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>	Form CLA-1 Averaç (20	ge of unit test	CL	ed Learning A-2 9%)		l Viva Voce 0%)		amination eightage)
		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

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Volume - 18C
(Syllabi for Mechatronics Engineering (Autonomous Driving
Technology) 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

21MHE437.1	ourse COMP	VELUOLEO	Course	E	PROFESSIONAL ELECTIVE	L	T	P	С
Code N	ame	VEHICLES	Category				U		3

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

Course L	earning Rationale (CLR):	The purpose of learning this course is to:		4			Progr	am Oı	itcom	es (PC	D)					rograi	
CLR-1:	introduce mathematical	orinciples <mark>and techni</mark> ques essential for autonomous vehicles (AVs)	1	2	3	4	_5	6	7	8	9	10	11	12		pecifi ıtcom	
CLR-2:	provide the mathematica navigate complex enviro	al tools n <mark>ecessary</mark> to process sensor data, make real-time decisions, ar nment <mark>s.</mark>				of	1	ety	ability		¥						
CLR-3:	understand the mathematical autonomous systems	atica <mark>l underpi</mark> nnings that is crucial to develop robust and reliable	Knowledge	ဟ	evelopment of	stigations	Usage	d society	Sustainability		m Work		Finance	рu			
CLR-4:	equip students with the	ma <mark>th skills</mark> needed to contribute effectively to the field of AVs.	Ϋ́	alysi	lop	vestigati	S	r and	∞ಶ		Team	ioi	∞ర	eaming			1
CLR-5:	apply verification and va	li <mark>dation te</mark> chniques to evaluate the system design	Engineering	Problem Analysis	0 0	의로 교	- 2	engineer	Environment		ual &	Communication	Mgt.	Long Le			
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	— Jaine	ople.	esign	Conduct	oder	The er	viro	Ethics	Individual	L L	Project I	ife Lo	PSO-1	PSO-2	PSO-3
			山山	<u> </u>	De	10,8	≥	È	ū	Ш	드	Ö	Ъ	_==	ď	ď	ď
CO-1:	apply linear algebra and	geometry to perception, planning and control of AVs	11.5	- 2	- 2	2	2	7				-	-	-	-	2	_ ′
CO-2:	utilize calculus for motio	<mark>n and tr</mark> ajectory planning	1	2	2	2	2	-	_	-	-	-	-	-	2	1	2
CO-3:	apply probability and sta	tistics in processing sensors data	1	2	2	2	2	-		-	-	-	-	-	2	1	2
CO-4:	evaluate numerical meth	ods for autonomous driving algorithms	1	2	2	2	2	-	-	-	-	-	-	-	2	1	2
CO-5:	analyze and apply graph	theory for mapping and planning	1	2	2	2	2	-	٠.	7	-	-	-	-	2	1	2

Unit-1: Linear Algebra and Geometry for Autonomous Vehicles

9 Hour

Introduction, Importance of mathematical foundations for perception, planning, and control, Vector spaces and matrix operations, Coordinate systems and transformations. Eigenvalues and eigenvectors, Linear regression and least squares estimation, Geometric algorithms for localization and mapping, Point cloud processing and 3D geometry, Applications of linear algebra in sensor fusion and perception, Kalman filtering.

Unit-2: Calculus and Optimization

9 Hour

Differentiation and integration for motion analysis, Optimal control and calculus of variations, Applications of calculus in motion planning and control, Path parameterization and curvature analysis, Trajectory generation and optimization, Derivatives, and gradients in optimization algorithms.

Unit-3: Probability and Statistics

9 Houi

Probability distributions and random variables, statistical inference and hypothesis testing, Conditional Probability and Bayes' theorem, Statistical methods for uncertainty modeling and management, Applications of probability and statistical theory in perception and sensor fusion, Regression analysis and modeling, Gaussian processes and kernel methods, Hidden Markov Models (HMM) for state estimation, Probabilistic modeling for decision-making, Monte Carlo methods for localization and mapping.

Unit-4:Numerical Methods

9 Hour

Numerical integration and differentiation, Root finding and interpolation techniques, Approximation methods for solving differential equations.

Basics of graph theory (e.g., graph representation, connectivity, shortest paths), Graph algorithms for mapping and path planning, Graph-based SLAM and localization, Road network representation and analysis.

		1. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT 4.	James Stewart, "Calcul
		Press, 2005. 5.	Ronald E. Walpole, Ray
	Learning	2. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	and Statistics for Engine
	Resources	Autonomous Mobile Robotics", Second edition, The MIT Press, 2011	
		3. David C. Lay, Steven R. Lay, and Judi J. McDonald, "Linear Algebra and Its	
		Applications", fifth edition, Pearson, 2015.	7
_			11.
		2 (C-A), (CC)	

James Stewart, "Calculus: Early Transcendentals", eighth edition, 2015.
Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye, "Probability and Statistics for Engineers and Scientists" ninth edition, Pearson, 2010.

Learning Assessme	ent	F. 1		72.5			
		7 500	Continuous Learnin	g Assessment (CLA)		Cum	mative
	B <mark>loom's</mark> Leve <mark>l of Thin</mark> king	Form CLA-1 Averaç (45	ge of unit test	Life-Long CL/ (15	4-2	Final Ex	native amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remembe <mark>r </mark>	5%	The section of the se			5%	-
Level 2	Understan <mark>d </mark>	10%	The second of	and the second second	70%	10%	-
Level 3	Apply	75%	The same of the same of the		30%	75 %	=
Level 4	Analyze	10%				10%	-
Level 5	Evaluate		5 f - No.	-)	-	-
Level 6	Create		-	-	7 -2.7	9 -	-
	To <u>tal</u>	100) %	100	1%	10	0 %

Course Designers			/
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo, Japan	71 - 0	1. Dr.P.Karthikeyan, MIT Campus, Anna University,	7. Dr.K Sivanathan, SRMIST
	V 11 AV	pkarthikeyan@annauniv.edu	
2. Mr.Elayaraj, apple, USA		2. Dr.Thiyagarajan, Indian Institute of Technology	2. Dr.R.Senthilanathan, SRMIST
		Tirupati, thiyagu@iittp.ac.in	

Course Code	21MHE438T	Course Name	FOUNDATIONS OF AUTO	NOMOUS VEHICLES	Course E	PROFESSIONAL ELECTIVE	L 3	0	0	3
Pre-requisi	ite	Nil	Co- requisite	Nil	Progressive	Nil				
Courses		IVII	Courses	IVII	Courses	IVII				
Course Of	fering Departm	ent	Mechatronics Engineering	Data Book / Codes / Star	ndards	Nil				

Course L	earning Rationale (CLR):	The purpose of learning this course is to:		4	1	· F	rogr	am Oı	<mark>itcom</mark> e	s (PC))					ograi	
CLR-1:	address Emerging Techn	ological <mark>Trends</mark>	1	2	3	4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	understand of Autonomo	us Veh <mark>icles</mark>	ge		of	SL	1	1			Work		8				
CLR-3:	promote Ethical and Reg	ulato <mark>ry Aware</mark> ness	Knowledge	S	nent	atior	Usage	ъ			Α		Finan	Б			
CLR-4:	foster Problem-Solving S	kills		nalysis	velopment of	investigations ex problems	l Us	r and	∞ ×		Team	ig	⊗ E	ami			
CLR-5:	prepare for a Multidiscipli	in <mark>ary Field</mark>	ering	< □	n/deve	tiny lex p	<u>8</u>	engineer stv	ronment ainability		<u>ळ</u>	Sommunication	Mgt.	g Le			
			ginee	roblem /	ign/	onduct i	Modern		iron	S	ndividual	nwu	Project	Long	7	⁵ 0-2	5-3
Course O	utcomes (CO):	At the end of this course, learners will be able to:	- E	Pro	Des	g ç	ĕ	The	Envir Sust	Ethics	Indi	Š	Proj	Life	PS0-1	PS(PSO-3
CO-1:	explain the Fundamenta <mark>l</mark>	Concepts of Autonomous Vehicle Technology	7	J.	- 3	2	-	2	_	-	- 1	-	-	-	-	2	1
CO-2:	design and Implement Pe	erception Systems for Autonomous Vehicles	0.5	10.7%	25	2	-	2	-	-	-	-	-	-	-	2	1
CO-3:	create Decision-making a	and Planning Algorithms for Safe Navigation		- 1-	100	2		2	-	-	-	-	-	-	-	2	1
CO-4:	analyze Vehicle Dynam <mark>ic</mark>	s and Apply Control Systems		-		13	2	2	-	-	3-	-	-	-	-	2	1
CO-5:	evaluate and Apply Safet	y Standards and Ethical Considerations	3.	-	L. P	-	2	2	-	-		-	-	-	-	2	1

Unit-1: Introduction to Autonomous Driving (Elementary Treatment only)

9 Hours

Overview of Autonomous Vehicle Technology, Historical Context and Evolution of Autonomous Driving, Levels of Automation (SAE J3016), Key Components of an Autonomous Vehicle System, Regulatory and Ethical Considerations, Evolution, Challenges, and Opportunities.

Unit-2: Perception and Sensor Fusion (Elementary Treatment only)

9 Hours

Understanding the Environment for Autonomous Vehicles, Types of Sensors Used in Autonomous Vehicles (LiDAR, Cameras, Radar, etc.), Data Preprocessing and Feature Extraction, Object Recognition and Tracking, Sensor Fusion Techniques for Accurate Perception, Case Studies on Perception Systems in Autonomous Vehicles.

