	opai, Control Sys	terns Engineering	y, Jui ⊑uille	ni, ivew Age interi	iauUIIai, 2007.	1														

			Co	ontinuous Learning	g Assessment (C	LA)			
	Bloom's Level of Thinking	exper	ge of first cycle iments 0%)	cycle exp	ge of second periments 9%)		Examination eightage)	Final Examination (0% weightage)	
		Theory	Practice Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember		20%	- T T N	1735		15%	-	-
Level 2	Understand	7	25%		1 . 11 .	- 1	25%	-	-
Level 3	Apply		30%		50%	A \	30%	-	-
Level 4	Analyze	. /-	25%	_	50%	$VV\lambda$	30%	-	-
Level 5	Evaluate	- 4	W	-	-	7.3	-0.	-	-
Level 6	Create		-	-V A-	-	- 7		-	
	Total	10	0 %	100	0 %	10	00%		-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Interna <mark>l Experts</mark>
1. Dr. K. Karthikeyan, R &D Team Manager, Power	1. Dr. M. Mythily Assistant Professor, Department of Electronics and Instrum	nentation 1. Dr. <mark>M.M</mark> ohamed Rabik, SRMIST
Quality Products, Hitachi Energy, Bangalore	Engineering, Email - mythilym@annauniv.edu	

Course	21MHC305J	Course	MANUIFACTURING PROCESSES	Course	_	PROFESSIONAL CORE	L	T	Р	С	1
Code	Z 11VIIT C3033	Name	MANUFACTURING PROCESSES	Category	C	PROFESSIONAL CORE	2	0	2	3	

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Mechatronics engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR): The purpose of learning this course is to:		4 .		- 1	Progra	am Ou	tcome	s (PO)					rograr	
CLR-1:	understand the principle and process of different metal forming and metal cutting process	1	2	- 3	4	5	6	7	8	9	10	11	12		pecific	
CLR-2:	impart knowledge on types and approaches of advanced manufacturing process	dge		of	SL			1		ork		9				
CLR-3:	gain knowledge in concept of compu <mark>terized ma</mark> chine tool for metal cutting process		S	evelopment	vestigations c problems	age	ъ	, N		N N		Finan	ning			
CLR-4:	understand the concept of automation in manufacturing process	Knowle	alysi	udoli	estig	Usage	r and	∞ ×		Team	ion	& F	ä			
CLR-5:	familiar in manufacturing metrology	ering	٩	/deve	ct inv	n Tool	engineer etv	ronment tainability		ual &	ommunication	roject Mgt.	ong Le			
Course C	outcomes (CO): At the end of this course, learners will be able to:	Engine	Problem	Designation	Condu of corr	Moder	The en society	Enviro Sustai	Ethics	Individual	Comm	Projec	Life Lc	PSO-1	PSO-2	PSO-3
CO-1:	explain the process of different metal forming and metal cutting processes	1	2	- 1	-	1	-	-		-	-	-	-	,	-	-
CO-2:	distinguish the types and approaches of advanced manufacturing process	1	2	2		- 1	<u></u>	-	1	-	-	-	-		-	-
CO-3:	implement the concept of computerized machine tool for metal cutting process	2	10-2	-1	2	- (-	1		-	-	-	-	-	-	
CO-4:	understand the concept of a <mark>utomatio</mark> n in manufacturing process	-1	2	1-	2	-	-	-		-	-	-	-		-	-
CO-5:	acquire knowledge on manu <mark>facturing</mark> metrology	1	2	2	1	- 1	-	1		-	-	-	-	-	-	-

Unit-1 - Conventional Manufacturing Process and Metal Cutting Theory

12 Hour

Introduction to casting process and mechanical working of metals- fundamentals of metal cutting process- types of cutting tools- Tool life- Prediction of tool life using tailors tool life equations- Cutting forces in orthogonal cutting, merchant circle analysis- Calculation of various forces involved during orthogonal cutting- finishing process and superfinishing process.

Experiments

*Multiple turning with grooving and thread cutting by applying canned cycle using CNC turning centre. *Multiple turning with axial drilling operation by applying canned cycle using CNC turning centre.

Unit-2 - Advanced Manufacturing Process

12 Hour

Rapid Prototyping- Working Principles- Rapid tooling, Techniques of rapid manufacturing- Additive manufacturing: concept, types- Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations - Methods of micromachining- Abrasive jet, Ultrasonic, Abrasive water jet micromachining, Micro turning, Micro drilling.

Experiments

1. Part Program for drilling and Peck drilling operation by applying canned cycle using CNC milling centre. 2. *Profile cutting using Wire cut Electrical Discharge Machine (WEDM)

Unit-3 - CNC Machines and Its Architecture

12 Hour

Introduction to CNC machine tools – Classifications and Constructional feature of CNC turning and milling centre – Open loop and closed loop CNC systems- CNC controllers- Structural members of CNC machines: slide ways, linear motion - Automatic tool changer- fundamentals of part programming- Types of programming: manual part programming- Canned cycle and subroutines.

Experiments

1. CNC Part Program for Facing, Step turning, Tapper and Finish turning using ordinary cycle. 2. CNC Part Program for Facing, Step turning, Tapper and Finish turning using canned cycle.

Unit-4 - Automation in Manufacturing Process

12 Hour

Automation in Production systems- Components of a Manufacturing systems- Single Station Manned Workstations and Single Station Automated Cells- Manufacturing Operations- Cellular Manufacturing, Flexible Manufacturing Systems: FMS Components, FMS Applications, and FMS Planning.

Experiments

1. Pocketing of Linear and Circular profile using CNC vertical machining centre. 2. Part Program for End milling and Drilling operation by applying canned cycle using CNC milling centre

Unit-5 - Advanced Inspection Technologies

12 Hour

Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, contact and non-contact Optical Inspection Techniques & Non-contact Non-optical Inspection Technologies.

Experiments

1. Profile cutting by applying Mirroring operation using CNC vertical machining centre

Learning Resources

- Sharma.P.C, "A textbook of Production Technology", Vol I and II, S. Chand and Company Ltd., New Delhi, 2007.
- SeropeKalpakjian and Steven Schmid, "Manufacturing Engineering and Technology". Pearson Education, 7th edition, 2014.
- Radhakrishnan.P, "CNC Machines", New Central Book Agency, 2000.
- Pandey and H.S.Shah, "Modern Machining Process", Tata McGraw Hill Publishing Co., New Delhi, 2008.
- Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 3rd edition, World Scientific Publishers, 2010.
- R. S. Khandpur"Printed Circuit Boards: Design, Fabrication, and Assembly" Tata McGraw Hill Publishing Co., New Delhi, 2010.
- 7. S.K. HajraChoudry, S.K.Bose, A.K. HajraChoudry, "Elements of Workshop Technology Vol II: Machine tools", Media promoters and Publishers Pvt Ltd, 2002.
- 8. Chapman.W.A.J, "Workshop Technology" Vol. I and II, Arnold Publisher, 1996.
- 9. Elanchezhian.C, VijayaRamnath.B and Sunder Selwyn, T., Engineering Metrology, Eswar Press, Chennai, 2004.
- 10. John A. Bosch, Giddings and Lewis Dayton, Co-ordinate Measuring Machines and Systems, Marcel Dekker, Inc, 1999
- 11. ZuechNello, Understanding and Applying Machine Vision, Marcel Dekker, Inc, 2000

Learning Assessm	nent						
	Blo <mark>om's</mark> Level of <mark>Thinking</mark>	CLA-1 Avera	Continuous Learnin ative ge of unit test %)	CL	Learning A-2 5%)	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	- 3/1//	-	15%	15%	-
Level 2	Understand	25%	- 143%	-	20%	25%	-
Level 3	Apply	30%			25%	30%	-
Level 4	Analyze	30%		7.5	25%	30%	-
Level 5	Evaluate	7140	ARNIII	Laters To the Control of the Control	10%	-	-
Level 6	Create	/ / / / /	THEY IT	AP-TEX	5%	-	-
	Total	100) %	10	0 %	10	0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.K.Balaguru, Deputy Manager, Hindustan Aeronautics limited, Structural Design, gurubala07@gmail.Com.	1. Dr.V. Senthilkumar , NIT Tiruchirappalli, Production department, vskumar@nitt.edu	1. Mr.Arivarasan J, SRMIST
2Mr.S.Hari bala manoj, Assistant Manager, Renault Nissan Technology, sbalamanoj@gmail.com	2. Dr.C.Velmurugan, IIIT Tiruchirappalli, Mechanical Engineering Department, velmuruganc@iiitt.ac.in	2. Mr.K.Saravanan, SRMIST

Course Code	21MHC306T	Course Name	KINEMATICS AND DY	NAMICS OF MECHANISMS	Course Category	С	PROFESSIONAL CORE	L T P 3 0 0	C 3
Pre-requisir Courses		Nil	Co- requisite Courses	Nil	Progre Cour		Nil		
Course Of	fering Departme	ent	Mechatronics Engineering	Data Book / Codes / Stand	ards		Nil		
			7 .0"	OLUM					

Course L	earning Rationale (CLR): The purpose of learning this course is to:	H .	Program Outcomes (PO)											rogram				
CLR-1:	appraise the fundamental concepts Mechanisms, degrees of freedom and inversions of different	1	2	3	4	5	6	7	8	9	10	11	12	_	pecific itcomes			
CLR-2:	analyze the forces of different machines under static and dynamic conditions	dge		of	SC	1	7			ork		e						
CLR-3:			9	<u>e</u>		velopment	vestigations problems	Usage	ъ			Μ		Financ	б			
CLR-4:	explore the undesirable effects of balancing in different real time systems		Analysis	ldol	estig	l Us	er and	y k	l.	Теа	tion	∞ర	arning					
CLR-5:	estimate the frequency of torsional, transverse and torsional vibrations under different loading conditions	ering		deve	tiny	\vdash	engineer stv	ment ability		<u>8</u>	ommunication	roject Mgt.	ng Le					
		nginee	plem	ign/	ag di	Modern	eş el		S	dividu	חת	ect	으	7	2-(
Course (Outcomes (CO): At the end of this course, learners will be able to:	Eng	Prof	Des	o do	Moc	The	Envirol Sustair	Ethics	lndi	Col	Proj	Life	PSO	PSO-2			
CO-1:	comprehend the basic concep <mark>ts of me</mark> chanisms and its inversions	1	2	Nig.		1	7.	- 1	1	-	-	-	-	-				
CO-2:	examine the forces and its impact on different machines under static and dynamic conditions	1	2	-	. ;	1	_	-	-	-	-	-	-	-				
CO-3:	understand the knowledge o <mark>f CAM a</mark> nd gyroscope	1	2	/	-	1		-		-	-	-	-	-				
CO-4:	learn and implement the balancing techniques in different loading conditions	1	2	1 -4	-	1	-	-		-	-	-	-	-				
CO-5:	gain the knowledge of vibrations and to estimate the frequency of different vibrations	1	2	Tab.	-	1	-	-		-	-	-	-	-				

Unit-1 - Elements of Mechanisms 9 Hour

Machine, mechanism, links, pair, Degrees of freedom, determining DOF using Kutzbach criteria - Grashoff law – 4 bar chain mechanism – inversions of 4 bar chain mechanism – single slider mechanism – si

Unit-2 - Force Analysis of Machines 9 Hour

Static force analysis: Constraint forces and applied forces – Free body diagrams – Conditions for equilibrium – Equilibrium for two, three and four force members – Centroid and Moment of inertia – D – Alembert's principle – Principle of super position – Turning of moment diagram of flywheel – Fluctuation of energy – dimensions of flywheel

Unit-3 - CAMS and Gyroscope 9 Hour

CAMS: Classifications of cam and follower- Construction of cam profile when the follower moves with uniform velocity and simple harmonic motion - Construction of cam profile when the follower moves in cycloidal motion- Gyroscope: Gyroscopic couple – Effect of gyroscopic couple on an aeroplane - Effect of gyroscopic couple - Effect o

Unit-4 - Balancing of Rotating and Reciprocating Masses

9 Hour

Balancing of rotating masses: Static balancing – dynamic balancing – Balancing of several masses in single plane – balancing of several masses in different planes Balancing of reciprocating masses: Primary and Secondary unbalanced forces of reciprocating masses – Partial balancing of locomotives – Tractive force – Hammer blow – Swaying couple

Unit-5 - Vibrations

9 Hour

Types of free vibration – Natural frequency of free transverse and longitudinal vibration - Natural frequency of free transverse vibration due to single and multiple point load over a simply supported shaft - Natural frequency of free transverse vibration due to uniformly distributed load over a simply supported shaft – Critical speed of shaft – frequency of free damped vibration – frequency of underdamped forced vibration - Frequency of free torsional vibration of a single, two and three rotor system – Torsionally equivalent shaft

Learning 1. Ratan.S.S, Theory of Machines, 5th ed., Tata McGraw Hill, 2019 4. Dechev, Nikolai. Cleghorn, William L. Mechanics of Machines. Oxford University Press,

Resources	2. R.L. Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill, 2017	2nd edition, 2015.
	3. Gordon R. Pennock & Shigley J.E John J Uicker, 4th ed., Theory of machines and	5. Dukkipati, Rao V. Mechanism and Machine Theory. India: New Age International (P)
	mechanisms, Oxford university press, 2016	Limited, 2nd edition, 2007.