Unit-3: Decision Making and Planning (Elementary Treatment only)

9 Hours

Behavior Planning and Decision-making, Path Planning Algorithms (e.g., A*, RRT, etc.), Control Systems for Autonomous Vehicles (PID, MPC, etc.), Handling Complex Traffic Scenarios and Dynamic Environments, Simulation and Testing of Decision-making Algorithms.

Unit-4: Vehicle Dynamics and Control Systems (Elementary Treatment only)

9 Hours

Basics of Vehicle Dynamics (Kinematics, Kinetics), Tire Mechanics and Contact Forces, Control Systems (PID, LQR, State Feedback, etc.), Stability Control and Handling Characteristics, Integration of Control Systems with Autonomous Driving.

Unit-5: Safety and Ethics in Autonomous Driving (Elementary Treatment only)

9 Hours

Safety Standards and Regulations for Autonomous Vehicles, Fail-safe Systems and Redundancies, Ethical Dilemmas in Autonomous Driving (Trolley Problem, etc.), Human Factors and Interaction with Autonomous Vehicles, Case Studies on Safety Incidents and Lessons Learned.

	1. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT	3. Richard Szeliski, "Computer Vision-Algorithms and Applications", Spinger, 2011.
Learning	Press, 2005.	I D
Resources	2. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	
	Autonomous Mobile Robotics", Second edition, The MIT Press, 2011	24/2

Learning Assessm	ent						
	Bloom's Level of <mark>Thinkin</mark> g	Form CLA-1 Averaç (50	ative ge of unit test	CL	Learning A-2 1%)	Final Exa	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	to and the disk	15%		1 5%	-
Level 2	Understand	25%		20%	177	25%	-
Level 3	Apply	30%		25%)	30%	-
Level 4	Analyze	30%	The 1997 May	25%	N C	30%	-
Level 5	Evaluate	27-73		10%			-
Level 6	Create	25 X 3	Company of the State of the Sta	5%	7	0 -	-
	Total	-100) %	100	0 %	10	0 %

Course Designers	N 7.9.5	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.K.Sridharan, Senior Engineer, GE Renewable Energy, Bangalore.	1. Dr.Thiyagarajan, Indian Institute of Technology	1. Dr.K Sivan <mark>athan, SR</mark> MIST
	Tirupati, thiyagu@iittp.ac.in	1 ' 600
2. Dr. Srinivasan, Principal Engineer, Mahindra and Mahindra, Chennai.	2. Dr., P Karthikeyan, MIT, Anna University,	2. Dr.M.Mo <mark>hamed R</mark> abik, SRMIST
	pkarthikeyan@annauniv.edu	

Course Code	21MHE4391	INTRODUCTION TO AUTO	OMOTIVE TECHNOLOGY		Course Category E PROFESSIONAL ELECTIVE								1 3	- T	P 0	3		
Pre-requis	IMII	Co- requisite Courses	Nil		ogres Cours		٠.					Nil						
Course C	Offering Department	Mechatronics Engineering	Data Book / Codes / Stan	dards	١.,			۳.			Nil							
Course Le	earning Rationale (CLR	R): The purpose of learning this cours	se is to:		7	7	P P	rogra	am Ou	tcome	es (PC	D)					rogra	
CLR-1:		ordinates of the vehicle		1	2	3	4	_5	6	7	8	9	10	11	12		pecifi utcom	
CLR-2:	identify the type of pov	ver train f <mark>or a vehicle</mark>	. with an Miles	ge		ф	S	7				Work		ф				
CLR-3:	realize the factors affe	cting lo <mark>ngitudinal</mark> control		yed		ent	ation	ge	\			Μ		Finance	Ð			1
CLR-4:	realize the factors affe	cting lateral motion for steering control		Kno	lysis	mdo	stig	Usage	and	∞ _		Team	uo	E	Leaming			1
CLR-5:	familiarize the advance	e co <mark>ncepts in</mark> automotive technology		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	n Tool	The engineer society	Environment { Sustainability		∞ర	Communication	Mgt.	Long Le			
Course Ou	urse Outcomes (CO): At the end of this course, learners will be able to:				Proble	Design/d	Condu	Modern	The en society	Enviro Sustai	Ethics	ndividual	Comm	Project I	Life Lo	PS0-1	PSO-2	PSO-3
CO-1:		p <mark>roper co</mark> ordinate control	CONTRACTOR LAND BURN	2	1.4	77.5		-			-	<u>_</u> -	-	-	•	-	2	-
CO-2:	design a proper drive t			6 1 5	الحاس	2	10-	-		-	-	-	-	-	-	-	2	-
CO-3:	implement the control	· ·	<u> </u>	1712	-	2	-1	-	-		-	-	-	-	-	-	2	-
CO-4:	implement the control		the state of the s	ىقىلىد	-	2	- 1	-	-	-	-	W- 1	-	-	-	-	2	
CO-5:	incorporate latest feat	ur <mark>es in the</mark> vehicle				2	4	-	-,40	-	-	-	-	-	-	-	2	
Unit-1 : In	ntroduction			-4-					-	_								9 1
		e in <mark>dustry, C</mark> oordinates and Notation for	Vehicle Dynamics -Longitudinal,	Lateral a	nd ver	tical ve	hicle m	otions	s, Hum	an Fa	ct <mark>ors</mark> i	n Vehi	cle Au	tomati	on, en	gine s	ysten	ı, eleci
	onic system overview		1.32						7									
	ower Trains and Drive		do Control of Automotod shift tre	nomiocio	~ // C' /	Cont	ol of cu	tomo	tio tron	omiosi	ono /	'ontro	of oc	atinuo:	ioli i vo	riobla	trons	9 1
Engine, En	electronic Transmission s electronic Transmission	system <mark>s train m</mark> anagement, Market Trend control <mark>, Electric</mark> al, Hybrid and Fuel cell v	us, Control of Automated shift tra rehicles	arismissioi	TAST	, Conti	oi oi au	toma	uc tran	SIIIISSI	oris, C	OHUIOI	OI COI	แแนบเ	isiy vai	lable	transi	HISSIO
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		nd momen <mark>ts on vehi</mark> cle, Equation of moti ing Force, Br <mark>ake Propo</mark> rtioning, Braking i													, Calcu	ılation	of Ma	aximur
11	· 15																	•

Lateral Dynamics - Steering geometry, Types of steering systems, Fundamental condition for true Rolling, Development of lateral forces. Steady-state handling characteristics. Yaw velocity, Lateral

Advanced Driver Assistance Systems (ADAS): Sensors, Algorithms, and Safety Features, Overview of Intelligent Transportation Systems, Preventing collisions

9 Hours

9 Hours

Unit-4 : Lateral Dynamics

Unit-5: Advanced Vehicle System

Acceleration, Curvature response and directional stability.

	1. I homas D. Gillespie, "Fundamentals of Vehicle Dynamics", 2013, Society of
Learning	Automobile Engineers Inc., ISBN: 978-1560911999
Resources	2. Ali, Ulsoy, Huei_Peng, "Automotive control system", Cambridge University Press 2012
Resources	3. James D. Halderman - "Automotive Technology_ Principles, Diagnosis, and Service"
	(4th Edition) Prentice Hall. 2011.

- Konrad Reif, "Automotive Mechatronics", Springer 2015
 J. Y. Woung, "Theory of Ground Vehicles", John Willey & Sons, NY.
 Rajesh Rajamani, "Vehicle dynamics and control", Springer publication.

earning Assessm	nent	· /	44.		1 (0/4)						
	Bloom's Level of <mark>Thinking</mark>		Continuous Learning Assessment (CLA) Formative CLA-1 Average of unit test (50%) Continuous Learning Assessment (CLA) Life-Long Learning CLA-2 (10%)				Summative Final Examination (40% weightage)				
		1	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember		15%	45.7	15%		15%	-			
Level 2	Understand		25%	1 30 A 18 115	20%	. 74 - 1-7	25%	-			
Level 3	Apply	7	30%	9 J. J. J 11 J. V. A	25%	17 July 200 - 18	30%	-			
Level 4	Analyze	~ .	30%		25%	·	30%	-			
Level 5	Evaluate	_	R 324 (1)	The state of the	10%	7		-			
Level 6	Create		Tar- 18		5%	_	-	-			
	Total		1	00%	100	%	100) %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. K. Karthikeyan , R &D Team Manager, Power Quality Products, Hitachi Energy, Bangalore	Dr.K.Balasubadra, Professor, Electronics, RMD Engineering College, Chennai.	1. Dr.K Sivanathan, SRMIST
2. Dr. Srinivasan, Principal Engineer, Ma <mark>hindra a</mark> nd Mahindra, Chennai.	2. Dr., P Karthikeyan, MIT, Anna University,	2. Dr.M.Mo <mark>hamed R</mark> abik, SRMIST
	pkarthikeyan@annauniv.edu	