			Commence of the co								
	Bloom's Level of Thinking	CLA-1 Avera	native ge of unit test 0%)	CL	Learning A-2 0%)	Summative Final Examination (40% weightage)					
	_	Theory	Practice	Theory	Practice Practice	Theory	Practice				
Level 1	Remember	15%	-	15%		15%	-				
Level 2	Understand	25%		20%	2 - 1	25%	-				
Level 3	Apply	30%	A STATE OF	25%		30%	-				
Level 4	Analyze	30%	27 2 7 7 10	25%	4 1-3	30%	-				
Level 5	Evaluate	- N	1 to 2-10 7777	15%		-	-				
Level 6	Create			- A		-	-				
	Tota <mark>l</mark>	100	0%	10	0 %	100 %					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions Internal Experts	
1. Mr. N. Manojprabhakar.N, FLSmidth Private	1. Dr. V. Muralidharan, Associate Professor, BS Abdur Rahman Crescent Institute of Science 1. Dr. S. Senthilraja, SRMIST	
Limited, mnp-in@flsmidth.com	& Tech, muralidharan@crescent.education	
2. Mr. P. Thangadurai, Aditya Auto Components,	2. Mr. P. Nantha Kumar, Associate Professor, Sri Sai Ram Institute of Technology, 2. Mr. M. Thirugnanam, SRMIST	
thangadurai08@gmail.com	nanthakumar.mech@sairamit.edu.in	

Course	21MHC307P	Course	MODEL BASED SYSTEMS ENGINEERING	Course	C	PROFESSIONAL CORE	L	Т	Р	С
Code	211111103071	Name	WODEL BASED STSTEMS ENGINEERING	Category)	THOI ESSIONAL CORE	1	2	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil Progressive Courses	Nil
Course Offering	ng Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil
			CILINIO	

Course Le	arning Rationale (CLR):	The purpose of learning this course is to:	И.	4 .		1	Progra	<mark>am</mark> Oı	ıtcome	es (PC))				P	rograr	n	
CLR-1:	introduce systems enginee systems	ering concepts for solving the problems in developing complex engineering	1	2	3	4	5	6	7	8	9	10	11	12	_	pecifi itcom		
CLR-2:	familiarize the various mode	eling appr <mark>oaches an</mark> d methodologies	O)	s		Y	of	1	ciety			×						
CLR-3:	analyze stakeholders' expectations using stakeholders value network and capture systems requirements effectively		wledge		Knowledge alysis	nent of	investigations problems	age	S			m Work		Finance	ng			
CLR-4:				ldole		vestiga	IUs	ar and	× × ×		Team	tion	∞ర	arning				
CLR-5:	apply verification and valida	atio <mark>n techni</mark> ques to evaluate the system design	Ingineering	oblem An	Design/development	호 j	ု	engineer	Environment 8 Sustainability	γ	ndividual &	ommunication	roject Mgt.	ong Le	-	-5	-3	
Course Ou	itcomes (CO):	At the end of this course, learners will be able to:	Engi	Prob	Desi	Condi		The	Envii Sust	Ethics	ıdi≤	Som	Proje	Life I	PS0-1	PS0-2	PSO-3	
CO-1:	familiarize the systems eng systems	ineering concepts for solving the problems in developing complex engineer	ng 3	3		1		1	-		-	2	-	-	2	2	2	
CO-2:	develop various models for	systems using SysML	3	3	10-3	2	2	-	-		-	-	-	-	1	1	1	
CO-3:	analyze stakeholders' exp <mark>ectations</mark> using stakeholders value network and capture systems requirements effectively		ts 3	3	3	1	1	2	-		2	3	2	-	3	3	3	
CO-4:	develop systems architectu <mark>re for ne</mark> w or improved complex systems		3	3	3	3	2	3	-		2	3	2	-	3	3	3	
CO-5:	use verification and validation techniques to evaluate the system design		3	3	1	3	2	3	-	- 1	2	2	2	-	1	3	3	

Unit-1 - Introduction to Systems Engineering

9 Hour

Definitions and concepts of system-system science and systems engineering, life cycle stages, definitions of requirement, architecture, design. System analysis, interface management, system integration, system verification, system transition, system validation, system operation, system maintenance, system disposal. Project planning, project management and control, decision management, risk management, configuration, Case studies: Refrigerator and Washing Machine.

Unit-2 - Introduction to MBSE and SysML Overview

9 Hour

Introduction to MBSE-MBSE concepts- MBSE Ontology-Introduction to Object Process modelling OPM- Object process language-Overview of SysML-Block definition diagrams-Internal block diagrams-Use case diagrams-Activity diagrams-Sequence diagrams-State machine diagrams-Parametric diagrams-Requirements diagram-package diagrams-Operational analysis modeling-functional analysis modeling-logical architecture modeling-Physical architecture modeling-architecture frameworks.

Unit-3 - Stakeholder Analysis and Requirements Definition

9 Hour

Stakeholder's identification, Concept of operations, Stakeholders value network analysis, Requirements: Purpose, Types, challenges, allocation and verification and validation and Volatility. Systems Requirements Review (SRR).

Unit-4 - System Design and Architecture

9 Hour

Architecture definition, architecture viewpoints, concept analysis, models and views of architecture (functional/behavioral/data/performance etc.) – Structure and behavior- Evaluating candidate architectures-System/subsystem analysis- tradeoff analysis- Architecture frameworks and standards-design progression-architecture domains (software/IT/ Manufacturing/social etc)-architecture heuristics- acquisition management-tailoring processes-industrial design-design for manufacturability- robustness design

Unit-5 - Verification and Validation 9 Hour

System verification-System validation-various approaches to system validation and verification-inspection/testing/analysis/demonstration-Generation of Test cases using the Markov Chain model-Writing verification/validation plans-introduction to formal methods-formal approaches to system validation/verification-focus on specialty areas (eg.. EMI/EMC)-test automation models (computation/timed automation)-simulation-model checking verification-verification validation activities prescribed in standards for safety critical systems

List of Recommended Exercises in Tutorial

- 1. Assign a case study to every batch (Washing Machine, Refrigerator, or any other equivalent systems), and ask them to identify characteristics of complex engineering systems and familiarize with complexity level
- 2. Analyze stakeholders associated with the system using SVN
- 3. Based on Stakeholder's analysis, develop requirements model for the system
- 4. Brainstorm and explore various possible concepts, choose the feasible concept for implementation based on trade-off study
- 5. Create an architecture based upon the chosen concept, mapping forms and functions.
- 6. Develop functional models for various functions and incorporate in the architecture
- 7. Perform model-based simulation by using various verification and validation strategies
- 8. Document the complete work carried out in this course

		(Rev 1,
Learning	2.	INCOSI
Resources	3.	Kossiak

- 1. National Aeronautics and Space Administration, "NASA Systems Engineering Handbook", (Rev 1, Dec 2007).
 - 2. INCOSE, "Syste<mark>ms Engin</mark>eering Handbook"
 - Kossiakof, Álexander and William N. Sweet; "Systems Engineering: Principles and Practice" Wiley. 2011
- "SysML distilled: A brief guide to the Systems modeling language". Lenny Deligatti-Addison Wesley Professional, Ed 1, 2013
- Rechtin, E., and M.W.Maier, "The art of Systems architecting", Boca Raton, FL: CRC Press, 2000
- 6. Engel, Avner, "Verification, Validation and Testing of Engineered Systems; John Wiley & Sons, 2010.

Learning Assessm	ent	100	100	-	Contract of the	4						
			Co	ntinuous Learning		LA)						
	Bloom's Level of Th <mark>inking</mark>	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)			l Viva Voce 0%)	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	40%			-		- 🔼	-	-			
Level 2	Understand	40%			7.5	-	7 0	-	-			
Level 3	Apply	20%	X 6 7 P	N:I	20%	-	20%	-	-			
Level 4	Analyze	- / -	1777	- 1 - TT	30%	EAFIE	30%	-	-			
Level 5	Evaluate	-	-	-	30%	The Principle	30%	-	-			
Level 6	Create		-	-	20%	-	20%	-	-			
	Total	100) %	100) %	10	0%		-			

Course Designers	.00	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gaurav Dubey, Mathworks, India	1. Dr.P.Karthikeyan, MIT Campus, Anna University, pkarthikeyan@annauniv.edu	1. Dr.K Sivanathan, SRMIST
2. Dr.Guna Surendra, Hitachi, Japan	2. Dr.Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in	2. Dr.T.Muthuramalingam , SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 18E
(Syllabi for Mechatronics Engineering (Industrial IoT and Systems Engineering) Programme Courses)



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code 21MHE	E465T Course Name	INTRODUCTIO	ON TO IOT AND IIOT	Course Category	Е	PROFESSIONAL ELECTIVE	L T 3 0	P 0	C 3
Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses		Nil			
Course Offering D	epartment	Mechatronics Engineering	Data Book / Codes / Standards		1	Nil			

Course Learning Rationale (CLR): The purpose of learning this course is to:				Program Outcomes (PO)													rogra pecifi itcom	ic
CLR-1:	acquire fundamental kr	owledge <mark>in IoT an</mark> d IIoT.	1		2	3	4	5	6	7	8	9	10	11	12			ſ
CLR-2:	explore the various act	uators <mark>and sen</mark> sors used in IoT applications.	9	2		of	S	1	1			Work		æ				
CLR-3:	acquire a basic unders	and <mark>ing of Io</mark> T networks and popular communication protocols.	a divide			ent	ation	sage	7					& Finance	g			i
CLR-4:	acquire fundamentals o	of n <mark>etwork l</mark> ayer, security, and cloud computing platforms.	Ž.] :	Analysis	lopu	stig	nsa N	r and	<u>«</u>		Team	<u>.</u> <u>0</u>	⊗ E	aming			i
CLR-5:	explore the various use	cases and applications of Industrial IoT.			em Ana	in/development ons	anduct investigations complex problems	im Tool	engineer stv	onment iinability	S	dual &	Communication	Project Mgt.	Long Le	-	.2	က္
Course C	Outcomes (CO):	At the end of this course, learners will be able to:		<u> </u>	Problem ,	Designation	Conduct of comple	Modern		Envir Susta	Ethics	Individual	Com	Proje	ife L	PSO-1	PS0-2	PSO.
CO-1:	explain the basic archit	ecture and elements of IIoT.	- 11 13	3	1	<u> </u>	-	1	-	-	-	Ī	-	-	-	-	-	3
CO-2:	describe the various se	nsors and actuators used in the IoT application.	1 73	}	1	me f		1	-	-	- 1	-	-	-	-	-	-	3
CO-3:	describe the various co application.	mmunication technologies and their selection criteria based on the		3	100	- 74	7	1	Ż			-	-	-	-	-	1	3
CO-4:	explain the network lay	e <mark>r and ba</mark> sics of data management in IoT systems	3	3	-	-	-	1		-		-	-	-	-	-	-	3
CO-5:	explain the application	a <mark>nd use c</mark> ases of IoT in various domains.	3	}	-	-	-	2	7	-	-	-	-	-	-	-	-	3

Unit-1: Fundamentals of IoT and IloT 8 Hours

History and evolution – basic framework, Architecture and elements of IoT – Sensor technologies – Connectivity and networking – data storage and processing in IoT- key difference between IoT and IIoT – Specific examples for IoT and IIoT (specific to industrial environments)

Unit-2: Actuators and Sensors in IoT

9 Hours

Basic sensors used in IoT (any case study- home automation, medical and industrial automation) - basic actuators used in IoT (any case study- home automation, medical and industrial automation) - Concept of Smart sensors - Data acquisition and methods - Sensor calibration - Data sampling and importance of processing - actuator and sensor integration in IoT.

Unit-3: IoT Networks and Communication Protocols

10 Hours

Introduction to types and features of Wireless comm<mark>unication technologies - Types of IoT networks: low power, short range networks (Bluetooth, Wi-Fi, Zigbee), low power, wide area networks (4G LTE IoT,</mark> 5G IoT, LoRaWAN) - Introduction to IoT protocols - Application Layer: Advanced Message Queuing Protocol (AMQP), Constrained Application Protocol (CoAP), Data Distribution Service (DDS), Message Queue Telemetry Transport (MQTT) - Transport layer: Transmission Control Protocol (TCP). User Datagram Protocol (UDP)

Unit-4: Connectivity and Data Management

9 Hours

Network Layer: IP (IPv4 and IPv6) - Data link Layer (IEEE 802.15.4, LPWAN) - Physical layer (BLE, Ethernet, LTE, RFID, Wi-Fi, Zigbee) - IoT Gateway - Cloud computing platforms -IoT security- IoT data management, processing and analytics.