Course Code	21MHE440J	Course Name	PERCEPTION FOR A	UTONOMOUS VEHICLES	Cour Categ		Е			PROF	ESSIC	NAL E	ELEC1	ΓΙVΕ		2	_ T	P 2	C 3
Pre-requi		Nil	Co- requisite Courses	Nil	Progressive Nil														
Course C	Offering Departm	ent	Mechatronics Engineering	Data Book / Codes / Standa	ards				70			Nil							
Course Le	earning Rationale	e (CLR): T	he purpos <mark>e of learnin</mark> g this co	urse is to:		1	1	7	Progr	am Ou	utcom	es (PC))					ogra	
CLR-1:	provide a compr perception syste	ehensive u	ndersta <mark>nding of the</mark> principles an nomo <mark>us vehicl</mark> es.	d techniques involved in designing	1	2	3	4	5	6	7	8	9	10	11	12		pecif tcom	
CLR-2:	identify the type	of power tr	ain <mark>for a vehi</mark> cle	A SHEET WAY						k.	ility								
CLR-3:	develop percept decisions.	ion module	that accurately interpret the envi	ironment of AV and make informed	edge		nt of	ions of	Ф	engineer and society	Sustainability		Work		Finance				
CLR-4:	equip learners w that are crucial f	evelop robust perception modules mous vehicles.	Engineering Knowledge	alysis	Design/development of	Conduct investigations complex problems	Modern Tool Usage	er and	∞		Team Work	tion	& Fina	earning					
CLR-5:	create systems	architectu <mark>re</mark>	for new or improved complex sy	vstems	eering	Problem Analysis	n/deve	uct inv lex pro	ırı Toc	engine	Environment	S	Individual &	Communication	Project Mgt. &	Life Long Le		5	က္
Course O	utcomes (CO):	1	At the end of this course, learn	ers will be able to:	lg.	robl)esiç	Conduct	Mode	The 6	i N	Ethics	ndivi	Som	Proje	life L	PSO-1	PSO-2	PSO-3
CO-1:	realize the signif	ficance of p	erception in Autonomous Vehicle	98	10.1		2	2	2	-	_	-	-	-	-	-	2	1	2
CO-2:	evaluate and se				- 3		2	2	2	-	_	-	1 -	-	-	-	2	1	2
CO-3:	apply image pro	cessing tec	h <mark>niq</mark> ues for various perception ta	asks			2	2	2		-	-	-	-	-	-	2	1	2
CO-4:	integrate sensor	rs data t <mark>hro</mark> u	u <mark>gh s</mark> ensor fusion techniques		45		2	2	2	-		-		-	-	-	2	1	2
CO-5:	design and anal	yze perc <mark>ept</mark>	ion modules for AVs			1-2	2	2	2		<u> </u>	-	h -	-	-	-	2	1	2
Unit-1: In	troduction to Pe	rception in	Autonomous Vehicles						+	÷	7	H						12	Hour
Overview o	of perception in au	itonomous	<mark>driving s</mark> ystems, Importance of p	erception for safe navigation, Historic	cal conte	ext, an	nd evo	lution o	f perc	eption	techno	ologies							
	nsors Technolog							7.	-7				1					12	Hour
Types of sessions		tonomous \	vehi <mark>cles (LiD</mark> AR, cameras, radar,	etc.), Sensor characteristics, streng	ths, and	limita	tions,	Data a	cquisit	ion an	d p <mark>re</mark> p	rocess	ing te	chniqu	ies, Se	nsor c	alibrat	ion a	nd
I Init_2: Im	ane Processina	and Vician	/ /	A DEALER NEW YORK	. Tr	-		400	1									12	<u></u>

Unit-3: Image Processing and Vision

12 Hour

Image filtering, edge detection, and feature extraction, Object detection and recognition using classical computer vision techniques (e.g., Haar cascades, HOG), Feature matching and descriptor-based methods, Case studies on real-time object recognition.

Unit-4: Sensors Fusion and Data Integration

12 Hour

Lidar point cloud processing and feature extraction, Segmentation and clustering for object identification, Ground plane estimation and removal, 3D object recognition and localization using Lidar data, Radar signal processing and target detection, Sensor fusion techniques (Kalman filtering, Extended Kalman Filter, Particle Filter), Multi-sensor fusion for robust perception, Case studies on sensor fusion in challenging environments.

Unit-5: Object Detection, Tracking and Motion Estimation

12 Hour

Single and multi-object detection and tracking algorithms (e.g., Kalman Filter, Hungarian Algorithm), Localization techniques using object tracking information, Integration with other perception modules for global localization, Metrics for evaluating perception systems (precision, recall, F1-score), Real-world data collection and annotation.

	1.Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT	3. Richard Szeliski, "Computer Vision-Algorithms and Applications", Spinger, 2011.
Learning	Press, 2005.	
Resources	2.Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	
	Autonomous Mobile Robotics", Second edition, The MIT Press, 2011	

Learning Assessment	t e									
_	Bloom's Level of <mark>Thinking</mark>	Form CLA-1 Avera (45	ative	g Assessment (CLA) Life-Long CLA-2- (15	Learning Practice %)	Summative Final Examination (40% weightage)				
	8 8	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	10%		J. 4272	20%	<mark>5</mark> %	1			
Level 2	Understand	30%	1 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	100	20%	10%	-			
Level 3	Apply	30%	St. 13 - 11 11 11 1		40%	75 %	-			
Level 4	Analyze	30%		ALC: NO PERSONAL PROPERTY AND ADMINISTRATION OF THE PERSONAL PROPE		10%	-			
Level 5	Evaluate	N 77 W (1.5)	Fig. 1999 May 1	 Bud 数 0.65%。)		-			
Level 6	Create	544. 18					-			
	Total	100)%	100) %	100	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo, Japan	1.Dr.P.Karthikeyan, MIT Campus, Anna University,	1. Dr.K Siva <mark>nathan, S</mark> RMIST
	pkarthikeyan@annauniv.edu	/
2. Dr.K.Sridharan, Senior Engineer, GE Renewable Energy, Bangalore.	2. Dr. Thiyagarajan, Indian Institute of Technology	2. Dr.M.M <mark>ohamed</mark> Rabik, SRMIST
	Tirupati, thiyagu@iittp.ac.in	

Course Code	21MHE441J	Course Name	LOCALIZATION AND ST	TATE ESTIMATION	Course E	PROFESSIONAL ELECTIVE	L T P 2 0 2	<u>C</u>
Pre-requisit	te	Nil	Co- requisite	Nii	Progressive	Nii		
Courses		IVII	Courses	IVII	Courses	IVII		

Data Book / Codes / Standards

Course L	earning Rationale (CLR):	The purpose of learning this course is to:		4.1	Λ,	1	Progr	am Oı	utcom	es (PC	D)					ograr	
CLR-1:	lay foundation for auton	omous sys <mark>tems</mark>	1	1 2 3 4 5 6 7 8 9 10						10	11	12		oecifi tcom			
CLR-2:	develop techniques for o	critical f <mark>or safe and</mark> precise navigation	ge	nt of nt of nt of ns													
CLR-3: address real-world challenges CI R-4: enable simultaneous localization and mapping (slam)		owledge	w	nent	ation	Usage	ъ			×		inan	bu				
CLR-4:	enable simultaneous loc	raliz <mark>ation and</mark> mapping (slam)	Α̈́	alysis	udol	vestigations problems	l Us	rand	∞ × >		Team	.io	& F	amii			
CLR-5:	equip students with indu	ist <mark>ry releva</mark> nce and innovation	ing.	Ā	development	l.⊑ ŏ	2	engineer etv	nment nability		<u>ळ</u>	ommunication	Mgt.	ıg Le			
		No. of the second secon	ginee	roblem	ign/	omple	ern		<u>8</u> . 2	S	/idu		Project	Long	7	7.5	53
Course C	Outcomes (CO):	At the end of this course, learners will be able to:	ЕÜ	Pro	Des	Con	Modern	The	Sus	Ethi	Individual	Sol	Proj	Life	PSO-1	PS0-2	PSO
CO-1:	understand the Fundam	entals of Localization and Estimation	1-	-	2	2	2	1			=-	-	-	-	2	1	2
CO-2:	implement Dead Recko	ning and Odometry Techniques	- 1		2	2	2		-	-	Ĭ-	-	-	-	2	1	2
CO-3:	apply Sensor-based Loc	calization Techniques	1111-2	J1	2	2	2	- "	-	-	-	-	-		2	1	2
CO-4:				-	2	2	2	-	-	-	1	-	-	-	2	1	2
CO-5:			-	-	2	2	2		-	-	-	-	-	-	2	1	2

Unit-1: Introduction to Localization and State Estimation

Mechatronics Engineering

12 Hour

Nil

Overview of Localization in Autonomo<mark>us Syste</mark>ms, Importance of State Estimation for Autonomous Vehicles, Probabilistic vs. Deterministic Approaches, Uncertainty Representation and Measurement Models, Bayesian Inference and the Bayes Filter

Unit-2: Dead Reckoning and Odometry

Course Offering Department

12 Hour

Principles of Dead Reckoning, wheel Enc<mark>oders an</mark>d Odometry Data, Error Accumulation and Drift, Odometry-based Localization Techniques, Calibration and Error Reduction Strategies

Unit-3: Sensor-based Localization

12 Hour

Sensor Types for Localization (e.g., GPS, IM<mark>U, LIDAR, C</mark>ameras), Sensor Fusion and Integration Techniques, Extended Kalman Filter (EKF) for Nonlinear Sensor Fusion, Particle Filter for Non-Gaussian Distributions, Case Studies on Sensor-based Localization in Real-world Scenarios

Unit-4:Simultaneous Localization and Mapping (SLAM)

12 Hour

Fundamental Concepts of SLAM, EKF-SLAM and FastSLAM Algorithms, Graph-based SLAM Approaches, Visual SLAM and Monocular Camera Systems, SLAM Challenges and Current Research
Trends

Unit-5: Kalman Filtering and Bayesian Estimation

12 Hour

Understanding Kalman Filters, Predictive and Corrective Steps in Kalman Filtering, Extended and Unscented Kalman Filter, Applications of Kalman Filters in State Estimation, Bayesian Estimation and its Applications in Robotics

	1.Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT	3.Richard Szeliski, "Computer Vision-Algorithms and Applications", Spinger, 2011.
Learning	Press, 2005.	
Resources	2.Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	
	Autonomous Mobile Robotics", Second edition, The MIT Press, 2011	
	- CIBN	

arning Assessmo	ent		Continuous Learning	Assessment (CLA)		Cum	mativa				
	Bloom's Level of Thin <mark>king</mark>				g Learning Practice 5%)	Summative Final Examination (40% weightage)					
	/ 6/	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	10%	2011		20%	5%	-				
Level 2	Understand	30%	A 1 (50) A 1 (1)	MC-11 TY	20%	10%	-				
Level 3	Apply	30%	1.74 (2.51)	74.5	40%	75%	-				
Level 4	Analyze	30%		4.74		10%	-				
Level 5	Evaluate	~ · ·	1 25 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	E		-	-				
Level 6	Create	A	3 5 7 7 - 12 W. V.	70	V21		-				
	<u>Total</u>	1	00 %	10	0%	10	0 %				
				加州							

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo, Japan	Dr.P.Karthikeyan, MIT Campus, Anna University, pkarthikeyan@annauniv.edu	1. Dr.K Sivanat <mark>han, SRM</mark> IST
2. Mr.Elayaraj, apple, USA	2. Dr.Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in	2. Dr.R.Senthilanathan, SRMIST
	LEARN · LEAP · LEAD	

Course Code	21MHE442J	Course Name	MOTION PLANNING AND CONTROL	Course Category		PROFESSIONAL ELECTIVE	2	T 0	P 2	<u>C</u>
	.,									
Pre-requis	site	K 1!1	Co- requisite	Progressiv	е	A I II				

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Mechatronic <mark>s Engineering</mark>	Data Book / Codes / Standards		Nil
			on the state of th		

Course Le	earning Rationale (CLR):	The purpose of learning this course is to:		. 4.0			Progi	am O	utcom	es (PC)					ogran	
CLR-1:	obtain critical skillset for	autonomo <mark>us vehicle</mark> engineers	1	1 2 3 4 5 6 7 8 9 10 11 12								12		ecific			
CLR-2:	address Real-world Cha	llenges	ge		of	SL	1				Work		Э				
CLR-3: make integration of Perception and Decision-making		lowledge	S	nent	ations	Usage	ъ			am W		inan	Б				
CLR-4: learn Safety and Ethical Considerations		Α̈́	alysi	velopment	vestiga proble		r and	∞ >		Lea	fion	& F	ami				
CLR-5: have relevance to Cutting-edge Techno		g- <mark>edge Te</mark> chnology and Research	ering	Ang	deve	J.≦ ŏ	ĕ	ngineer	ment ability		<u>ح</u>	nication	Mgt.	g Le			
			je	Ser	/ugi	omple	eru	enge	a ig	S	Individual	Jmur	ect	Long	7	7.5	5.
Course O	utcomes (CO):	At the end of this course, learners will be able to:	EI G	Prof	Des	5000	Moc	The	Sus	EFI	Indi	Con	Project	Life	PSO-1	PS0-2	PSC
CO-1:	design and Implement E	ffective Motion Planning Algorithms	Sec. 15	1.4	2	2	2			-	-	-	-	-	2	1	2
CO-2:	CO-2: integrate Behavior Planning for Complex Decision-making			10.5	2	2	2			-	-	-		-	2	1	2
CO-3:	CO-3: apply Control Systems for Precise Vehicle Maneuvering		1111-2	7.	2	2	2	-	-	-	-	-	-	-	2	1	2
CO-4: evaluate and Address Safety Considerations in Motion Planning				2	2	2	-	-	-	122	-	-	-	2	1	2	
CO-5:			-	-	2	2	2	-,-		-	-	-	-	-	2	1	2

Unit-1: Introduction to Motion Planning and Control for Self-Driving Vehicles

9 Hour

Overview of Motion Planning and Control in Autonomous Vehicles, Historical Context and Evolution of Motion Planning Algorithms, Challenges in Real-world Environments and Safety Considerations, Integration with Perception and Localization Systems, Ethical and Legal Aspects of Motion Planning for Autonomous Vehicles

Unit-2: Path Planning 9 Hour

Principles of Path Planning and Trajectory Generation, Static and Dynamic Environments, Grid-based and Sampling-based Planning Algorithms (A*, RRT, etc.), Heuristic Functions and Cost Functions, Real-time Path Planning and Dynamic Obstacle Avoidance, Algorithms and Techniques for Generating Safe and Optimal Trajectories

Unit-3: Behavior Planning

9 Hour

Behavior-based Systems for Autonomous Vehicles, Finite State Machines and Decision Trees, High-level Decision-making and Task Allocation, Collision Avoidance and Safe Navigation, Coordination of

Behavior-based Systems for Autonomous Vehicles, Finite State Machines and Decision Trees, High-level Decision-making and Task Allocation, Collision Avoidance and Safe Navigation, Coordination of Multiple Agents in Complex Scenarios, Decision-Making Strategies for Navigating Complex Traffic Scenarios

Unit-4: Control Systems for Autonomous Vehicles

9 Hour

Basics of Control Theory and Feedback Loops, Feedback Control and Stability Analysis, PID Controllers and State-space Control, Model Predictive Control (MPC), Nonlinear Control Techniques, Stability Analysis and Robust Control

Unit-5: Motion Control 9 Hour

Low-level Motion Control Strategies, Trajectory Tracking and Following, Vehicle Dynamics and Kinematics, Vehicle Stability and Handling, Integration with Perception and Localization for Seamless Control, Techniques for Vehicle Maneuvering and Tracking Desired Trajectories

_			
		1. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT	3.Howie Choset and et al, "Principles of Robot Motion: Theory, Algorithms, and
L	earning	Press, 2005.	Implementations", Bradford books, 2005.
R	esources	2.Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	4.Bruno Siciliano, Oussama Khatib, "Spinger Handbook of Robotics", Springer, 2008
		Autonomous Mobile Robotics", Second edition, The MIT Press, 2011	

Learning Assessme	nt		J-	_ ~41/						
	Bloom's Level of Thi <mark>nking</mark>	CLA-1 Avera	Continuous Learning native ge of unit test 5%)	CLA-2-	Learning Practice 5%)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	10%	10 A. S. C.	- Water State	20%	5%	-			
Level 2	Understand	30%	TEN: 40.5000 / 1	774 5	20%	10%	=			
Level 3	Apply	30%		A. 18.75	40%	75%	-			
Level 4	Analyze	30%	1 July 1 18 18 18 18 18 18 18 18 18 18 18 18 1			10%	-			
Level 5	Evaluate		St. 18 - 12 16 1	St. 1 - 1 - 1 - 1	177 3 - 1	0 -	-			
Level 6	Create	- (17/2)		AND ADDRESS OF		2 -	-			
	Total	10	0%	100	0 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo <mark>, Japan</mark>	Dr.P.Karthikeyan, MIT Campus, Anna University,	1. Dr.K Sivana <mark>than, SR</mark> MIST
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2. Dr.K.Sridharan, Senior Engineer, GE Renewable Energy,	2. Dr. Thiyagarajan, Indian Institute of Technology Tirupati,	2. Dr.M.Moh <mark>amed Ra</mark> bik, SRMIST
Bangalore.	thiyagu@iittp.ac.in	

LEARN · LEAP · LEAD

Course Code	21MHE443T	Course Name	VEHICLE MECHANICS	Course	E	PROFESSIONAL ELECTIVE	3	0	0	3
Pre-requi	site		Co- requisite	Progressi	ive					

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Mechatronic <mark>s Engin</mark> e <mark>ering</mark>	Data Book / Codes / Standards		Nil
			~ MILLIAND	11 A	