Unit-5: Application and use Cases of Industrial

9 Hours

Health care – predictive maintenance – Virtual Reality and IoT – Digital twins and IoT – Manufacturing Industries

	1.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.	Ī
Lagraina	2.	Arsheep Bahga , Vijay M <mark>adisetti , " IN</mark> TERNET OF THINGS - A HANDS-ON	۹
Learning		APPROACH", Orient Blackswan Private Limited - New Delhi; First Edition, 2015	
Resources	3.	Raj Kamal, "Internet o <mark>f Things: A</mark> rchitecture and Design Principles", McGraw	
		Hill Education: First Edition March 2017	l

- https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols
 Hiroto Yasuura, Chong-Min Kyung, Yongpan Liu, Youn-Long Lin, "Smart Sensors at the IoT Frontier, Springer; 1st ed. 2018.

earning Assessm	nent			4.72		•				
	Bloom's Level o <mark>f Thinki</mark> ng	Forma CLA-1 Average (50%	tive e of unit test	g Assessment (CLA) Life-Long CLA (10	4-2	Summative Final Examination (40% weightage)				
	6 F	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%		10%		15%	-			
Level 2	Understan <mark>d</mark>	25%	State of the state	20%		25%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	30%	to the same state of the	30%		30%	-			
Level 5	Evaluate	F1 3 F1		10%			-			
Level 6	Create		Marie E.		7-0	2	-			
	Total	100	%	100) %	100	0 %			

Course Designers	AL.	1 1 5
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohammed Sagheer, ZF commercial vehicle control systems Pvt. Ltd	1. Dr. P. Karthikeyan, MIT, Anna University pkarthikeyan@annauniv.edu	1.Dr. R. R <mark>anjith Pill</mark> ai, SRMIST
2. Mr. Ganesh Ram, Tunga Systems		2.Dr. S Vasanth, SRMIST

Course	21MHE466T	Course		GITAL AND SMART MANUFACTURING Cour		F	PROFESSIONAL ELECTIVE	L	T	_ <u>P</u> _	С
Code	ZIWIIIE4001	Name	TEC	CHNOLOGY	Category	_	THO EGGIOTALE ELECTIVE	3	0	0	3
Pre-requi	site	Nil	Co- requisite	Nil	Progressive		Nil				
Course	s	INII	Courses	INII	Courses		IVII				
Course C	Offering Departm	ent	Mechatronics Engineering	Data Book / Codes / Standards	UE_A .		Nil				

Course L (CLR):	earning Rationale	The purpose of learning this course is to:	Program Outcomes (PO)								Program Specific Outcomes						
CLR-1:	explore the various app lloT.	olication <mark>s, archite</mark> ctures, and popular communication protocols used in	1	2	3	4	5	6	7	8	9	10	11	12			ĺ
CLR-2:	acquire knowledge in t	he do <mark>main of</mark> data management and processing in IoT.	ge		of	SL			7		Work		9.				
CLR-3:	explore the concept of	digi <mark>tal twin t</mark> echnology	Knowledge		ent	atior	sage	-5	_		W W		Finance	βι			
CLR-4:	acquire knowledge in t	he <mark>building</mark> block of cyber-physical systems	N S	Analysis	lopi	investigations ex problems	Usa	rand	∞ _	1	Team	io	& Fi	arning			
CLR-5:	explore the various ma	nu <mark>facturin</mark> g techniques and automation process	neering	lem Ana	gn/development of	.⊑ ∺		engineer atv	Environment Sustainability	S	Individual &	Communication	Project Mgt.	Long Le	<u>-</u>	-2	က္
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Problem	Design	Conduct	Modern	The (Envir Sust	Ethics	ndiy	Com	Proje	ife l	PS0-1	PSO-2	PSO.
CO-1:	describe the various ap	p <mark>plication</mark> s and architectures of IIoT.	3	-	-		1	-	_	_	7	-	-	_	-	-	3
CO-2:	apply the knowledge of	Al and data analysis in the IIoT domain.	3	-		L-1	1	-	-	-	-	-	-		-	-	3
CO-3:	familiarize with the con	c <mark>epts of D</mark> igital Twin Technology.	3	125	- 5		1	-	-	<i>-</i>	-	H -	-	-	-	-	3
CO-4:	explain the fundamenta	al elements and integration of Cyber-Physical Systems.	3	-	-	-	1	_	1	-	-	-	-	-	-	-	3
CO-5:	describe the various m	an <mark>ufacturin</mark> g techniques and processes used in the I4.0.	3	-	-	-	1	7-	٦.	-	1	-	-	-	-	-	3

Unit-1: Industrial Internet of Things (IIoT) in Manufacturing

10 Hours

Introduction to IIoT and its role in digital manufacturing - IIoT architectures and layers - Popular communication protocols - IIoT applications in various manufacturing domains (case study)- Industrial Ethernet Networks, types of Ethernet networks (e.g. PROFINET, EtherNet/IP, Modbus TCP), Ethernet network design and implementation considerations, Ethernet network communication protocols and standards (e.g. TCP/IP, UDP, Ethernet/IP) - IIoT Data Communications, protocols (e.g. OPC UA, MQTT, CoAP), Data transfer methods (e.g. Request/Response, Publish/Subscribe), Security considerations in IIoT data communications

Unit-2: Data Analytics and Artificial Intelligence in Manufacturing

9 Hours

Data collection and management - data collection methods used in IIoT, including sensors, gateways, and other devices - storage and managing large amounts of data - Data preprocessing, managing missing data, outliers, and other anomalies (Use of AI tools) - Descriptive analytics, summarizing and visualizing data, including statistical methods, charts, and graphs – Predictive analytics: regression analysis, time-series analysis, and machine learning algorithms - Prescriptive analytics: optimization algorithms and decision trees.

Unit-3: Digital Twin Technology

9 Hours

Concept and principles of digital twin in manufacturing, Digital twin development-software tools used - integration with physical systems-case study

Unit-4: Introduction to Cyber-Physical Systems (CPS)

9 Hours

Definition of CPS - Physical components- sensors and actuators, Computational and Communication Elements, Integration and Control- Data Acquisition, Data Analysis, network and security

9 Hours

Unit-5: Manufacturing Techniques and Automation
Robotics and Automation in Manufacturing, Additive Manufacturing and 3D Printing, Manufacturing Process Optimization

2016	
Learning 2 Weidong Li Yuchen Liang Sheng Wang " Data Driven Smart	# H
Resources Manufacturing Technologies and Applications", Springer; 1st ed. 3. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press;	

- Anand Nayyar and Akshi Kumar, "A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development", Springer, 2020. https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols Aboul Ella Hassanien, Ashraf Darwish, Vaclav Snasel, "Digital Twins for Digital Transformation: Innovation in Industry", Springer, 2022.

earning Assessm	nent	A) /		344.			
	Bloom's Level o <mark>f Thinkin</mark> g						
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	AND SHOP I	10%		15%	-
Level 2	Understand	25%		20%		25%	-
Level 3	Apply	30%	1 1 1 1 1 1	30%		30%	-
Level 4	Analyze	30%	Add the second	30%	7 -	30%	-
Level 5	Evaluate	- E-27 -	1000	10%	- 780 - 1		-
Level 6	Create	- 4.0	37 S. L. 200	1	-		-
	Total	10	00 %	100	0 %		100 %

Course Designers	1 V	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr. P. Karthikeyan, MIT, Anna University pkarthikeyan@annauniv.edu	1. Dr. G. Murali, SRMIST
2. Mr. Ganesh Ram, Tunga Systems	2.Dr. R. Thiyagarajan, IIT Tirupati thiyagu@iittp.ac.in	2. Dr. R. Ranjith Pillai, SRMIST

Course Code	21MHE467J	Course Name	SENSORS AND AC	TUATORS FOR IOT	Course Category	Е	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
Pre-requis		Nil	Co- requisite Courses	Nil	Progre Cour		Nil				
Course O	ffering Departm	ent	Mechatroni <mark>cs Engineering</mark>	Data Book / Codes / Stand	lards	4	Nil				
				()) ·							

Course L	earning Rationale (CLR):	The purpose of learning this course is to:			7	0	Progr	am Oı	utcom	es (PC	D)				S	ogran pecific tcome	С
CLR-1:	explore the sensors, act	uators, <mark>and their</mark> integration in IoT.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	CLR-2: acquire knowledge in the field of sensors used in IoT and its technical interpretation.				of	s of	P	ciety			Work		a)				
CLR-3:	acquire knowledge in the	e fi <mark>eld of act</mark> uators used in IoT and their integration into IoT systems.	Knowledge	l.		ation	ge	So			J WC		inance	<u>g</u>			
CLR-4:				Analysis	opu	stig	Usa	and	જ ્		Feam	.u o	& Fir	aming			
CLR-5:	explore various applicat	i <mark>ons of se</mark> nsor and actuator integration in IoT.	ering	Ana	sign/development	t investigations	Modern Tool Usage	engineer	Environment & Sustainability		ا ا ا	ommunication	Mgt.	Le			
			nginee	roblem	ign/	omplex	Jern	ence	iron	S	ndividual	n L	roject	Long	1-08		53
Course C	outcomes (CO):	At the end of this course, learners will be able to:	ЕLE	P	Des	2 2	Moc	The	Envir Susta	Ethi	<u>n</u>	Ö	Pro	Life	PS(PSO	PSO
CO-1:	describe the role of sens	sors and actuators in IoT.	3	P ,-4	25	1	1	-	-	-		-	-	-	-	-	3
CO-2:	describe various sensor	s used in IoT and their specifications.	3	-	2	- 53	1	-	-	-	-	-	-	-	-	-	3
CO-3:	CO-3: describe various actuators used in IoT and their specifications.		3	<u> </u>	2	17	1	- /		-		-	-	-	-	-	3
CO-4:	CO-4: apply the concept of data acquisition and data processing in IoT.		3	5-1	2	-	1	- 1	-	-	10-	-	-	-	-	-	3
CO-5:			3	-	3	-	1	_	N -	-	-	-	-	-	-	-	3

Unit-1: Introduction to Sensors and Actuators in IoT

12 Hours

Role of sensors and actuators in IoT application - Characteristics of a smart sensor - Selection of sensor and its important industrial interfaces - applications of actuators in IoT - Sensor and actuator integration for IoT

Exp 1: Study on specifications of smart sensor Exp 2:

Study of sensor interfaces

Unit-2: Sensor technologies and types for IoT

12 Hours

Sensor selection, Characteristics, and datasheet interpretation — Calibration and pre-processing — Types of sensors popular for a specific application (industrial process, healthcare, home automation, vehicle safety and networking, biomedical, etc.): environmental — (humidity, temperature, light, gas etc.), proximity, motion, position, biometric, IMU, used in Biomedical applications, wearable sensors.

Exp 3: Sensor interface and calibration

Exp 4: Real time sensor data acquisition and transmission.

Unit-3: Actuator Technologies and Application

12 Hours

Types of actuators- motor, relays, valves - selection criteria - Integration of actuator with IoT systems - control of actuators - application: robotics & automation, smart doors, smart lighting, etc.

Exp 5: Actuator drive and control.

Exp 6: Sensor actuator integration and control.

Unit-4: Sensor data acquisition and processing

12 Hours

Acquisition methods – Acquisition hardware and selection criteria- consideration to acquire series of data from multiple sensors -pre-processing - signal conditioning and filtering – concept

of fusion algorithms- example of data acquisition (for multiple sensors) with hardware with real-time application. Exp 7: Sensor processing and visualization in IoT dashboard.

Exp 8: Data analytics and decision-making .

Unit-5: Case Study and Practical Application

12 Hours

Home automation: Smart lighting systems – Automotive management systems: Power train sensor, chassis management, vehicle convenience and security systems – Wearable sensors

Exp 9: Home automation. Exp 10:

Factory automation .

Learning
Resources

- Jacob Fraden, "Handbook of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
- Maurizio Di Paolo Emilio, "Data Acquisition Systems- Fundamentals to Applied Design", Springer, 2013.
- 3. Data Acquisition Toolbox User's Guide, MathWorks, 2016

- Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" 2011, 1st ed., John Wiley & Sons, New Jersey.
- Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, 1st Edition, Academic Press, Cambridge.
- 6. Prof. Satish Jain , Shashi Singh , "Internet of Things and its Applications: Made simple, BPB Publications; 1st edition , 2020.

Learning Assessm	nent	A SHANNING	And the second	aug 及りを第一。					
		Fig. 12	Continuous Learning	Sumn	nativo				
	Bloom's Level of Thinking	Forma CLA-1 Averag (45)	e of unit test	CLA-2-	Learning Practice 5%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	- 1	-	15%	15%	-		
Level 2	Understand	25%	- 3 () 1/4	-	20%	25%	-		
Level 3	Apply	30%	- /3///	-	25%	30%	=		
Level 4	Analyze	30%			25%	30%	-		
Level 5	Evaluate				10%	-	-		
Level 6	Create	747 54	RN-ID	Di n'as any	5%	-	=		
	Total	100	%	10	0 %	100) %		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Mohammed Sagheer, ZF commercial vehicle control	1. Dr. P. Karthikeyan, MIT, Anna University	1. Dr. R. Ranjith Pillai, SRMIST
systems Pvt. Ltd	pkarthikeyan@annauniv.edu	
2. Mr. Ganesh Ram, Tunga Systems	2. Dr. R. Thiyagarajan, IIT Tirupati thiyagu@iittp.ac.in	2. Dr. S Vasanth, SRMIST

Course Code	21MHE468T	Course Name		COMMUN	NICATION	NETWORKS IN IoT			urse egory	E		P	ROFES	SSION	NAL EI	LECTI	VΕ	1 3	T 0	P 0	C 3
Pre-requi Course		Nil		Co- requisite		Nil	T.en	rogres			٠,,				Ni	I					
Course C	ffering Departn	nent	Mechatr	ronics <mark>Engineeri</mark>	ng	Data Book / Codes Standards	1	$E_{}$	4	1				Nil							
Course Le	earning Rationa	In		e of learning th	L0.1					7	Progr	am O	utcom	es (P	O)					ogra pecif	
CLR-1:	acquire knowle	dge of vario	us w <mark>irele</mark> s	<mark>s tec</mark> hnologies u	sed in IoT.	A THE LA	1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	explore the IoT	networks ar	nd <mark>commo</mark> i	n protocols.			ge		of	SI		-	7		ork		90				
CLR-3:	explore the IoT	network arc	c <mark>hite</mark> ct <mark>ure</mark> a	and the role of Id	T gateway	4.00	- Ne		ent	ation	ge			l l	Ņ		าลท	g			
CLR-4:	familiarize with	the concep <mark>t</mark>	t of data ma	anagement in Id	T.	11.74	- S	lysis	opu	stig	USa	and	∞		& Team Work	u	& Fii	Learning			
CLR-5:	explore the con	cept of clou	<mark>id com</mark> putir	ng and open-sou	ırce platfor	ms.	Engineering Knowledge	Problem Analysis	Design/development of	Conduct investigations	Modern Tool Usage	The engineer	Environment & Sustainability	S	Individual & T	Communication	Project Mgt. & Finance	Long Le	-	7	က
Course O	utcomes (CO):	A	t the end o	of this course,	learners w	ill be able to:	Figir	Probl	Design/d	Cond	Mode	The e	Envir	Ethics	Indivi	Comi	Proje	Life L	PS0-1	PS0-2	PSO-3
CO-1:	explain the vari				ues used in	IoT.	- 3	112-5	114	-77	1	-	-	-	-	<u> </u>	-	-	-	-	3
CO-2:	describe the po				14.15		3	- 25	-	1115	1	-	-	-	-	B -	-	-	-		3
CO-3:	familiarize the I				ept of IoT g	ateways.	3	-	2.5	1.	1	-	_	-	1	-	-	-	-	-	3
CO-4:	explain the con						3	1	-1		1	-	-	-	-		-	-	-	-	3
CO-5:	familiarize the o	concept of <mark>cl</mark>	ioua compi	uting and platfol	ms.		3	-	-	-	2	L		-	-	-	-	-	-	-	3
Unit-1: W	ireless Commur	ication Ted	<mark>chnolo</mark> gie:	s in IoT								7	۰							8 F	lour
						ket communication, Netwo	rks, TCP	-IP, su	bnettii	ng, IP\	/4 add	Iressir	ng, and	l chal <mark>l</mark>	enges). <mark>I</mark> PV6	addre	essing	-		
	of Wireless techn				gbee, NFC						_	4		_4						40.1	
	T-Specific Com				notuorko a	nd Low power, wide area n	not works	Annl	iootion	lover	tron	on ort	lovor	notu	ork lov	,or D	oto lin	le lave		10 F	lour
						rid Low power, wide area r. ribe modes, HTTP, COAP, .						sport	ayer –	netw	ork lay	rer – D	ala IIII	k layel	_		
	T Network Archi					ibe modes, III II , OOAI , .	Alvigi ai	ia gaic	,way p	701000	713	F	7	•	7					9 F	lour
Edge com	outing and fog co	mputing for	r distributed	d loT networks -	Hierarchic	al network architectures fo			nts - P	eer-to	-peer	(P2P)	and m	esh n	etwork	ing in	loT				
					, IPv6 and	IoT Addressing, OPC UA a	architectu	re.						e e						•	
	twork Protocol				in det :		laman le :	li a fuila : -	ن ما من	- 4 - uz -		14 a.f.			lala na ti	·				9 F	lour
	oud Computing					synchronization and consist ns	ency in d	IISTIIDU	iea sy	stems	- quai	ny of s	service	cons	ıueratı	ons				9 F	lour
						ssing, Integration of IoT dev	vices with	cloud	infras	tructui	e, Clo	ud-ba	sed an	alytics	s and o	decisio	n-mak	king in	loT		
	is – Cloud dashb					J,					,			,				J	-		

	 Industrial Wireless Sensor Networks: Applications, Protocols, and Standards (Industrial Electronics), Gerhard P. Hancke, V. Cagri Gungoer, CRC Press Inc., 1st edition, 2012.
Learning	1st edition, 2013 2. Ian F. Akvildiz, Mehmet Can Vuran, "Wireless Sensor Networks", 2011, 1st ed.,
Resources	John Wiley & Sons, New Jersey.
	3. Cloud Computing, Mehul Mahrishi Kamal Kant Hiran, Ruchi Doshi, Dr.
	Fagbola Temitayo, BPB, Publications; 1st edition, 2019

- Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: "Private Communication in a public World", PTR Prentice Hall, Second Edition, 2002.
 https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols

Learning Assessm	ent					•	
	Bloom's Level of T <mark>hinking</mark>	Level of Thinking (50%) (10%)					
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	Mark States	10%	A	15%	-
Level 2	Understand	25%	A STATE OF THE STATE OF	20%		25 %	-
Level 3	Apply	30%	500 15 1100	30%	A SAN SAN SAN SAN SAN SAN SAN SAN SAN SA	30%	-
Level 4	Analyze	30%	AME SECTION	30%		30%	-
Level 5	Evaluate	11-17/20	QB 799 B.	10%	7. 2		-
Level 6	Create	504 A	1.1 4.4 7. 0	4 1 3 3 3 3 3	- T		-
	Total	10	0 %	100	0 %	_ 1	00 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Guna Surendra, Hitachi, Japan	1. Dr. G Nagamanikandan, IIIT Hyderabad	1. Dr. R. Ranjith Pillai, SRMIST
2. Mr. Mohammed Sagheer, ZF comme <mark>rcial veh</mark> icle control	2. Dr. R. Thiyagarajan, IIT Tirupati	2. Ms. M. Nandhini <mark>, SRMIS</mark> T
systems Pvt. Ltd	thiyagu@iittp.ac.in	

Course Code	21MHE469J	Course Name	CYBER PHYSICAL S	SYSTEM DESIGN	Course Category	Е	PROFESSIONAL ELECTIVE	L T P 2 0 2	3
Pre-requisi Courses		Nil	Co- requisite Courses	Nil	Progres Cours		Nil		
Course Off	fering Departm	ent	Mechatronic <mark>s Engineering</mark>	Data Book / Codes / Standar	ds		Nil		

Course L	earning Rationale (CLR)	: The purpose of learning this course is to:						ograi										
CLR-1:	acquire knowledge in th	e domain <mark>of Cyber-</mark> Physical Systems and their basic elements.		1 2 3			4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	explore the modeling ar	nd cont <mark>rol techniq</mark> ues used in the design of CPS.	Ş	e OG		of IS			A.		,	추		ce				
CLR-3:	explore the techniques	and methods to implement the CPS for real application.	W			ge	-			≥		inanc	ing					
CLR-4:	acquire knowledge of th	ne s <mark>oftware t</mark> ools and security aspects in the implementation of CPS	3 - 5		alysis	lopr	velopment ivestigation	Usage	r and	∞ >		Team	ioi	& Fi	arnir			
CLR-5:	explore the various exa	mp <mark>les of C</mark> PS through case study.		6	₹	de ve	ë i	100 1	engineer etv	ment ability	١, ١	.∞ 	ommunication	Mgt.	g Le			
	1	2 2 2 3 3 3 m	! [6] . }	<u> </u>	plem	ign/de tions	Auct mple		dem dem e eng			Individual	III.		Long	7	7.	က္
Course O	utcomes (CO):	At the end of this course, learners will be able to:		<u></u>	Prop	Des	Con	Mod	The	Envi Sust	Ethic	Indi	Com	Project	Life	PS0-1	PSO-2	PSO-3
CO-1:	explain the elements ar	nd system-level understanding of CPS.	1.00	3	Ξ.	7.9	-,1	1	- 7	-	-	=	-	-	-	-	-	3
CO-2:	apply the modeling tech	<mark>nniques a</mark> nd the control in CPS.		3		- 2	-4	1	- 1	-	-	-	-	-	-	-	-	3
CO-3:	familiarize the tools and	methods in the implementation of CPS.		3	-	2		1	-	-	-	-	-	-	-	-	-	3
CO-4:	familiarize the software	tools and security in the implementation of CPS.	7 5 7 5	3		2		1	- 1	-	-		-	-	-	-	-	3
CO-5:	describe the case study	of CPS.		3	7.	3	-	1		-	-	-	-	-	-	-	-	3

Unit-1: Introduction to CPS

CPS: Motivational examples and compute platforms - Key design drivers and quality attributes of CPS - Overview of integrating physical components with computing and communication systems - physical systems (sensors and actuators) - Real-time sensing and communication for CPS - Real-time task scheduling for CPS - Examples of CPS applications in various domains such as smart grids, autonomous vehicles, and healthcare

Exp 1: Study on the key elements of CPS

Exp 2: Study of various sensor interfaces and actuator integration in CPS

Unit-2: Modelling, Simulation, and Control of CPS

12 Hour

Modeling techniques: Continuous systems modeling - Discrete time system modeling - Finite state machine - event modeling - Extended state machines - Hybrid system modeling - simulation tools - exercise on simulation – Analysis and Verification - Control of CPS- Examples for feedback control design, with logic specifications, Event-triggered control, Distributed control.

Exp 3: Mathematical modeling of CPS system -1

Exp 4: Physical modeling and control of CPS – 2

Unit-3: Design and implementation

12 Hour

Sensor and actuators interfacing and acquisition - data processing and filtering - network and interfaces - Embedded processors - Communication Protocols - Input/output interface - multitasking - task scheduling - time synchronization.

Exp 5: Sensor interface, data processing, and data registration.

Exp 6: Sensor- Actuator control integration – Specific application-based

Unit-4: Software, middleware platforms and Security in CPS

12 Hours

Introduction to various software tools for CPS design - Secure Deployment of CPS: Attack models, Secure task mapping and Partitioning, State estimation for attack detection — Security in Industrial control systems — Model-based method to detect attack on sensors - Review of graph theory-based models for security characterization and their limitations - Case study: Automotive hacking and smart grids

- Exp 7: Study of software tools in CPS for various system-level integration
- Exp 8: Study of security aspects and their considerations in CPS.

Unit-5: Case study on CPS

12 Hours

CPS case studies and tutorial, Automotive: ABS, Lane departure warning systems, Suspension control - Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker, Green Buildings: automated lighting, AC control.

- Exp 9: System level implementation Home automation
- Exp 10: System level implementation -Factory automation.

Learning
Learning Resources

- 1. "Embedded Systems Foundations of Cyber-Physical Systems", Peter Marwedel, Springer
- 2. Principles of Cyber-Physical Systems", Rajeev Alur, MIT Press
- 3. F. Pasqualetti, F. Dörfler and F. Bullo, "Attack Detection and Identification in Cyber Physical Systems," in IEEE Transactions on Automatic Control, vol. 58, no. 11, pp. 2715-2729, Nov. 2013.
- 4. F. Pasqualetti, F. Dörfler and F. Bullo "Control Theoretic methods for Cyber Physical Security", in IEEE Control System Magazine, pp. 110-127, Feb. 2015

Learning Assessn	nent			and the second section of		i i	
			Continuous Learnii	Sumi	mative		
	Bloom's Level <mark>of Think</mark> ing	CLA-1 Avera	native ge of unit test 5%)	CLA-2	ng Learning P- Practice 15%)	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice
Level 1	Remember	15%	-	- 15%		15%	-
Level 2	Understand	25%	- //	-	20%	25%	-
Level 3	Apply	30%	- ///	-	25%	30%	-
Level 4	Analyze	30%	- 400		25%	30%	-
Level 5	Evaluate	2.		7.5	10%		-
Level 6	Level 6 Create		7 by CADA T		5%	-	-
	Total		0%	$CAP \cdot IE1$	00 %		0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohammed Sagheer, ZF commercial vehicle control	1.Dr. P. Karthikeyan, MIT, Anna University	1. Dr. R. Ranjith Pillai, SRMIST
systems Pvt. Ltd	pkarthikeyan@annauniv.edu	
2. Mr. Ganesh Ram, Tunga Systems	2. Dr. R. Thiyagarajan, IIT Tirupati thiyagu@iittp.ac.in	2. Dr. S Vasanth, SRMIST

Course Code	21MHE470T	Course Name	CLOUD COMPUTING, BIG D	ATA ANALYTICS AND SECURITY	Course Category	Е	PROFESSIONAL ELECTIVE	L 3	P 0	C 3
Pre-req Cour		Nil	Co- requisite Courses	Nil	Progressive Courses	٠.,	Nil			
Course Offering Department		nent	Mechatronic <mark>s Engineering</mark>	Data Book / Codes / Standards	17' 2		Nil			

Course L (CLR):	earning Rationale	The purpose of learning this course is to:			Y	1	Progr	am O	utcom	es (Po)					ogra pecifi	
CLR-1:	gain an understanding o	f the co <mark>ntemporar</mark> y landscape of IT infrastructure and services.	1	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	offer a comprehensive s	tudy o <mark>f cloud c</mark> omputing covering diverse technologies &platforms					7	5	ility								
CLR-3:	technologies, and batch	ntal <mark>s of big d</mark> ata analytics, including data preprocessing, storage vs. real-time processing.	edge	Tee.	int of	ions of	Φ	society	Sustainability		Work		Finance	_			
CLR-4:		pi <mark>cs in big</mark> data analytics, including data mining, machine learning, and ur <mark>al langu</mark> age processing and social media analysis.	Knowledge	Analysis	n/development	investigations problems	Tool Usage	and	∞ర		Team	tion	∞ర	earning			
CLR-5:	explore essential securit	y components in both cloud computing and big data environments.	ering	ing		75 ×	- L	engineer	Environment		lal &	Communication	Project Mgt.	Ĭ			
			le l	<u>e</u>	B.i	킁음	er	e e	ē	တ္သ	₫.	Ē	ect	Long	-1	-2	-3
Course O	outcomes (CO):	At the end of this course, learners will be able to:	Eng	Problem	Des	Conduct	Modern	욛	Ē	Ethics	Individual	Son	Proj	Life	PSO-1	PS0-2	PSO.
CO-1:	analyze and design clou security, scalability, and	od solutions, considering service and deployment models, addressing virtualization.		-3	in		-	-	-	-		-	-	-	-	1	3
CO-2:	empower with cloud con	nputing for effective cloud-based solution design and management.	-	-	3	2	-	- /	-	-		-	-	-		-	3
CO-3:	familiarize in big data an	d analytics for effective large dataset analysis and insights.	- 3-	2	T-	-	-	- 1		-	-	-	-	-	-	-	3
CO-4:		il <mark>ls in big</mark> data analytics, enabling effective application of machine	1	2	-	-	7	Ý	7	7		-	-	-	-	-	3
CO-5:	implement robust securi threat mitigation in mode	ity <mark>measure</mark> s in cloud and big data environments for data protection and ern I <mark>T landsc</mark> apes.	1	-	2	-	/-	7	-	7-:		-	-	-	-	-	3

Unit-1: Introduction to Cloud Computing and Virtualization

Cloud computing concepts and Architecture-Cloud Service models (SaaS, PaaS, IaaS)-Cloud deployment Models (Public, Private, Hybrid)-Cloud Security and Privacy Considerations-Virtual Machines and Hypervisors-Containerization (Docker, Kubernetes)-Cloud Storage and Networking-Scalability and Elasticity in Cloud Environments)

Unit-2: Cloud Computing Technologies and Platforms

10 hours

Cloud Storage Technologies: Object Storage, Block Storage and Content Delivery Networks (CDNs)- Cloud Computing Platforms: AWS, Microsoft Azure, Google Cloud Platform, and IBM Cloud-Serverless Computing: Function as a Service (FaaS) and Microservices Architecture4daw-Cloud Application Development: DevOps, Containers, and Continuous Integration/Continuous Deployment (CI/CD)-Cloud Orchestration and Management: Kubernetes, OpenStack, and CloudStack)

Unit-3: Big Data Fundamentals and Data Analytics

9 hours

Introduction to Big Data Analytics: Definition, Characteristics and Data Sources-Data Preprocessing: Data Cleaning, Transformation and Integration-Big Data Storage Technologies: Hadoop Distributed File System (HDFS)-NoSQL Databases- Batch Processing vs. Real-time Stream Processing-Big Data Visualization and Tools: Tableau, Power BI, and Apache Superset:

Unit-4: Big Data Analytics Techniques and Tools

9 hours

Introduction to Data Mining and Machine Learning-Supervised Learning: Classification and Regression-Unsupervised Learning: Clustering and Dimensionality Reduction-Big Data Analytics for Natural Language Processing (NLP)-Big Data Analytics for Social Media Data and Graph Analysis

Unit-5: Security in Cloud Computing and Big Data

9 hours

Cloud Security: Data Encryption, Access Control, and Identity Management-Securing Cloud Applications and APIs: OAuth, OpenID Connect, and JWT-Big Data Security: Privacy-Preserving Techniques and Anonymization-Threat Detection and Incident Response in Cloud and Big Data Environments-Compliance, Governance, and Legal Issues in Cloud Computing and Big Data

Learning
Learning Resources

- John W. Rittinghouse, <u>James F.</u> Ransome, "Cloud Computing Implementation, Management and Security", CRC Press, 2010.
- Syed Thouheed Ahmed, Syed Muzamil Basha, Sajeev Ram Arumugam, Kiran Kumar Patil, "Big Data Analytics & Cloud Computing", Milestone Research Publications, 2021.
- 3. Mostapha Zbakh, Mohammed Essaaidi, Pierre Manneback. Chunming Rong, "Cloud Computing and Big Data: Technologies, Applications and Security", Springer, 2019.
- 4. Renu Yadav, "Big Data Analytics tools and technologies used in cloud environment", IJCRT, 2022.