Course L	earning Rationale (CLR): Th	e purpo <mark>se of learn</mark> i	ng this course is to:			-71	Λ,	/ 1	rogra	am Ou	<mark>itcom</mark> e	es (PC	D)					ogran	
CLR-1:	critical skillset for vehicle me	chanic <mark>s</mark>	V 0.		1	1 2 3 4 5 6 7 8 9 10 11 12								12		ecific			
CLR-2:	optimizing vehicle performar	nce <mark>in terms of</mark> stabilit	y, maneuverability and r	ide comfort	ge		of	SI	1				ork		9				
CLR-3:	SLR-3: safety and handling considerations				Knowledge	(0	velopment	estigations x problems	Usage	Ь			≥		Finan	пg			
CLR-4:	integration of control systems knowing the vehicle mechanics				δÃ	nalysis	ldol	estig robl		r and	∞ >		Team	ion	& Fi	amii			
CLR-5:	cLR-5: equip students to address challenges in vehicle dynamics and control				ering	⋖	n/deve	Ji <u>≒</u>	1 Tool	engineer ety	nment nability		wal &	ommunication	: Mgt.	ong Le			
Course O	utcomes (CO):	t the end of this cou	rse, learners will be ab	ole to:	Engine	Problem	Design	Conduct of comple	Modern	The en	Enviro Sustaii	Ethics	Individual	Comm	Project	Life Lo	PS0-1	PS0-2	PSO-3
CO-1:	analyze vehicle motion and o	d <mark>yn</mark> amics	197	and wast to like		1.2	2	2	2	7	-	-	-	-	-	-	2	1	2
CO-2: navigate coordinate systems for vehicle motion				18 18 TO 18	- 1	100	2	2	2	-	1	-	-	-	-	-	2	1	2
CO-3: optimize tire performance		11.5	15-27	2	2	2	- 1	-	-		-	-	-	2	1	2			
CO-4: enhance vehicle handling and stability		L L	-	2	2	2	-	-	-	10.	-	-	-	2	1	2			
CO-5:			12 E S F			2	-2	2	-,-	-	-	Ξ-	-	-	-	2	1	2	

Unit-1: Introduction to Kinematics and Dynamics of Vehicles

9 Hours

Basic Concepts and Terminology, Overview of Vehicle Kinematics and Dynamics, Forward and Inverse Kinematics, Analysis of Vehicle Motion in 2D and 3D Space, Vehicle Dynamics Equations and Constraints, Maneuverability and Turning Radius

Unit-2: Vehicle Motion and Coordinate Systems

9 Hours

Modeling and Analysis of Vehicle Movem<mark>ent, Und</mark>erstanding Vehicle Motion Patterns (Translation, Rotation), Coordinate Systems for Vehicle Motion An<mark>alysis (Bo</mark>dy-fixed, Earth-fixed), Transformation Matrices and Euler Angles, Velocity and Acceleration Analysis in Different Coordinate Systems, Trajectory Planning and Control.

Unit-3: Tire Mechanics 9 Hours

Tire Characteristics and Properties (Traction, Grip, Rolling Resistance), Tire-terrain Interaction and Friction Models, Slip Ratio and Slip Angle Analysis, Tire Force and Moment Estimation, Tire Modeling for Vehicle Dynamics Simulations

Unit-4: Vehicle Handling and Stability

9 Hours

Concepts of Vehicle Handling (Understeer, Oversteer), Cornering Forces and Weight Transfer, Lateral and Longitudinal Stability Analysis, Control Systems for Stability Control (e.g., ESC), Impact of Handling on Autonomous Driving Algorithms

Unit-5: Suspension Systems and Ride Comfort

9 Hours

Concepts of vertical dynamics, Degrees of freedom of suspension system, Suspension system for autonomous vehicles, Control system for Suspension systems and Ride comforts.

	1.H.B. Pasjka, "Tire and Vehicle Dynamics", Butterworth-Heinemann Ltd; 3rd edition	5. Howie Choset and et al, "Principles of Robot Motion: Theory, Algorithms, and
	(2012).	Implementations", Bradford books, 2005.
Loorning	2.Rajesh Rajamani, "Vehicle Dynamics and Control", Springer New York, NY, 2011.	6. Bruno Siciliano, Oussama Khatib, "Spinger Handbook of Robotics", Springer, 2008
	3.Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics" MIT Press,	
Resources	2005.	
	4.Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to	
	Autonomous Mobile Robotics". Second edition. The MIT Press. 2011	

Learning Assessme	ent	~ / N	A 18 18 18 18 18 18 18 18 18 18 18 18 18	- 14							
		Co	ontinuous Learning	Cum	mativa						
	Bl <mark>oom's</mark> Level <mark>of Think</mark> ing	Formative CLA-1 Average of u (50%)	nit test		Learning 4-2 %)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%				15 %	-				
Level 2	Understan <mark>d </mark>	25%	ation and the	20%		25%	=				
Level 3	Apply	30%	11-10-5	25%	4	30%	-				
Level 4	Analyze	30%	Same appropriate	25%		30%	-				
Level 5	Evaluate	No. 2 (1)	- 10%			2 -	-				
Level 6	Create	- Apr 14 g 2	- 100	5%		-	-				
	T <mark>otal </mark>	100 %		100) %	100 %					

Course Designers	
Experts from Industry	Experts from Higher Technical Institutions Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo, Japan	1. Dr.P.Karthikeyan, MIT Campus, Anna University, 1. Dr.K Sivanathan, SRMIST
	pkarthikeyan@annauniv.edu
2. Mr.Elayaraj, apple, USA	2. Dr.Thiyagarajan, Indian Institute of Technology 2. Dr.Mohamed Rabik, SRMIST
	Tirupati, thiyagu@iittp.ac.in

Course	21MHE4441 Cou	se	AI FOR PERCEPTION, PLANNING AND CONTROL	Course	Е	PROFESSIONAL ELECTIVE	L	T	Р	С
Code	21MHE444J Nar	ne	AI FOR PERCEPTION, PLANNING AND CONTROL	Category	_	PROFESSIONAL ELECTIVE	2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil	
Course Offerin	ng Department	Mechatronic <mark>s Engin</mark> eering	Data Book / Codes / Standards		Nil	
			THE RESERVE AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO PARTY.	7 4 .		

Course	Learning Rationale (CLR)	: The purpos <mark>e of learnin</mark> g this course is to:		. < 1	\cup	7 1	Progr	am O	utcom	es (PC	O)					ograr	
CLR-1:	obtain motivation for artif	icial intellige <mark>nce and m</mark> achine learning.	1	2	3	4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	get exposed to classical	and conv <mark>olutional n</mark> eural networks and deep learning philosophy.	0			of	1	ciety	, -		V						
CLR-3: realize various convolutional neural network architectures that are applied for computer vision tasks.			owledge	S	nent of	Jations 18	Usage	nd socie			m Work		Finance	пg			
CLR-4: develop and train deep neural networks for computer vision task		줃	Analysis	lopr	vestigati		מ	y t %		Team	tion	& ∓	earnin				
CLR-5:	LR-5: explore the applications of reinforcement learning in planning and control tasks.		Sering	ım Ana	n/development	ict inve	2	engineer	nmen		lual &	ommunication	Project Mgt.	Long Le			
Course	Outcomes (CO):	At the end of this course, learners will be able to:	Engine	Problem	Design	Condu	Modern	The er	Environment Sustainability	Ethics	Individual	Comm	Projec	Life Lo	PSO-1	PS0-2	PSO-3
CO-1:	define various terminolog	i <mark>les and c</mark> oncepts in artificial intelligence and machine learning.	3	172	-		1		-	-	-	-	-	-	-	2	-
CO-2:	express the concepts of	classical and convolutional neural networks.	- 3	2	$\pm z$		1	- 1	-	-	-	-	-	-	-	-	2
CO-3: implement convolutional neural network architectures to various perception tasks.		3	- 2	100	11.5	1		-	-	-	-	-	-	-	2	-	
CO-4: demonstrate the applications of deep learning for planning and control tasks			3	4	2	7	1		-	-	5-	-	-	-	-	-	2
conceive and defend legal and ethical aspects arising when humans and autonomous vehicles interact		3		2	-	1	1		-	-	-	-	-	-	-	2	

Unit-1: Introduction to AI and ML

Introduction to artificial intelligence - Intelligent agent - Categorization of AI - Overview of different forms of learning - Statistical decision theory - Machine learning - Feature selection and feature extraction - Training concepts in machine learning - Train-val-test split - Cross-validation - Generalization - Overfitting and Underfitting - Regularization techniques - Hyperparameters and tuning - Classification and Regression - Performance evaluation metrics for classification and regression algorithms - SDC sensors - Camera - RADAR - Ultrasonic sensors - Odometric sensors - LiDAR - Introduction to sensor fusion Experiments:

- 1. Implementation of classification algorithm and its performance evaluation.
- 2. Linear regression algorithm and computation of its performance metrics.

Unit-2: Classical and Convolutional Neural Networks

12 Hour

Overview of biological neuro-system - Single layer perceptron - Learning rules - Multilayer perceptron - Types of gradient descent - Chaining derivatives - Backpropagation - Multilayer perceptron - Learning Boolean functions - Classical neural networks vs. deep learning - Convolutional neural networks - Activation functions - vanishing gradients - over-fitting and under-fitting - Optimization techniques- Applying trained networks for prediction - Image classification with multi-layer perceptron - Deep learning hardware.

Experiments:

- 1. Implementation of the backpropagation learning algorithm.
- 2. Implementation of gradient descent optimization algorithm.

Unit-3: CNN for Perception 12 Hour

Motivation for CNN - 1D, 2D and 3D convolutions - Convolutional neuron - Pooling layers and Initialization - Understanding Softmax Function - Image classification - LeNet, AlexNet architectures - CNN for Regression- Understanding the principle and Motivation for RNNs - RNN for Image Classification - LSTM Motivation and Principle Understanding

Experiments: 1. CNN for object detection, 2. RNN for Image Classification

Unit-4: Advanced Architectures and Embedded Implementations

12 Hour

12 Hour

ResNet and Inception - Key Aspects - Recent Image Classifications Architectures - Object Detection by RCNN and YOLO - Object Tracking by MOT and SORT- Semantic Segmentation - Instance Segmentation - Panoptic Segmentation - Multi task Attention Network - SFA3D Object Detection - UNetXST camera to bird's eye view

Experiments: 1. Image panoptic segmentation network. 2. SFA3D for object detection

Unit-5: Planning and Control

Markov decision process - Deep reinforcement learning – DRL for motion planning planning and control – CNN for End to End Learning of driving task – RNN for steering through time – DL for human centered semi-autonomous vehicles - implementation in end-to-end decomposition manner.