Learning Assessm	nent	4 / 6		1 J. A. 12		•	
	Bloom's Leve <mark>l of Thin</mark> king	CLA-1 Avera	Continuous Learning mative age of unit test 50%)	CL	g Learning A-2 0%)	Final Ex	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	The state of the state of	10%	9	15%	-
Level 2	Understan <mark>d</mark>	25%	The second of the second	20%		25%	-
Level 3	Apply	30%		30%		30%	-
Level 4	Analyze	30%	D7 - N/7	30%	- 6	30%	-
Level 5	Evaluate	/, -	- 1	10%			-
Level 6	Create	-	- 11/1/	-	7 - 7	-	-
	Tot <mark>al</mark>	10	00 %	10	0 %	10	0 %

Course Designers	Comment of the commen	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. R. J. Swathy, Lead Consultant, HCLTech	1. Dr. Tamilarasi K, Assistant Professor, VIT	1. M <mark>s. M. Nand</mark> hini, SRMIST
2. Mr. K. Suresh, Software Engineer, Accenture	2. Dr. G Nagamanikandan, IIIT Hyderabad	2. Dr. Ranjith Pillai R, SRMIST

Course Code	21MHE471J	Course Name	X- REALITY FOR I	NDUSTRY 4.0	Course Category	E	PROFESSIONAL ELECTIV	VE _	L T	P 2	C 3
Pre-requis Courses		Nil	Co- requisite Courses	Nil	Progres Cours		Nil				
Course Of	ffering Departme	ent	Mechatronic <mark>s Engineeri</mark> ng	Data Book / Codes / Stand	lards	4	Nil				
					***	L				rogr	om

Course L	earning Rationale (CLR): The purpose of learning this course is to:	Program Outcomes (PO)										Progra Specif Outcom				
CLR-1:	Gain knowledge on Immersive Technologies	1 2 3 4 5 6 7 8 9 10 11 12					12			ĺ						
CLR-2:	Familiarize the fundamentals of Virtual Reality	ge		of	s of	7	ociety	١.		Work		е				
CLR-3:	Familiarize the fundamentals of Augmented and Mixed Reality	vled			ation s	sage	S		. 1			Finance	g			
CLR-4:	Explore the various applic <mark>ations of</mark> X Reality in I4.0	Knowledge	Analysis	opm	vestigations oblems	Usa	and.	ૐ ્		Feam	u	& Fir	aming			
CLR-5:	Explore the various appli <mark>cations of X Reality in smart factories</mark>	ngineering		sign/development utions	will 런 은		engineer	Environment 8 Sustainability		ual &	ommunication	t Mgt.	ong Le			_
Course C	outcomes (CO): At the end of this course, learners will be able to:	Engine	Problem	Design/o	Condu	Modern	The er	Enviro Sustai	Ethics	Individual	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Familiarize with the Immersive Technology	2	0.46	44	1	-	-	-	-		-	-	-	-	-	3
CO-2:	Describe the fundamentals of Virtual Reality	2	-	2	- 41	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Describe the fundamentals of Augmented and Mixed Reality	3	-	2	1-5	-			-	-	-	-	-	-	-	3
CO-4:	Learn the applications of X Reality in general	3	5-1	2	-	-	- 1	-	-	-	-	-	-	-	-	3
CO-5:	Learn the applications of X Reality in smart factories	3	-	2	-	-	_	-	-	-	-	-	-	-	-	3

Unit-1: Foundations of Immersive Technologies

12 Hour

History of Immersive technologies, Evolution and definitions, key concepts, General pipeline in XR, ideas of experience, Motivation, The Reality-Virtuality continuum, Examples for each category, VR AR/VR characteristics, start of the art in VR/AR/MR technologies, start of the art in VR/AR/MR technologies, Overview of the graphics pipeline

Unit-2 : Virtual Reality Stereo rendering, pose tracking: types and principles, navigation and controllers, VR Interfaces, VR Workflows, specifications of VR HMDs

12 Hour

Unit-3: Augmented and Mixed Reality

12 Hour

AR types, devices and techniques, specifications of AR devices, Holograms, Calibration, Object Recognition, Object tracking, Spatial mapping, scene understanding.

Unit-4: Nature of Applications of X-Reality

12 Hour

XR ecosystem: hardware and software components, XR for assembly and maintenance tasks, Quality control and inspection using AR, Remote assistance and expert guidance in MR, XR in technical training and skill development, Virtual prototyping in automotive engineering

Unit-5: Applications of X-Reality in Smart Factories

12 Hour

Integrating Design and Manufacturing, Training Shop floor Workers, Supporting complex Assembly Operations, Service and Maintenance, Supporting complex Sales solutions, Executive Oversight and Data Visualisation, Industry 5.0, Future prospectus

Learning Resources	2.	Syec
		Arun

- John W. Rittinghouse, James F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press, 2010.
- ed Thouheed Ahmed, Syed Muz<mark>amil Basha, Sajeev Ram</mark> Arumugam, Kiran Kumar Patil, "Big Data Analytics & Cloud Computing", Milestone Research Publications, 2021.
- Mostapha Zbakh, Mohammed Essaaidi, Pierre Manneback. Chunming Rong, "Cloud Computing and Big Data: Technologies, Applications and Security", Springer, 2019.
 Renu Yadav, "Big Data Analytics tools and technologies used in cloud
- environment", IJCRT, 2022.

earning Assessi	ment		Continuous Learning A	Assessment (CLA)		0			
	Bloom's Level of Think <mark>ing</mark>	CLA-1 Avera	mative age of unit test 15%)	Life-Long CLA-2-	y Learning Practice 5%)	Summative Final Examination (40% weightage)			
	/67	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	No. of the last	15%	15%	-		
Level 2	Understand	25%	A 11/2000 A 11/11/11	MARKET PRO	20%	25%	-		
Level 3	Apply	30%	3 (4) (2) (3) (3)	Day 16.8	25%	30%	-		
Level 4	Analyze	30%	A Property of	14 M. C.	25%	30%	-		
Level 5	Evaluate	- W	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	70 - 10 -	10%	0 -	-		
Level 6	Create		Carlot Company to 1888	Sec. 1 - 32.	5%	7 -	-		
	Total	10	00 %		0 %	100) %		

Course Designers	English Control of the Art of the Control of the	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sathyanarayanan, NIOT	1. Dr. P V Manivannan, IITM	1. Dr. R Senthilnathan, SRMIST
2. Mr. Jai Naresh , HP	2. Dr. P Karthikeyan, MIT Campus, Anna University	2. Dr. Ranjith Pillai R, SRM <mark>IST</mark>

Course Code	1MHE472J	Course Name	AI AND ROBOTICS IN SM	MART FACTORIES	Course Category	PROFESSIONAL ELECTIVE	L T P C 2 0 2 3
Pre-requisite Courses		Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offerin	ng Departme	ent	Mechatronics Engineering	Data Book / Codes / Standards	$\cup E_A$	Nil	

Course I (CLR):	_earning Rationale	The purpose of learning this course is to:				Z	Progr	am O	utcom	es (P	O)					rograi pecifi	
CLR-1:	get exposed to the role	of artific <mark>ial intellig</mark> ence and robotics in smart factories.	1	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	analyze the technical re	equire <mark>ments of</mark> various types of robots for smart factories.				of	4	ety			~						
CLR-3:	explore the applications	s of a <mark>rtificial in</mark> telligence techniques in smart factories.	edge	H.	nt of	ions	Ф	society			Work		ance				
CLR-4:	acquire knowledge of a factories.	uto <mark>mation t</mark> echniques and optimization strategies driven by AI in smar	Knowle	alysis	velopment	estigations blems	l Usage	r and	∞ >		Team	tion	& Fina	arning			
CLR-5:	realize the features of in	nt <mark>egrating</mark> artificial intelligence with IIoT systems.	ineering	oblem Ana	and/deve	uct inve	ern Tool	engineer	ronment	S	ndividual &	Communication	ct Mgt.	ong Le	-	7.	က္
Course (Outcomes (CO):	At the end of this course, learners will be able to:	Engir	Probl	Desig	Sond	Mode	The	Envir Susta	Ethics	Indivi	Comi	Project	Life L	PSO.	PSO.	PSO-(
CO-1:	articulate the role of art	ificial intelligence and robotics in smart factories.		3	17-1	-	1	-	-	-	-	-	-	-	-	-	2
CO-2:	describe the technical of	considerations of various types of robots used in smart factories.		3	- 1	- 4	1	-	L-	-	-	-	-	-	-	-	2
CO-3:	apply artificial intelligen	ce algorithms to tasks relevant to smart factories.	-	_	- 3	1.74	1	-	-	-	- 1	-	-	-	-	-	2
CO-4:	implement Al-enabled a	automation techniques and optimization strategies in smart factories.	7.3	, in	3	-	1	-	-	-		-	-	-	-	-	2
CO-5:	explain the features of i	int <mark>egrating</mark> artificial intelligence with IIoT systems.	-	3	-	-	1	_		-			_	-	-	_	2

Unit-1: Introduction to AI & Robotics in Smart Factories

12 Hour

Introduction to smart factories - Overview of technologies used in smart factories - Role of artificial intelligence and robotics - Technological requirements - Challenges - Applications of artificial intelligence and robotics in smart factories - Real-world smart factories - Examples.

Experiments: 1. Introduction to programming language and software platforms for implementing Al algorithms and robot control. 2. Implementation of basic machine learning algorithms.

Unit-2: Robots for Smart Factories

Industrial manipulators – Collaborative robots – Adaptive robots – Autonomous Guided Vehicles (AGV) – Autonomous Mobile Robots (AMR) – From AGV to AMR – Swarm robots – Technical considerations – Simultaneous Localization and Mapping (SLAM) – Real-world examples.

Experiments: 1. Implementation of part handling by a collaborative robot. 2. Implementation of control of an autonomous mobile robot.

Unit-3: Al Techniques for Smart Factories

12 Hour

Artificial intelligence in the context of smart factories – Fuzzy logic – Machine learning algorithms and their applications in smart factories – Learning paradigms – Neural networks – Deep Learning for computer vision tasks in smart factories – Object recognition and detection for quality control and assembly.

Experiments: 1. Implementation of fuzzy logic control for a smart factory application. 2. Implementation of a deep learning algorithm for object recognition and detection.

Unit-4: Al-Enabled Automation and Optimization in Smart Factories

12 Hours

Reinforcement learning for robot navigation, control, and optimization – Al in process control and automation – Al in condition monitoring and predictive maintenance – Intelligent scheduling and

resource allocation – Impacts of AI-enabled automation techniques and optimization strategies in smart factories.

Experiments: 1. Implementation of a reinforcement learning algorithm for mobile robot navigation and control. 2. Implementation of a machine learning algorithm for condition monitoring and predictive maintenance.

Unit-5: Al Integration in IIoT 12 Hours

Integration of AI with IIoT systems – Advantages of AI integrated IIoT in smart factories – Data collection, analysis, and decision-making in smart factories – Real-time monitoring and optimization of manufacturing processes – Example.

Experiments: 1. Data collection and analysis from IIoT system. 2. Implementation of Al-driven process control on IIoT system.

	1.	Alasdair Gilch <mark>rist, "Indust</mark> ry 4.0: The Industrial Internet of Things",	3. Dominik T. Matt, Vladimir Modrak and Helmut Zsifkovits, "Implementing Industry
Learning		Apress, 201 <mark>6.</mark>	4.0 in SMEs: Concepts, Examples and Applications", Palgrave Macmillan, 2021.
Resources	2.	Souvik Pal, Debashis De and Rajkumar Buyya, "Artificial Intelligence-	4. 4. Anand Nayyar and Akshi Kum <mark>ar, "A Roa</mark> dmap to Industry 4.0: Smart Production,
		based In <mark>ternet of</mark> Things Systems", Springer, 2022.	Sharp Business and Sustainable Development", Springer, 2020.

Learning Assessn	nent		A \$1.00 (10)	2.844.33			
	. / 2	7 / 21	Continuous Learnin	g Assessment (CLA)		Sumi	native
	Bloom's Level of Thinking	CLA-1 Averag	ative ge of unit test %)	CLA-2-	g Learning Practice 5%)	Final Ex	native amination eightage)
		Theory	Practice	Theory	- Practice -	<u>Theo</u> ry	Practice
Level 1	Remember	15%	W 200 MV	 But 80 (34) x 	15%	15%	-
Level 2	Understan <mark>d</mark>	25%	17 F F F F F F F F F F F F F F F F F F F		20%	25%	-
Level 3	Apply	30%	1	professional profe	25%	30%	-
Level 4	Analyze	30%			25%	30%	-
Level 5	Evaluate			A selection of	10%		-
Level 6	Create		W - 1077	-	5%		-
	T <mark>otal </mark>	100	0 %	10	00 %	10	0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Guna Surendra, Hitachi, Japan	1. Dr. P. Karthikeyan, MIT, Anna University	1. Mrs. G. <mark>Madhumit</mark> ha, SRMIST
	pkarthikeyan@annauniv.edu	3D - 3D
2. Mr. Elayraj Jayaraj, Apple, USA	2. Dr. R. Thiyagarajan, IIT Tirupati	2. Dr <mark>. R. Ranjith</mark> Pillai, SRMIST
	thiyaqu@iittp.ac.in	

Course	21MHE473J	Course	DATA MODELING AND SIMULATION	Course	 PROFESSIONAL ELECTIVE	L	Т	Р	С
Code	Z 11VII 1E4733	Name	DATA MODELING AND SIMULATION	Category	 PROFESSIONAL ELECTIVE	2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L (CLR):	earning Rationale	The purpose of learning this course is to:			V	V	rogr	am Oı	utcom	es (P	0)					ograr ecifi	
CLR-1:	explore the various app	lications o <mark>f modelin</mark> g and simulation in IoT.	1	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	acquire knowledge of th	ne popu <mark>lar data m</mark> odeling techniques.	ge		of	S	7	×	1		Work		æ				
CLR-3:	explore the simulation t	echni <mark>ques in t</mark> he data analytics used in IoT.	Knowledge	(0	ent	stigations oblems	age	70					nanc	βL			
CLR-4:	acquire knowledge of th	ne v <mark>arious pe</mark> rformance measures used in the prediction algorithms.	Ϋ́	alysis	velopment		ol Usa	r and	∞ _		Team	<u>.</u>	⊗ E	amir			
CLR-5:	explore the AI technique	es <mark>used in t</mark> he data modeling and analytics.	ring	₽	(D)	inve	Tool	engineer etv	ironment a	١	<u>∞</u>	ommunication	Mgt.	ng Le			
l .	1	27 A 3 100	inee	Problem	ign/de	duc	lern	eng	ronr	SS	Individual	III.	roject I	P	7	-2	<u>ج</u>
Course C	outcomes (CO):	At the end of this course, learners will be able to:	Engi	Pro	Des	o d	Mod	The	Sus	Ethics	Indiv	Con	Proj	Life	PSO	PSO	PSO-
CO-1:	describe the application	of data modeling and simulation in IoT.	3	-	Ú.	4	1	-	-		-	_	-	-	-	-	2
CO-2:	apply the data modeling	g techniques in IoT applications.	3	12	2	h -	. 1	_	-		- 1		-	-	-	-	2
CO-3:	familiarize the simulation	<mark>n tools a</mark> nd methods in IoT data analytics.	3	1 -	2	165	1	-	-	-	- 1	1 -	-	-	-		2
CO-4:	familiarize the performa	nnce measure and optimization tools in IoT data analytics applications.	3		2	1.14	1	-	-	-	-	-	-	-	-	-	2
CO-5:	apply the concept of ma	achine learning in data analysis and prediction.	-3	100	-3		1	_	-	-	_	_	_	-	_	-	2

Unit-1: Application of data modeling and simulation in IoT

12 Hour

Importance of data modeling and simulation in I4.0 - Data collection and management - Data preprocessing – Understanding behavior, performance, and optimization of IoT systems - data modeling and simulation for better analysis and prediction. Exp 1: Study on the application of data modeling and simulation. Exp 2: Organize and explore system data

Unit-2: Data modelling techniques

12 Hour

Data modeling concepts and principles - time series data modeling- data aggregation, interpolation, and forecasting - data integration and fusion - Descriptive analytics, summarizing and visualizing data, including statistical methods, charts, and graphs - Predictive analytics, regression analysis, time-series analysis - Prescriptive analytics, optimization algorithms, and decision trees.

Exp 3: Preparing time series data (Signal pre-processing and filtering) Exp 4: Application of analytics: Descriptive/ Prescriptive / Predictive.

Unit-3: Simulation Techniques

12 Hour

Network behavior, sensor interactions, data flows, simulation of sensor data streams and event-driven scenarios, validation of data against the real world.

Exp 5: Sensor data simulation and validation

Exp 6: Predictive modeling and output simulation

Unit-4: Performance Evaluation and Optimization

12 Hour

Data Collection and processing time - Data Throughput and bandwidth - Latency, Response time, Security performance - Optimization: Edge computing, Data filtering and aggregation -Performance considerations for Predictive analytics and maintenance.

Exp 7: Study of various performance measures in data modeling.

Exp 8: Study of performance measure and optimization in predictive analytics.

Unit-5: Emerging Trends and Future 12 Hour

Data modeling and analytics using machine learning and Al-driven simulations - Supervised learning, generative algorithms, Support Vector machines, Unsupervised learning, K means clustering, Expectation maximization - integration of data modeling with edge computing and cloud platforms.

Exp 9: Al tools for data generation and modeling.
Exp 10: Data classification and prediction using machine learning methods.

	1.	Internet of things <mark>and data an</mark> alytics handbook, Hwaiyu Ge, John	3.	Thomas A. Runkler, "Data Analytics: Models and Algorithms for Intelligent Data
Learning		Wiley & Sons, 2017		Analysis", 2016, 2nd ed., Sp <mark>ringer Verla</mark> g, UK
Resources	2.	Matlab for <mark>da</mark> ta analysis:	4.	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective" 2012, 1st ed.,
		https://in.m <mark>athworks</mark> .com/products/matlab/data-analysis.html	Page .	MIT Press, USA.
			12.80	

earning Assessı	ment		Continuous Learnin	g Assessment (CLA)		Cum	motivo
	Blo <mark>om's</mark> Level <mark>of Thinki</mark> ng	CLA-1 Avera	native nge of unit test 5%)		g Learning Practice 5%)	Final Exa	native amination eightage)
	1 6 6	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice
Level 1	Remember	15%		THE RESERVE OF	15%	15%	-
Level 2	Understan <mark>d</mark>	25%	The State of the	· 西瓜 数12条法	20%	25 %	-
Level 3	Apply	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	7 7 7 10	25%	30%	-
Level 4	Analyze	30%	The same and the	P 12 2 2 2 2 2 2	25%	30%	-
Level 5	Evaluate	777		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10%		-
Level 6	Create		11.		5%		-
	Total	10	0 %	10	00 %	10	0 %

Course Designers	人 人	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohammed Sagheer, ZF commercial vehicle	1.Dr. P. Karthikeyan, MIT, Anna University	1. Dr. R. Ranji <mark>th Pillai,</mark> SRMIST
control systems Pvt. Ltd	pkarthikeyan@annauniv.edu	
2. Mr. Ganesh Ram, Tunga Systems	2. Dr. R. Thiyagarajan, IIT Tirupati thiyagu@iittp.ac.in	2. Dr. S <mark>Vasanth, S</mark> RMIST

Course 21MHE474T Course	FOUNDATIONS OF SYSTEMS ENGINEERING	Course	F	PROFESSIONAL ELECTIVE	L	T	Р	С
Code Name	TOUNDATIONS OF STOTEMS ENGINEERING	Category		THOI EGGIONAL ELECTIVE	3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	NII I	rogressive Courses	Nil	
Course Offering D	Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil	
			The second of the second of the second			

Course Louise (CLR):	earning Rationale	The purpose of learning this course is to:		Program Outcomes (PO)									Pr				
CLR-1:	introduce systems engineering systems	neering concepts for solving the problems in developing complex	1	2	3	4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	R-2: acquire knowledge in the domain of data management and processing in IoT.			S	nen		Usage	þ		N	Е			рu			
CLR-3:	CLR-3: familiarize the various modeling approaches and methodologies			alysis	velopmen ns	s of	I Us	r and	۲ × ۷ ×		Team	tion	∞	arni			
CLR-4:	CLR-4: analyze stakeholders' expectations using stakeholders value network			F	deve	t ations	Tool	engineer	ment ability		∞ర	ommunication	Mgt.	ıg Le			
			ě ě	roblem	/ug ng	nduc estig	em	eu à	ain		je v	JUL.	ject	Lon	-1	-7	5-3
Course O	utcomes (CO):	At the end of this course, learners will be able to:	Eng.	Prob	Desi t of s	Con	Modern	The	Envi	Ethic	Individual Work	Con	Proje Fina	Life	PSO-	PSO.	PSO
CO-1:	familiarize the systems	engineering concepts for solving the problems in developing complex	3			1	2	-		-	-	- 1	-	-	-	-	3
CO-2: develop various models for systems using Sys ML		3	, -x	return		2	-			-	<u>.</u>	-	-	-	-	3	
CO-3: analyze stakeholders' expectations using stakeholders value network		3	227	1.42	4	2	-	-	-	-	4-	-	-	-	-	3	
CO-4:			3	-	-		2	-	-	-	-	1	-	-	-	-	3
CO-5:	use verification and val	i <mark>dation te</mark> chniques to evaluate the system design	3	-		100	2	_	-	L -	-		-	-	-	-	3

Unit-1: Introduction to Systems Engineering

9 hour

Definitions and concepts of system-system science and systems engineering, life cycle stages, definitions of requirement, architecture, design. System analysis, interface management, system integration, system verification, system transition, system validation, system operation, system maintenance, system disposal. Project planning, project management and control, decision management, risk management, configuration.

Unit-2: Introduction to MBSE and SysML Overview

9 hour

Introduction to MBSE-MBSE concepts- MB<mark>SE Onto</mark>logy-Introduction to Object Process modelling OPM- Object process language-Overview of SysML-Block definition diagrams-Internal block diagrams-Use case diagrams-Activity diagrams-Sequence diagrams-State machine diagrams-Parametric diagrams-Requirements diagram-package diagrams-Operational analysis modeling-functional analysis modeling-logical architecture modeling-Physical architecture modeling-architecture frameworks.

Unit-3: Stakeholder Analysis and Requirements Definition

9 hour

Stakeholder's identification, Concept of operations, Stakeholders value network analysis, Requirements: Purpose, Types, challenges, allocation and verification and validation and Volatility.

Systems Requirements Review (SRR).

Unit-4: System Design and Architecture

9 hour

Architecture definition, architecture viewpoints, concept analysis, models and views of architecture (functional/behavioral/data/performance etc.) – Structure and behavior- Evaluating candidate architectures- System/subsystem analysis- tradeoff analysis- Architecture frameworks and standards-design progression-architecture domains (software/IT/ Manufacturing/social etc)-architecture heuristics- focus on specialty areas (eg.. EMI/EMC)-test automation models (computation/timed automation)- simulation-model checking verification

Unit-5: Systems Integration and Testing

9 hour

System verification-System validation-various approaches to system validation and verification-inspection/testing/analysis/demonstration-Generation of Test cases using the Markov Chain model-Writing verification/validation plans-introduction to formal methods-formal approaches to system validation and verification- Ensuring System Functionality and Performance

1.	National Aeronautics and Space Administration, "NASA	4.	"SysML distilled: A brief guide to the Systems modeling language". Lenny
	Systems Engineering Handbook", (Rev 1, Dec 2007).	100	Deligatti- Addison Wesley Professional, Ed 1, 2013
2.	INCOSE, "Systems Engineering Handbook"	5.	Rechtin, E., and M.W.Maier, "The art of Systems architecting", Boca Raton,
3.		1.7	FL: CRCPress, 2000
		6.	Engel, Avner, "Verification, Validation and Testing of Engineered Systems; John
			Wiley &Sons, 2010.
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	1. 2. 3.	Systems Engineering Handbook", (Rev 1, Dec 2007). 2. INCOSE, "Systems Engineering Handbook"	Systems Engineering Handbook", (Rev 1, Dec 2007). 2. INCOSE, "Systems Engineering Handbook" 3. Kossiakof, Alexander and William N. Sweet; "Systems Engineering:

earning Assessm	nent	- C Y /					
	Bloom's Level of <mark>Thinking</mark>	CLA-1 Avera	Continuous Learning native ge of unit test 9%)	CL	J Learning A-2 0%)	Final	ummative Examination 6 weightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	Selection of the select	15%	A SACAL TO	15%	-
Level 2	<i>Understand</i>	25%	State of the	20%	No. of the last	25%	-
Level 3	Apply	30%	The Property	25%	7 4	30%	-
Level 4	Analyze	30%	100	25%	- T	30%	-
Level 5	Evaluate	147. As.		10%			-
Level 6	Create	A 1 5-7" TO	4.70	5%			-
	Total	10	0 %	10	0 %		100 %

Course Designers	- AL	1.7		
Experts from Industry	Experts from High	her Technical Institutions	Internal Experts	
1. Mr.Gaurav Dubey, Mathworks, India	1. Dr.P.Karthikeyan pkarthikeyan@anna	n, MIT Campus, Anna University, nauniv.edu	1. Dr.K Sivanatha <mark>n, SRMI</mark> ST	
2. Dr. Yogananda Jeppu, Honeywell, India	2. Dr.Thiyagarajan, thiyagu@iittp.ac.in	, Indian Institute of Technology Tirupati,	2. Dr.T.Muthuramalingam , SRMIST	