Experiments: 1. DRL for autonomous navigation of mobile robots in end-to-end manner, 2. DRL in planning and control of mobile robots.

Learning
Resources

- 1. Bruno Siciliano, Oussa<mark>ma Khati</mark>b, "Handbook of Robotics", 2nd Edition, Springer, 2016. 2. Ian Goodfellow and Yo<mark>shua Be</mark>ngio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.
- 3. Simon Haykin, "Neural Networks and Learning Machines: A Comprehensive Foundation", 3rd Edition. Pearson, 2011.

 Timothy J Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley, 2011.
 Ranjan, Sumit, Senthamilarasu, Dr. S, Applied Deep Learning and Computer Vision for Self-Driving Cars: Build autonomous vehicles using deep neural networks and behavior-cloning technique, Packt Publishing, 2020

earning Assessme	Bloom's Leve <mark>l of Thin</mark> king	Form CLA-1 Avera (45	ative ge of unit test	CLA-2-	Learning Practice %)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	10%	N. J. Company	-	20%	5%	-				
Level 2	Understand	30%	- 177	-	20%	10%	-				
Level 3	Apply	30%	- 11177	-	40%	75%	-				
Level 4	Analyze	30%	- 742	-	7 1	10%	-				
Level 5	Evaluate		- 74 77	-	7		-				
Level 6	Create	7.			/-	-	-				
	Total	100)%	100)%	100	0 %				
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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 pkarthikeyan@annauniv.edu	1.Dr. K. Sivanathan, SRM IST
2. Mr. Elayraj Jayaraj, Apple, USA	2.Dr. R. Thiyagarajan, IIT Tirupati thiyagu@iittp.ac.in	2.Mrs.T.S.Rajalakshmi, SRMIST

Course 2	1MHE445LQ Course Name	CAPSTONE PROJECT	Course Category E	PROFESSIONAL ELECTIVE	0 0 6 3
					_
Pre-requisite	A I'I	Co- requisite	Progressive	A I'I	

Pre-requisite	Nil	Co- requisite	Nil	Progressive	Alil
Courses	IVII	Courses	IVII	Courses	IVII
Course Offeri	ng Department	Mechatronic <mark>s Engin</mark> e <mark>ering</mark>	Data Book / Codes / Standard	3	Nil
			V THEN ALL	11 A C	

Course Le	earning Rationale (CLR): The purpose of learning this course is to:		-3.7	40	6	Progr	am Oı	utcom	es (P0	O)				Program		
CLR-1:	Engage in high-level work focusing on an area of specialization where immersive technologies may be applied.	1	2	3	4	5	6	7	8	9	10	11	12	Specific Outcomes		
CLR-2: Bridge theory and practice and are aimed to have an impact on the professional life of students		neerin	lem vsis	gn/dev ment	duct	ern Usage	neer	ronme	S	idual & n Work	munic	ect &	Long ning	-1	-2	₋ رع
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engi	Prob	Desi elopr	Conc	Mod	The	Envii nt &	Ethic	Indiv Tear	Comation	Proje Mgt.	Life I Lear	PSO	PSO-2	PSO
CO-1:	illuminate and bring new insight to one or more technologies involved in autonomous driving.	3	2				7							3		-
CO-2:	demonstrate a depth and breadth of knowledge and the application of this knowledge to scholarship and/or practice;		2	3.0		3	E	7						3		-
CO-3:	procept a clearly articulated investigative framework, while situating projects within established					3				i					3	-

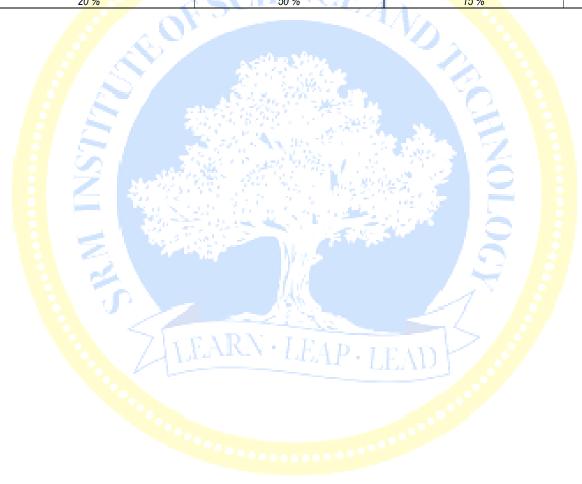
Nature of the Capstone Project

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 Autonomous driving technology may be applied.
- 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 during the end of sixth semester study of the program.
- Capstone projects often take their inspiration from projects, papers, and experiences related to course work 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, and 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 may take both only simulation works as well as hardware-involved work depending on the time, will and the needs involved in the chosen application. These may
 be, but are not limited to, the investigation of practices and educational ideas, the development of curricular materials, or teaching approaches which may utilize the autonomous
 driving technologies for better understanding of concepts.
- It may involve work, but not limited to, in one or more of following four broad modules namely
 - Perception
 - ➤ Localization and Mapping
 - Motion Planning

➢ Control

	Continuous Learning Assessment								
		(100% weightag	e)						
	Review - 1	Review - 2	Project Report	Presentation					
Capstone Project	20 %	50 %	15 %	15 %					



Course Code	21MHE446T	Course Name		CONNECTED \	EHICLES		ourse tegor		Е			PROF	ESSIC	NAL E	ELECT	ΓIVE			T 0	P 0	C 3
Course	Pre-requisite Courses Co- requisite Nil								sive es	٠.,					Nil	1					
Course C	Offering Departm	nent	Mechatronics En	gin <mark>eering</mark>	Data Book / Codes /	Standards								Nil							
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			e purpose of learn		s to:			4			rogr	am O	utcome	es (PC	<u> </u>	1	1	1		ograi oecifi	
CLR-1:	select a suitable	e communicat	tion m <mark>odule for a</mark> ve	ehicle			1	2	3	4	5	6	7	8	9	10	11	12		tcom	
CLR-2:	covert the comm	nunication mo	odu <mark>les as an</mark> intellig	ent transport syst	e m	Aug	ge		of	IS	1				ork		æ				
CLR-3:	apply a suitable	communicati	io <mark>n model</mark> for a spe	cific application	1,000	116	wled	' 0	ent	ation ems	Usage	70		. 1	Team Work		Finance	Б			
CLR-4:	select the type of	of broadcasti <mark>r</mark>	<mark>ng meth</mark> od for infori	nation disseminat	on	2777	S S	alysis	lopn	stig		r and	∞ _		Tear	.uo	⊗ E	Learning			
CLR-5:	design a safe tr	ansport sys <mark>te</mark>	<mark>em in a</mark> cooperative	way			Engineering Knowledge	Problem Analysis	Design/development solutions	Conduct investigations of complex problems	Modern Tool	engineer stv	Environment Sustainability		∞ర	Communication	Project Mgt. &	Long Le	1	2	က
Course O	utcomes (CO):	At	the end of this co	urse, learners w	II be able to:		lg	Proble	Desig soluti	Conduct of comple	Mode	The eng	=nvird Susta	Ethics	ndividual	Somr	Proje	Life L	PSO-1	PS0-2	PSO-3
CO-1:	apply a suitable	wireles <mark>s m</mark> od	<mark>dule</mark> for a specific a	pplication	The first of the second by		3	-	- 2	-			-	-	7-	-	-	_	-	2-	-
CO-2:	design an intelli			1000	2000 Sept. 1970		2	Ψ,	2	-1	-	-		-	-	-	-	-	-	-	2
CO-3:	fix a suitable co	mmunic <mark>ation</mark>	model for an applic	ation	VAL 18 10 13 13 13 13 13 13 13 13 13 13 13 13 13		2	-1	2	-1	-	1		1	-	-	-	•	-	2	-
CO-4:			<mark>adc</mark> asting message		<u> </u>		2	<u>- 1</u>	2	-51	-	-	-	-	10.	-	-	-	-	2	-
CO-5:	design a safety	standar <mark>d fo</mark> r a	<mark>a g</mark> roup of vehicles	in a cooperative v	<i>y</i> ay		2	24	2		-	-/	-	-	-	-	-	-	-	-	2
Unit-1 : In	troduction to Ve	hicle Comm	unication	13				-				- 2	_							9	Hour
FM Radio, RADAR, S	GPS, Short range Side RADAR, GPS	e RADAR, <mark>Wi</mark> S, Cellular tra <mark>i</mark>		gent Roadway-Infr nt Recorder.	d congestion avoidance, astructure to vehicle and															Forwa	
Intelligent Communic	Transportation Sy cation Systems - I	rstem (TTS) – Inter and Intra	Vision for ITS Com Vehicle Communi	munications-Multi cation-VANETS-D	media communication in evices-Optical Technolog	a car –Cur gies and Mi	rent I illimet	TS (ter W	Commu Vave T	inicatio echnol	on Sys	stems	and Se	ervices	s-Vehi	cle to	Vehicle	and F	Road to		
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Introduction, enabling technologies, cooperative architecture, Mapping for safety application, Safety application using active VANET, Case study any safety application using VANET