Course Code	21MHE475J Cor Na	TECTURE AND DESIGN	Cours		E		F	PROFI	ESSIO	NAL E	ELECT	TIVE		<u>L</u>	T 0	P 2	C 3		
Pre-requis			Co- requisite Courses	Nil		ogres Cours							Nil						
Course O	ffering Department	Мес	chatronics E <mark>ngineering</mark>	Data Book / Codes / Stan	dards	7		7				Nil							
Course Le	earning Rationale (CI	R): The nu	urpose of learning this o	course is to:		-	1	7.	Progr	am O	utcom	es (P(<u>)</u>				Pro	ogran	n
CLR-1:	introduce about syste			U''	1	2	3	4	5	6	7	8	9	10	11	12		ecific	
CLR-2:	acquire knowledge of	the popula	r data modeling techniqu	es.						Ŋ.			-		4		Ou	COIIIC	;3
CLR-3:			of architecture modelling		ledg		ant o	tions ms	e e	1		. *	Wo		& Finance				
CLR-4:	analyze about system			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- Nou	/sis	bmd	tiga	Jsac	and	∞ర		eam	Ę	i.	rning			
CLR-5:	apply reusable structu			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- B	Inal	svelc	nves x pr	1 100	eer	ent &		~>	catic	gt. &	Lea			
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Course O	utcomes (CO):	At the	end of this course, lear	rners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and	Environment & Sustainability	Ethics	ndividual & Team Work	Communication	Project Mgt.	ife Long Learning	PSO-1	PS0-2	PSO-3
CO-1:	` '			or solving the engineering problem		Д	2	O o	2	- <i>0</i>	ыш о	Ш		O				<u>а</u>	3
CO-2:	develop the key conc				3	85	2		2			7							3
CO-3:	analyze the needs of	st <mark>ack</mark> h <mark>old</mark> e	ers		3		2		2										3
CO-4:	develop design patter			Contact the second	3	4			2		L								3
CO-5:	use trade-off analysis	a <mark>nd decis</mark> i	on making in sy <mark>stem d</mark> esi	ign	3			1 14	2										3
				3 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	43						X								
Unit-1: Int	roduction about Syst	em Archit	ecture and Design	1000	-						+=							12 H	ur
				faces, Procedures for System desi	an. Types	of Arc	hitectu	ıre. So	ftware	e Arch	itectur	9		7					
	y Concepts of Archit			446	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					1								12 Hc	ur
System Arc	chitecture Model Eleme	nts, Info <mark>rm</mark>	ation systems developme	ent, Web information systems, Beh	aviour mo	delling	g, Integ	grated	mode	lling ,	Archite	cture	frame	works					
	stems Requirements				7.5					4	7		7				1	2 Ηοι	ır
Role of stai	ke holders on systems	design, Re	q <mark>uirements</mark> analysis, deri	iving system requirements and use	cases fro	m sta	kehold	er requ	ıireme	ents. A	Art <mark>ifact</mark> s	s, Spe	cificat	ion of	systen	ns requ	uireme	nts	
	usable Structures for			4 May parker 1 Tal	MY	-	L.	$\Delta 1$	15		/ _*						12	? Hou	r
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	ade-off Analysis and									_+								12 H	our
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irivoivea in	Decision management																		
Learning	1. National A	eronautics	and Space Administration	n, "NASA Systems	4.	Crow	der, J.	A., Car	bone.	J.N.,	Demijo	hn, R	2. (201	6). Sv	stems	of Sys	tems		

Resources	Engineering Handbook",(Rev 1, Dec 2007).		-
	INCOSE, "Systems Engineering Handbook"	= 5.	ı
	3. Kossiakof, Alexander and William N. Sweet; "Systems Engineering: Principles		-
	and Practice" Wiley, 2011	6.	L
			- 1

Architecture Design. In: Multidisciplinary Systems Engineering. Springer, Cham. Rechtin, E., and M.W.Maier, "The art of Systems architecting", Boca Raton, FL: CRCPress, 2000
Engel, Avner, "Verification, Validation and Testing of Engineered Systems; John Wiley &Sons, 2010.

earning Assessr	ment	- P /	C. HILL	Wall A				
	Bloom's Level of Thin <mark>king</mark>	CLA-1 Avera	Continuous Learning mative age of unit test 5%)	CLA-2	ng Learning 2- Practice 15%)	Summative Final Examination (40% weightage)		
		Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember	15%	2-1	4.	15%	15%	-	
Level 2	Understand	25%	1. The State of th	THE ALL THE	20%	25%	-	
Level 3	Apply	30%	174 19 19 19 19	74.5	25%	30%	-	
Level 4	Analyze	30%		A. 75 A.	25%	30%	-	
Level 5	Evaluate	w / - w	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- TATE	10%		-	
Level 6	Create		Bereit Burner	Start To The	5%	0 -	-	
	Total	10	00 %	19 M. F. S. L. 1	100 %	100	0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gaurav Dubey, Mathworks, India	1.1. Dr.P.Karthikeyan, MIT Campus, Anna University,	1. Dr.K Sivanathan, SR <mark>MIST</mark>
	pkarthikeyan@annauniv.edu	
2. Dr. Yogananda Jeppu, Honeywell, I <mark>ndia</mark>	2. Dr.Thiyagarajan, Indian Institute of Technology Tirupati,	2. Dr.T.Muthuramaling <mark>am , SR</mark> MIST
	thiyagu@iittp.ac.in	

Course Code	21MHE476J	Course Name	OBJECT PROCESS MO	MODELLING AND SysML Course Category		PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3	
Pre-requis Courses		Nil	Co- requisite Courses	Nil	Progre		Nil				
Course Of	fering Departm	ent	Mechatronics Engineering	Data Book / Codes / Standards	$\Box E$	A	Nil				
				W			17.				

Course L	Learning Rationale (CLR): The purp <mark>ose of lea</mark> rning this course is to:				1/1	rogr	am O	utcom	es (P	0)					ogra	
CLR-1:	Introduce Object Proce	ss Modell <mark>ing and S</mark> ysML	1	2	3	4	4 5		7	8	9	10	11	12		oecifi tcom	
CLR-2:	acquire knowledge of the	he popu <mark>lar data</mark> modeling techniques.	ge		of	SI	7	4			Work		æ				
CLR-3:	Understanding the Key	Conc <mark>epts of O</mark> bject Process Modelling	Knowledge	S	n/development	ations	sage	ъ					inance	βL			
CLR-4:	Analyze Comprehensiv	ve O <mark>verview and its Role in Object Process Modelling</mark>	~ ~	alysis	lop	estig	\supset	rand	∞ >		Team	cation	⊗ E	arning			
CLR-5:	Apply Object Process I	ing in System Design and Development		An L	deve	ĕ ⊒	Tool	ingineer tv	ment ability		<u>∞</u>	nical	Mgt.	g Le			
	•		nee	lem	gu/g	duct	dern	eng •	ronm	SS	ndividual	ommuni	oject I	Long	7	7-7	<u>د</u> -ر
Course (Outcomes (CO):	At the end of this course, learners will be able to:	Engi	Prob	Desi	Son	0	The	Envi	Ethics	ndiv	Son	Proj	∟ife	PSO.	PSO.	PSO-
CO-1:	Familiarize the SysML	concepts for solving the problems in developing complex engineering	3	185	100		2										3
CO-2:	Develop the Key Conce	epts of Object Process Modelling	3		100	1	2										3
CO-3:	Analyze Object Proces	s Modelling using engineering tool	. 3			1	2										3
CO-4:	Develop Object Proces	s Modelling for new or improved complex systems	3		11.5	1	2		4								3
CO-5:	Use Object Process Mo	o <mark>delling w</mark> ith SysML in case studies	3	250	7.		2		4								3

Unit-1: OPM Conceptual Modeling	12 Hour
OPM Conceptual Modeling: Purpose and Context, Structure Modeling, MBSE methodologies, Structural and	behaviour modeling using OPM,
Unit-2: Advanced OPM Concepts	12 Hour
Object-Process Diagrams . language, Objects and processes, System Lifecycle and Evolution, Advanced OF	M Concepts.
Unit-3: SysML	12 Hour
SysML: Foundations and Diagrams; SysML Taxonomy, Use Case, Block, and State Machine Diagrams, Sys.	ML-Lite diagrams, relation between S <mark>ysML and</mark> UML,
Unit-4: Structural and behavioral modeling us <mark>ing SysML</mark>	12 Hour
SysML structural diagram, Five structural diagram, Package diagram and parametric diagram, SysML behav	oral diagram, structural mod <mark>elling,</mark>
Unit-5: Systems and Traditional Engineering	12 Hour
Examples for systems engineering fields, Examples for systems engineering approaches, Life cycle systems complexities through different levels of abstractions and refinement, Examples of Engineered complex systems.	

	1.	National Aeronautics and Space Administration, "NASA	4.	"SysML distilled: A brief guide to the Systems modeling language". Lenny						
		Systems Engineering Handbook",(Rev 1, Dec 2007).		Deligatti- Addison Wesley Professional, Ed 1, 2013						
Learning	2.	INCOSE, "Systems Engineering Handbook"	5.	Rechtin, E., and M.W.Maier, "The art of Systems architecting", Boca Raton,						
Resources	3.	Kossiakof, Alexander and William N. Sweet: "Systems Engineering:		FL: CRCPress, 2000						
		Principles and Practice" Wiley, 2011	6.	Engel, Avner, "Verification, Validation and Testing of Engineered Systems; John						
			100	Wiley &Sons, 2010.						

Learning Assess	ment		Continuous Learnin	g Assessment (CLA)	4				
	Bloom's Level of Thin <mark>king</mark>	CLA-1 Avera	mative age of unit test 5%)	Life-Lo CLA-	ng Learning 2- Practice (15%)	Summative Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	4.00	- 100	15%	15%	-		
Level 2	Understand	25%	The Address	774.7	20%	25%	-		
Level 3	Apply	30%	1972 T. E. C. S. C.	3.545.4	25%	30%	-		
Level 4	Analyze	30%	R 37 - 1 3 3 1	A 413 1 - 127	25%	30%	-		
Level 5	Evaluate		Call Fr 1286	188 . 4 - 10	10%		-		
Level 6	Create	5 - JAN		1992 1 - 17	5%	9	-		
	Total	10	00 %	 西心教徒 	100 %	10	0 %		

Course Designers	W2.4221	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Gaurav Dubey, Mathworks, India	 Dr.P.Karthikeyan, MIT Campus, Anna University, pkarthikeyan@annauniv.edu 	1. Dr.K Sivanathan, SRMIST
2. Dr. Yogananda Jeppu, Honeywell, In <mark>dia</mark>	Dr. Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in	2. Dr.T.Muthuramalingam , SRMIST
	LEARN · LEAP .	LEAD

Code	21MHE477J	Course Name		VERIFICATION A	ND VALIDATION	Cate		E		F	PROF	ESSIOI	NAL E	LECT	IVE		2		P 2	C 3
Pre-requis Courses		Nil		Co- requisite Courses	Nil		rogres Cours		•	N				Nil						
Course O	fering Departm	ent	Mech	atron <mark>ics Engineerin</mark> g	Data Book / Codes / Standa	ırds	-4						Nil							
Course Lea	erning Rational	e (CLR):	The purp	ose of learning this cours	se is to:		4	4	7	Progr	am Oı	utcome	es (PC))				Pr	ograi	n
		, ,		ation in systems Engineer		1	2	3	4	_5	6	7	8	9	10	11	12		ecifi tcom	
CLR-2:				ta modeling techniques.	يونان والدور	0			<u> </u>						10			Ou	COIII	:5
CLR-3:	Familiarize the \	• .		3	4	ede)	nt of	ions	Φ	society			Wor		Finance				
	Familiarize the \	/V method	S	~~		Engineering Knowledge	/Sis	bme	Conduct investigations o	Modern Tool Usage	and	જ		& Team Work	E	Fin	ife Long Learning			
				timize the VV process		티	Analysis	yelo		8	engineer and	ent 8		∞ ⊢	catic	gt. &	Leal			
			or arra op.			eerij	em /	ab/u	e de la	E	ngin	onmi	"	dual	nuni	ct M	ong	1	7	က
Course Ou	tcomes (CO):		At the en	d of this course, learners	will be able to:	igi i	Problem /)esiç	ono dwo	lode	The	Environment 8 Sustainability	Ethics	Individual	Communication	Project Mgt. &	ife L	PSO-1	PS0-2	8-0Sd ო
	· ,			tems Engineering	7-80	3		ں ں	0 0	2		шо		=	0	ч	7	ш		3
	Describe the VV			23.777	TARREST TO MAN AND ADMINISTRATION OF THE PARTY OF THE PAR	3	2000	17.		2										3
CO-3:	Analyze the VV	method <mark>s</mark>			7. J. W. S. E. B. W. W. W.	3		100		2									1	3
CO-4:	Describe the VV	′ modeli <mark>ng</mark>	<mark>and </mark> optim	ization techniques		3			2	2									1	3
CO-5:	Analyze the app	lication <mark>of</mark>	VV			- 3	y - 4		2	2										3
Un:4 4 In4		wifi 4i - w	u al Maliala	diam in Contant Francis			1.2				_								40	
				tion in Systems Enginee		1	1/			. '('	107 4			. 11'	1		// / !!f			Hou
	and validation (\ nt lifecycle phase		piem state	ernent vv systems and pro	cess, nature of mechatronics syste	erris, v	v conc	epis a	na aeni	IIIIOII,	v v ali	emma,	mode	ening s	system	s and	v v iiied	сусте,	Sysie	ms
Unit-2 –VV		7.0								1		- /							12	Нои
		Desian Im	ple <mark>mentati</mark>	on Integration Qualification	on, Production, Use/Maintenance,	Dispos	sal			7										
Unit-3 - VV		2 00.g,	oron contact	on, mogration, quantous	, , , , , , , , , , , , , , , , , , , ,	2.000				₹.			7						12	Hou
VV Method:	s for Non-testing.	: Requirem	ents, <mark>verif</mark> i	i <mark>cation</mark> matrix, system inte	gration laboratory, hierarchical VV	optimi	zation,	defect	manag	emen	t and i	racking	g, clas	sificat	ion tree	e meth	od, de	sign o	f	
					Basics, high-volume, special, envi	ironme	nt, pha	se test	ing		7									
	delling and Op						-	-22-3		<u>س</u> د		- 1							12	Hou
			uality data	acq <mark>uisition and</mark> aggregati	on, any one popular optimization r	nethod	for cos	at and	time			7							40	11
	tailed Case Stu		D ' '		lan annual de la Colonia		-4	-1:00	-11 1	. "	1-				-4:	t'		1:0		Hou
					ign approaches for automated driv y: Test driven development and fe															
	ceptance criteria				y. Test dilveil developillelit alla le	alui e-	inven C	ievei0	Jillelil,	icsi ut	zsiyii d	มาน เช่ง	ı u c pli	11, l U Sl	suite,	ισοι μι	৩০৮১১,	(COIIII	y III U	16

Learning

1. Mourad Debbabi et al Verification and validation in Systems

3. Plato Pathrose, ADAS and Automated Driving: A Practical Approach to Verification and

Resources	Engineering, First Edition, Springer, 2010	Validation, First Edition, SAE International, 2022.
	1. Anrew P. Sage, Verification, Validation, And Testing Of Engineered Systems, First	****
	Edition, Springer, 2010.	