		1. Gilbert Held "Inter and Intra Vehicle Communications", Auerbach Publications, 2008.	4.	Yunpeng Wang, Daxin Tian, Zhengguo Sheng, Wang Jian - "Connected
	Learning	2. Mohamed Kassab "Communication Technologies for Vehicles" Springer, 2015		Vehicle Systems_ Communication, Data, and Control" CRC Press.
	Resources	3. Yue Cao · Yuanjian Zhang · Chenghong Gu ,"Automated and Electric Vehicle: Design,	5.	Hannes Hartenstein, Kenneth P Laberteaux "VANET:
		Informatics and Sustainability", Springer, 2023.	6.	Vehicular Applications and Inter-Networking Technologies" JohnWiley & Sons Ltd, 2010.
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earning Assessm	ent		C.F.				
	Bloom's Level of Th <mark>inkin</mark> g	CLA-1 Avera	Continuous Learning Assessment (CLA) Formative CLA-1 Average of unit test (50%) Continuous Learning Assessment (CLA) Life-Long Learning CLA-2 (10%)				native nmination nightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%		15%		15%	-
Level 2	Understand	25%	7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		25%	-
Level 3	Apply	30%		25%		30%	-
Level 4	Analyze	30%	20 1 1 3 30	25%		30%	-
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Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. K. Karthikeyan, R &D Team Manager, Power Quality Products, Hitachi	1.Dr.K.Balasubadra, Professor, Electronics, RMD	1. Dr. K Sivanathan, SRMIST
Energy, Bangalore	Engineering College, Chennai	
	2.Dr. P. Karthikeyan, Assistant Professor, Department of	2. Dr. Mohamed Rabik, SRMIST
2.Dr.Srinivasan, Principal Engineer, Ma <mark>hindra a</mark> nd Mahindra, Chennai	Production Technology, MIT Campus, Anna University,	
	Chennai- 600044.	<i>1</i> '
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Course	21MHE447T	Course	SAFETY, ETHICS AND REGULATIONS FOR DRIVERLESS CARS	Course	_	PROFESSIONAL ELECTIVE	L	T	Р	С
Code	21MHE4471	Name	SAFETT, ETHICS AND REGULATIONS FOR DRIVERLESS CARS	Category		PROFESSIONAL ELECTIVE	3	0	0	3

Pre-requisite Courses	21MHE438T	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offerin	ng Department	Mechatronics Engineering	Data Book / Codes / Standards		Nil

Course L	earning Rationale (CLR): The purpose of learni	ng this course is to:		Program Outcomes (PO)						ograr							
CLR-1:	identify risks related to ethics in autonomous veh	cles	1	2	3	4	5	6	7	8	9	10	11	12		pecifi tcom	
CLR-2:	categorize the type of ethics for autonomous veh	cles	ge		of	SI	1		. "		Work		e				
CLR-3:	experiment with the trolley problem for the study	of ethics	Knowledge	S	Jent	estigations roblems	sage	ъ			× ×		Finan	бL			
CLR-4:	balance the ethics and risks of autonomous vehic	le design		nalysis	udoli	estig orobl		r and	× ×		Team	ig	∞ర	aming			
CLR-5:	CLR-5: build structural assurance for ethics.		ering	\triangleleft	sign/development utions	ĕ ≦.	Tool r	engineer etv	onment		s le	unicat	. Mgt.	ong Le			
Course C	Outcomes (CO): At the end of this cou	rse, learners will be able to:	Engine	Problem	Design	Conduct of compl	Modern	The en	Enviror Sustair	Ethics	Individual	Communication	Project	Life Lo	PS0-1	PS0-2	PSO-3
CO-1:	apply ethics for risk balancing		<u> </u>	1.2	- 2	100	4.		_	-	-	-	-	-	-	2	-
CO-2:	design risk-balanced A <mark>Vs based</mark> on the classifica	tion of ethics	2	400	2			-		-	-	-	-	-	-	2	-
CO-3:	apply the results of the trolley problem as ethics t	or AVs	2	15.40	2	-1	-	-	-	-	-	-	-	-	-	2	-
CO-4:	design an AV with the balancing of risk and ethic		2	-	2		-	-	-	-	10-	-	-	-	-	2	-
CO-5:	construct structural-based assurance for ethics	W. 424 11 12 2 V	2		2		-	-,-	-	-	-	-	-	-	-	2	-

Unit-1: Introduction to Ethics

9 Hours Ethics and risk distribution, Post trolley ethics, Moral uncertainty in Autonomous Vehicles, Broad social impacts-pandemic, possible hazards, risk in Lown and ocean, Contaminated AV, Ethics of AV and discrimination

Unit-2: Ethics Classification and Machine Learning

9 Hours

Moral significance of classification, Moderate subjectivism for automated vehicles, From theory to practice toward a decision procedure, trolley optimism, machine learning basis for trolley Pessimism, Machine learning and autonomous vehicles, Objections-technological and Philosophical objections

Unit-3: Trolley Problem and Ethics in the Public Domain

9 Hours

Trolley problem, experiment, implications of results for ethics, normative pluralism-the situation, The Predicament of Pluralism, Hostage Situation, Designer Ethics, Considerations of Value and the Type of Vehicle

Unit-4: Ethics and Risk Balancing in the Design

9 Hours

Engineering ethics and implemented ethics, AVs and ethical risk reduction, Perception of risks posed by AV and man, ethics and risk balance-As Low As Reasonably Practicable (ALARP). Ethical motivation for risk balancing, refinement of risk factors-area impact, exposed population, causes, profiles and ethical positions, risk profile selection quidance, Justification and implementation of risk profiles for various scenarios.

Unit-5: Structural Assurance for Ethical Principles and Safety Regulations

9 Hours

Introduction, Principles of ethics assurance cases, Ethics assurance case templates, Business ethics and risk distribution in Hybrid traffic, Safety regulations-overview, Autonomous vehicle technology regulation, case studies on regulations and safety, US and UK safety standards

Learning	1. Ryan Jenkins, David Cerny, Tomas Hribek - "Autonomous Vehicle Ethics_ The Trolley	y 2. Ryan Jenkins, David Cerny, Tomas Hribek - "Autonomous Vehicle Ethics_ The Trolle
Resources	Problem and Beyond" Oxford University Press, 2022	Problem and Beyond" Oxford University Press, 2022

arning Assessm	ent			Wall Av					
			Continuous Learnii	ng Assessment (CLA)		Cum	mativa		
Bloom's Level of Think		CLA	Formative A-1 Average of unit test (50%)	CL	y Learning A-2 0%)	Summative Final Examination (40% weightage)			
		Theor	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	2 to 1 to 1	15%		15%	-		
Level 2	Understand	25%	4.0000000000000000000000000000000000000	20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	30%		25%		30%	-		
Level 5	Evaluate		2.77 4.35	10%		-	-		
Level 6	Create	-	10 6 1 1 1 - Land W.	5%	The same of the sa		-		
	Total	-	100 %	10	0%	10	0 %		

Course Designers	그는 이렇게 하는 사람들이 가면 되고 하셨다.	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. K. Karthikeyan, R &D Team Manager, Power Quality Products, Hitachi	1.Dr.K.Balasubadra, Professor, Electronics, RMD	1. Dr. K Sivanatha <mark>n, SRMI</mark> ST
Energy, Bangalore	Engineering College, Chennai	
	2.Dr. P. Karthikeyan, Assistant Professor, Department of	2. Dr. Mohamed Rabik, SRMIST
2.Dr.Srinivasan, Principal Engineer, Mahindra and Mahindra, Chennai	Production Technology, MIT Campus, Anna University,	
	Chennai- 600044.	

Course Code	MINERASTRICTURE FOR SELE-DRIVING LECTROLOGY				OLOGY	÷ a		urse egory	Е		Р	ROFE	SSION	IAL EI	LECTI	VΕ	l (- T	P 0	3		
Pre-requis	s	1MHE438T	C	requisite ourses		Nil	NC	'nD	ogres Cours			٠.,	M			Ni	il					
Course C	Offering Departm	nent	<u>Mechatronics</u>	Engineering	Data B	ook / Codes	/ Standar	ds	-4	_			٠,	<u> </u>	Nil							
Course Le	earning Rational	e (CLR): The	e purp <mark>ose of le</mark>	arning this cours	se is to:					4	7	Progr	am Oı	utcom	es (PC	D)					ogra pecifi	
CLR-1:	CLR-1: realize the guidelines of infrastructure for AVs					1	2	3	4	4 5 6 7 8				9	10	11	12	Ou				
CLR-2:	realize the police	ies of infrastr	ru <mark>cture</mark> for AVs				5.72	ge		of	S		Α.			ž		φ				
CLR-3:	LR-3: describe the framing mechanism for infrastructure.				-1794 T	wled		ent	ation	ge				Μ		Finance	D D			i		
CLR-4:					7	Kno	lysis	opm	stig	Modern Tool Usage	and	∞ _		& Team Work	lo O	& Fir	Leaming					
CLR-5:	practice case si	tudies					1154 - 17	Engineering Knowledge	Problem Analysis	gn/devel	Design/development of solutions Conduct investigations of complex problems		engineer and etv	Environment 8 Sustainability	ςΩ	Individual & 7	Communication	Project Mgt.	Life Long Lea	-1	-2	ကု
Course Ou	utcomes (CO):	At	the end of this	course, learners	will be able	e to:	478. c	ingi	Prob	Designation	Sono	Mode	The en	Sust	Ethics	ndiv	E S	Proje	le l	PSO-1	PSO-2	PSO-3
CO-1:	implement the i	nfrastru <mark>cture</mark>	<mark>ba</mark> sed on guidel	ines for AVs	77,780	160 E	7 7	2	10.70		-	-	- "	-	-	-	-	-	-	-	2	-
CO-2:	implement the i	nfrastru <mark>cture</mark>	<mark>ba</mark> sed on policie	s for AVs	13.3			2	1999	7.0	-1	-	-	<u> </u>	-	112	-	-	-	-	2	-
CO-3:	frame the infras			Acres N	10.00			2	-	2	- 23	-	-	-	-	12	-	-	-	-	2	_
CO-4:	design of AV ba			cture		the the	N 18	2	-	2		-	-/		-	<u> </u>	-	-	-	-	2	
CO-5:	design an infras	structure <mark>as a</mark>	case study		The same			2		2	-	-	-	-		-	-	-	-	-	-	2
Unit-1 : In	troduction and (Guidelines o	f Infrastructure	for AV-Enabled	System		by and					_	←	•							9 F	lours
				ways of infrastruc		AVs. Link fo	r policy ma	kers a	and int	rastru	cture o	perato	rs. Im	provinc	and and	mainta	ainina ı	ohvsica	al infras	structu		
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Learning
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Resources

- Othman, Kareem. (2021). Impact of Autonomous Vehicles on the Physical Infrastructure: Changes and Challenges. Designs. 5. 40. 10.3390/designs5030040.
 ITF research report "Preparing Infrastructure for Automated Vehicles" 2023
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Learning Assessme	Learning Assessment											
	Bloom's Level of <mark>Thinking</mark>	Form CLA-1 Averaç (50	ative ge of unit test	CL.	Learning A-2 %)	Summative Final Examination (40% weightage)						
	8	Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%		15%		15%	-					
Level 2	Understand	25%	to part of the disc	20%		25%	-					
Level 3	Apply	30%	3 . S - 13 L. S	25%	12.5	30%	-					
Level 4	Analyze	30%		25%		30 %	-					
Level 5	Evaluate	A STATE OF THE STA	The 1997 May	10%			-					
Level 6	Create	F 11- 1 5		5%			-					
	Total	100)%	100) %	100	0 %					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. K. Karthikeyan, R &D Team Manager, Power Quality Products, Hitachi	1.Dr.K.Balasubadra, Professor, Electronics, RMD	1. Dr. K Sivanat <mark>han, SRM</mark> IST
Energy, Bangalore	Engineering College, Chennai	
	2.Dr. P. Karthikeyan, Assistant Professor, Department of	2. Dr. Moham <mark>ed Rabik</mark> , SRMIST
2.Dr.Srinivasan, Principal Engineer, Mahindra and Mahindra, Chennai	Production Technology, MIT Campus, Anna University,	
	Chennai- 600044.	

Course		Course	SOFTWARE ARCHITECTURE FOR SELF-DRIVING CARS	Course	Е	PROFESSIONAL ELECTIVE	L	Τ	Р	С
Code	21MHE4491	Name	SOFTWARE ARCHITECTURE FOR SELF-DRIVING CARS	Category	L		2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	Mechatronics Engineering	Data Book / Codes / Standard	S	Nil
			No Contract of the Contract of	$I' : A \subset \mathbb{R}^n$	

Course L	earning Rationale (CLR)	The purpose of learning this co	urse is to:		Program Outcomes (PO)					Program Specific									
CLR-1: equip students with practical skills that are directly applicable in the industry			1	2	3	4	5	6	7	8	9	10	11	12		tcom			
CLR-2:	provide Hands-On Expe	rience <mark>with Leadi</mark> ng Platforms like <i>i</i>	Autoware	Ass Whee	edge edge se e e e e e e e e e e e e e e e e e														
CLR-3:	LR-3: develop a holistic understanding of autonomous vehicle software architecture				nowledge	S	nent	ations	sage	ъ					Finan	ĝ			1
CLR-4:	develop a holistic understanding of autonomous vehicle software architecture learn to debug and optimize software components, an invaluable skillset Learn to debug and optimize software components, an invaluable skillset Learn to develop a holistic understanding of autonomous vehicle software architecture Learn to develop a holistic understanding of autonomous vehicle software architecture Learn to debug and optimize software components, an invaluable skillset					ami			1										
CLR-5:	prepare students for Future Innovations				neering	oblem Ana	gn/deve ions	duct inve	ern Too	enginee	onment	တ္	Individual &	munication	ect Mgt.	ong Le	<u>-</u>	-2	-3
Course O	utcomes (CO):	At the end of this course, learn	ers will be able to:	NA 100 113	Engine	Prob	Desi	Sono	Mode	The	Envil	Ethics	ndiv	Som	Project	<u>l</u> e	PSO	PSO.	PSO
CO-1:	setup and Navigate Aut	oware / Apollo Environments	A Marie Property	an bilitin	7	J.	7.7	2	2	2		-	-	-	-	-	-	2	1
CO-2: calibrate and Configure Sensors for Data Collection			n indi		2	2	2		-	-	-	-	-	-	2	1			
CO-3: implement Data Processing and Sensor Fusion Algorithms				11 4		241	2	2	2	-	-	10-	-	-	-	-	2	1	
CO-4:						-	12/15	2	2	2	-	-	1.1	-	-	-	-	2	1
CO-5:	design and Implement F	<mark>Path Pla</mark> nning and Control Algorithm	S	2 8 6		4	1	2	2	2	-	-		-	-	-	-	2	1

Unit-1: Introduction to Autoware and Apollo

9 Hour

Overview of Autoware and Apollo Platforms, setting up Development Environments, Introduction to ROS (Robot Operating System) and ROS-based Development, Simulating Autonomous Vehicle Environments, Basic Autoware / Apollo Architecture and Components.

Unit-2: Sensor Setup and Calibration

9 Hour

Types of Sensors Used in Autonomous Vehicles (LiDAR, Cameras, IMU, etc.), Sensor Calibration Techniques, Intrinsic and Extrinsic Calibration, Configuring Sensor Drivers in Autoware and Apollo, Data Collection and Dataset Management.

Unit-3: Data Processing and Sensor Fusion

9 Hour

Preprocessing of Sensor Data (Filtering, Downsampling, etc.), Sensor Data Fusion Techniques, Object Detection and Tracking, Localization and Mapping with Fused Sensor Data, Debugging and Optimization of Data Processing Pipelines.

Unit-4: Mapping and Localization

9 Hour

Creating and Updating Maps for Autonomous Driving, Techniques for SLAM (Simultaneous Localization and Mapping), Localization Methods (GPS, IMU, Visual Localization, etc.), Global and Local Localization Strategies, Handling Challenging Environments and Dynamic Changes.

Unit-5: Planning and Control

9 Hour

Path Planning Algorithms (e.g., A*, Dijkstra, RRT), Behavior Planning and Decision-making, Control Systems for Autonomous Driving (PID, Model Predictive Control, etc.), Integration of Perception and Planning Modules, Real-time Control and Adaptive Algorithms.

		SCIEN	CF	
	1.	Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics"	3.	Howie Choset and et al, "Principles of Robot Motion: Theory, Algorithms, and
Learning		MIT Press, 2005.		Implementations", Bradford books, 2005.
Resources	2.	Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction	4.	Bruno Siciliano, Oussama Khatib, "Spinger Handbook of Robotics", Springer, 2008
		to Autonomous Mobile Robotics", Second edition, The MIT Press, 2011		
			103	

Learning Assessme	ent	4	A 3 A 3 In 1999	- 12 3						
	Bloom's Level <mark>of Think</mark> ing	Forma CLA-1 Average (50%	tive e of unit test	g Assessment (CLA) Life-Long CL/ (10	Learning 4-2 %)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remembe <mark>r</mark>	15%		15%		15%	-			
Level 2	Understan <mark>d </mark>	25%	Fig. 40	20%		25%	=			
Level 3	Apply	30%	the first on the sa	25%	47 - L	30%	-			
Level 4	Analyze	30%	the same of the	25%		30%	=			
Level 5	Evaluate	3.00		10%			-			
Level 6	Create	- Carolina	- 100	5%		-	-			
	T <mark>otal _</mark>	100	%	100) %	100 %				

Course Designers		从3	6 /
Experts from Industry	77	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Guna Surendra, Hitachi, Tokyo, Japan		1. Dr.Thiyagarajan, Indian Institute of Technology Tirupati, thiyagu@iittp.ac.in	1. Dr. K Sivanathan, SRMIST
2. Mr.Elayaraj, apple, USA	77	2.Dr. P. Karthikeyan, Assistant Professor, Department of Production Technology,	2. Dr. Mohamed Rabik, SRMIST
	/ / /	MIT Campus, Anna University, Chennai- 600044.	



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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