			Continuous Learning	g Assessment (CLA)		C	
	Bloom's Level of Thinking	CLA-1 Avera	Formative Life-Long Learning CLA-1 Average of unit test CLA-2- Practice (45%) (15%)				mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	وا مساور د	the contract of	15%	15%	-
Level 2	Understand	25%		2 T 7 7 -	20%	25%	-
Level 3	Apply	30%	2 to 1 to 1 to 1	HALL TO THE	25%	30%	-
Level 4	Analyze	30%	A 17 COM 1 T	T. Marie TV	25%	30%	-
Level 5	Evaluate	7 /	THE RESIDENCE	100000	10%		-
Level 6	Create	7 /- 1		A 78.55	5%	-	-
-	Total	10	0%	9 74 1 - 5 1	100 %	10	0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gaurav Dubey, Mathworks, India	1.1. Dr.P.Karthikeyan, MIT Campus, Anna University,	1. Dr.K Sivanathan, SRMI <mark>ST</mark>
	pkarthikeyan@annauniv.edu	rus en
2. Dr. Yogananda Jeppu, Honeywell, <mark>India</mark>	2. Dr. Thiyagarajan, Indian Institute of Technology Tirupati,	2. Dr.R Senthilnathan , S <mark>RMIST</mark>
	thiyagu@iittp.ac.in	

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Course Code	21MHE478L	Course Name	CAPSTON	E PROJECT	Course Category	Е	PROFESSIONAL ELECTIVE	L T P C 0 0 6 3
Pre-requisit Courses	е	Nil	Co- requisite Courses	Nil	Progres Cours		Nil	
Course Offe	ering Departme	ent	Mechatronics Engineering	Data Book / Code	s / Standards		Nil	

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Course L (CLR):	earning Rationale	The purpose of learning this course is to:	Program Outcomes (PO)										Progra Specif				
CLR-1:	Engage in high-level wo may be applied.	rk focusing on an area of specialization where immersive technologies 1 2 3 4 5 6 7 8 9 10 11				11	12		tcom								
CLR-2:	LR-2: Bridge theory and practice and are aimed to have an impact on the professional life of students.				ign/dev ment	duct	dern I Usage	ineer	ironme	cs	vidual & m Work	nmunik	. sect)-1)-2)-3
Course C	outcomes (CO):	At the end of this course, learners will be able to:	Eng	Problem Analysis	Des	S .	ĕ 6	The	E S	Ethi	Teal	Con	Proj Mgt	Life Lea	PSO.	PSO	PSO
CO-1:	demonstrate the importa mechatronics systems.	ance of loT technology and systems Engineering in building smart	-3	2		ď.		5	- to	-		-	-	-	3	-	-
CO-2:	demonstrate a depth an scholarship and/or pract	<mark>d breadt</mark> h of knowledge and the application of this knowledge to t <mark>ice;</mark>	i.	2	4	Option The second	3	- 1		-		-	-	1	3	-	-
CO-3:	present a articulated inva	estigative framework, while situating projects within established <u>/or</u> ideas;	10%	2	新	Ţ,	3			-		-	-	-	-	3	-

Nature of the Capstone Project

The following points describe the nature of the Capstone project course:

- The Capstone Project provides an opportunity for students to engage in high-level work focusing on an area of specialization where IoT technology and systems engineering may be applied to a mechatronics system.
- Capstone projects (CP) will be inquiry and practice-centred.
- All Capstones aim to bridge theory and practice and are aimed to have an impact on the professional life of students.
- Students will identify the topics for their Capstone Project at the end of the sixth-semester study of the program.
- Capstone projects often take their inspiration from projects, papers, and experiences related to coursework in the degree program. However, to ascertain students' abilities for independent work and their capacity for self-directed inquiry, capstone projects must demonstrate in what ways individual graduate students have researched, developed, extended, or applied the ideas and strategies under investigation.
- Capstone Projects encourage the application of knowledge gained on teaching and learning throughout the degree program.
- Additionally, the Capstone Project should demonstrate the depth and extent of knowledge of students.
- Capstone projects should have hardware-involved work depending on the time, will, and the needs involved in the chosen application.
- The chosen project should ensure the integration of IoT and Systems Engineering in the application. It is mandatory to choose application involving both the fields

Project Evaluation

The capstone project will be evaluated by a team of faculty members. The following points will be evaluated in each review.

- BASIC KNOWLEDGE ABOUT THE FIELDS AND TOPICS RELATED TO THE PROJECT: (Basics of the fields of study related to the project in the context of what the student presented in the scope of the respective review)
- INTELLECTUAL CONTRIBUTION (Elements that the student presented which require the proper application of physics, mathematics, theory, etc)
- PROGRESS IN THE PROJECT TOWARDS THE CLAIMED OBJECTIVE (How much the student has progressed towards the claimed objective for the respective phase of the project)
- ACCOUNTABILITY OF TIME (How effectively the student has used the time towards the project and other activities that might help him/her do perform better in the project)
- Ability to understand, reason, and explain the ALLOWABLE elements of the project borrowed, outsourced, copied from the internet, etc
- TIMELY COMPLIANCE TO PROJECT RELATED FORMALITIES (Activities such as timely progress report submission, project report submission, etc)
- CONTENT OF THE PRESENTATION: Clarity and Supporting Data
- ORGANISATION OF THE PRESENTATION: Appropriate Media (such as images, videos, tables, flowcharts for illustrative purposes), Logical Flow of Slides and Smooth Transition Between Topics
- DELIVERY OF THE PRESENTATION: Professional, Confidence and Body Language, Clear Voice and Language with Good Pace, Engagement with Panel Members

		(2) (2) (2) (3) (3) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4		
		Continuous Learning A	ssessment	
		(100% weighta	ge)	
	Review - 1	Review - 2	Project Report	Presentation
Capstone Project	20 %	50 %	15 %	15 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gaurav Dubey, Mathworks, India	1. Dr.P.Karthikeyan, MIT Campus, Anna University,	1. Dr.K Sivanath <mark>an, SRM</mark> IST
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2. Dr. Yogananda Jeppu, Honeywell, India	2. Dr. Thiyagarajan, Indian Institute of Technology Tirupati,	2. Dr.R Senthilnathan, SRMIST
	thiyagu@iittp.ac.in	- N

Course Code	21MHE479J	Course Name	OPTIMIZATION TECHNIQUES IN SYSTEMS ENGINEERING	Course Category	Е	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
D	.4.		0	D	•		'		•	_

Pre-requisite Nil	Co- requi <mark>site Courses Course </mark>	Nil	Progressive Courses	Nil	
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	1 /	Nil	
			7/1//		

Course Learning Rationale (CLR): The purpose of learning this course is to:			Program Outcomes (PO)									Program Specific Outcomes					
CLR-1:	formulate real life proble	ms in <mark>to optimiz</mark> ation problems	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	CLR-2: acquire knowledge of the popular data modeling techniques.				of	s of	V	society			ž		8				
CLR-3:	gain knowledge of differ	en <mark>t optimiza</mark> tion techniques	vled	14	_	ation	ge				Work L		Financ	D		i	
CLR-4:	CLR-4: explore applications of optimization techniques in systems engineering		Knowledge	Kno lysis	Know alysis	relopment	vestigations oblems	Š	and.	જ ્		Team	6	& Fir	aming		ı
CLR-5:	apply modern tools for s	olving optimization problems	neering l	oblem Ana	gn/devel	prof	은	engineer	onment		vidual & 7	ommunication	Project Mgt.	Long Lea	-	-2	
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	Engir	Prob	Design	Conduct	Mode	The (Envir	Ethics	Indiv	Som	Proje	life L	PSO-	PSO.	
CO-1:	solve single- and multi-v	variables unconstrained optimization problems	14 <u>7</u> -	177	2		2	-	-	7	-	-	-	-	-	- 3	
CO-2:	apply and analyze Linea	r Programming techniques to various applications		-	2	1	2	1	-	-	-	-	-	-	-	- 3	
CO-3:	CO-3: apply and analyze Non-Linear Programming (NLP) techniques to various applications		- -		-2	112	2	-	-	-	-	-	-	-	-	- 3	
CO-4:			غمات			2	2		-	-	-	-	-	-	-	- 3	
CO-5:	analyze the challenges in global optimization and apply meta heuristic algorithms		_	_	_	2	2	1			_	_	_	_	_	- 3	

Unit-1: Unconstrained Optimization

12 Hour

Introduction to Unconstrained optimization problem. Objective function. Stationary points and extremum of a function. Single variable problems - Dichotomous and Golden-section search algorithms.

Multi-variables problems, Gradient and Hessian of functions. Conditions for existence of solution. Steepest ascent method and Newton-Raphson algorithm.

Recommended lab exercises

- 1. Solving unconstrained optimization problem finding extremum of a function symbolic & numerical
- 2. Solving unconstrained optimization problem finding extremum of a function with Gradient symbolic & numerical
- 3. Finding extremum of single variable function using Dichotomous (bisection) and Golden-section search algorithms
- 4. Finding extremum of single variable function using Newton-Raphson algorithm

Unit-2: Constrained Optimization - Linear Programming (LP)

12 Hour

Introduction. Classification of constrained optimization problem. Types of solutions. Introduction to Linear Programming (LP) – Problem definition – Solutions – Graphical solution, Simplex method. Recommended lab exercises

- 5. Solving Linear Programming problem Graphical approach
- 6. Solving Linear Programming problem Simplex method

Unit-3: Constrained Optimization - Non-Linear Programming (NLP)

12 Hour

Introduction to Non-Linear Programming (NLP). Convex and concave functions. Multivariable optimization with constraints - Lagrange multiplier, Penalty function, Kuhn-Tucker condition of optimality Recommended lab exercises

- 7. Solving NLP problem with multi-variables– finding optimal solution
- 8. Solving constrained NLP problem symbolic and numerical Lagrange multipliers
- 9. Solving constrained NLP problem symbolic and numerical Penalty function

Unit-4: Network Optimization

12 Hour

Network – graphs, definitions and terminology. Minimum spanning tree problem, shortest route problem. Maximum flow problem, Transportation problem (Travelling salesman, Chinese postman problems)

Recommended lab exercises

- 10. Application of minimum spanning tree problem and solution Modelling and simulation
- 11. Finding solutions to shortest route problem Modelling and simulation
- 12. Finding solutions to transportation and network-related problems Modelling and simulation

Unit-5: Global Optimization

12 Hour

Local vs Global solution. Handling many variables and objectives. Introduction to bio-inspired and meta-heuristic approaches. Simulated Annealing, Particle Swarm optimization (PSO), Genetic Algorithm (GA). Pareto optimality.

Recommended lab exercises

- 13. Application of Simulated Annealing Modelling and simulation
- 14. Application of PSO Modelling and simulation
- 15. Application of GA Modelling and simulation
- 16. Demonstration of Pareto optimality

Learning
Resources

- Suresh Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Alpha Science International, 2009, ISBN: 1842654276
- Hamdy A. Taha, Operations Research: An Introduction (9th Ed), Pearson, ISBN: 013255593X
- 3. Richard Bronson and Govindasami Naadimuthu, Schaum's Outline of Operations Research, McGraw Hill, ISBN: 9780070080201
- Hanif D. Sherali Mokhtar S. Bazaraa, John J. Jarvis, Linear Programming and Network Flows, 2nd Ed, Wiley India, ISBN: 8126518928.
- 5. Deb K, Optimization for engineering design: Algorithms and examples, 2012, PH India, ISBN: 8120346785
- 6. Eligius M.T. Hendrix and Boglárka G.-Tóth, Introduction to Nonlinear and Global Optimization: 37 (Springer), ISBN: 1461425824
- 7. Rangarajan K. Sundaram, A First Course in Optimization Theory, Cambridge University
 Press. ISBN: 0521497701

			Cummativa					
	Bloom's Level of Thinking	CLA-1 Avera	native age of unit test 5%)	CLA-2-	g Learning - Practice 15%)	Summative Final Examination (40% weightage)		
		Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember	15%	A COLUMN	141. 1	15%	15%	-	
Level 2	Understand	25%	C .	1	20%	25%	-	
Level 3	Apply	30%			25%	30%	-	
Level 4	Analyze	30%	-	-	25%	30%	-	
Level 5	Evaluate	AV	, - The h	Higg -	10%	-	-	
Level 6	Create		-	7.6772	5%		-	
	Tota <mark>l</mark>	10	00 %	10	00 %	10	0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohammed Sagheer ,Wabco Technology Center, India,		1. Dr Mad <mark>havan Sh</mark> anmugavel, SRMIST
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2. Mr.Ganesh Ram, Intel Labs ,Bangalore, ganeshram.nandakumar.@intel.com	2. Dr., F Karunkeyan, wirr, Anna University, pkarunkeyan@annauniv.edu	2. Dr. N Sivanauran, Skiviis i
		3. Dr. T Mu <mark>thurama</mark> lingam, SRMIST

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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

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