ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 7
(Syllabi for Automobile Engineering Programme Courses)
(Revised on Jul 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

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	21AUC201T	Course Name	APPLIED THERMAL ENGINEERING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*identify the fundamental concepts of thermodynamic systems and energy transfer*
CLR-2:	*utilize thermodynamic laws and their applications*
CLR-3:	*utilize the concept of pure substance and rankine cycle*
CLR-4:	*enlighten the knowledge in Otto, Diesel, Dual cycle*
CLR-5:	*construct knowledge on air compressors, refrigeration systems and air conditioning systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concept of thermodynamic properties to quantify energy transfer*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*2*	*-*
CO-2:	*apply thermodynamic laws to analyze various thermodynamic systems, Exergy analysis*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*2*	*-*
CO-3:	*apply the concept of entropy and availability to thermodynamic systems and to do*	*-*	*2*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*1*
CO-4:	*evaluate the properties of pure substances and analyze vapour power cycles*	*-*	*2*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*1*
CO-5:	*calculate performance of air conditioning system using Psychrometric chart and applications in automotive climate control*	*-*	*-*	*1*	*-*	*-*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*1*

Unit-1 – Concept of Energy, Systems, Processes, Work and Laws of Thermodynamics ***9 Hour***

Thermodynamic system, control volume, properties, state, process and cycle, thermodynamic equilibrium, Quasi-static process, pure substance, state postulate, concept of temperature, zeroth law of thermodynamics, work and heat interactions, path function and point function, PdV work for various quasi-static processes, tutorials on work and heat transfer. First law of thermodynamics for a closed system, Forms of energy, concept of total energy E, Tutorials on first law of thermodynamics for a closed system, constant volume, constant pressure, process in which PV=C, Tutorials on poly tropic, adiabatic process, Combination of different process, Internal energy and Enthalpy, specific heats, derivation of general energy equation for a control volume, application of SFEE to various steady flow devices, Tutorial on first law applied to various steady flow devices

Unit-2 – Limitations of First Law and Second Law of Thermodynamics ***9 Hour***

Limitations of first law of thermodynamics, cyclic heat engine, energy reservoirs, pump, thermal efficiency and COP, Kelvin – Planck and Clausius statement of second law of thermodynamics, equivalence of the two statements, tutorials on second law of thermodynamics, reversible and irreversible process, causes of irreversibility, Carnot cycle, working of a Carnot engine, thermal efficiency of a Carnot engine, Tutorials on Carnot engines, ReversedCarnot cycle, Carnot's theorem, efficiency of Carnot heat engine, COP of Carnot refrigerator, Carnot heat pump, COP, Tutorials on combined heat engine & refrigerator/heat pump system. Clausius theorem, Concept of entropy, T-s diagram, Clausius inequality, Entropy principle, Application of the concept of Clausius theorem, Tutorials on change in entropy for solids and liquids, Available and unavailable energy, Irreversibility, Tutorials on availability

Unit-3 - Pure Substances ***9 Hour***

Phase change phenomenon of a pure substance, Property diagrams for phase change process, T-V, P-V, P-T diagram, P-v-T surface, Critical point and Triple point, T-s and h-s diagram, Dryness fraction, Use of Steam tables, Mollier chart, Identification of states & determination of properties, Tutorials oncalculation of steam properties, Rankine cycle, Operation of Rankine cycle, Analysis of Rankine cycle, Problems solving on Rankine cycle, Reheat – regeneration in Rankine cycle – Organic Rankine cycle

Unit-4 - Properties of Ideal Gases	***9 Hour***
Equation of state, Vander Waal's equation of state, specific heats and entropy of gas mixtures, Maxwell's relations, T-ds relations, Equations for dH and dU, Clausius – Clapeyron Equation, Joule – Thomson experiment, Joule – Thomson coefficient, Tutorials on Thermodynamic relations, Introduction, air standard cycles –Otto cycle, Diesel cycle, Dual cycle – significance, Pv and Ts diagram, work done, mean effective pressure, brake thermal efficiency	
Unit-5 – Air Compressor	***9 Hour***
Construction and Working of Single acting and double acting air compressors, basics of Intercooler, construction, working of multi – stage air compressor, compressor –Isentropic, adiabatic and polytropic, work done without clearance volume – FAD definition – fundamentals of refrigeration cycle – simple vapor compression refrigeration system, simple vapor absorption refrigeration system – construction and working, desirable properties of an ideal refrigerants. Properties of atmospheric air, psychrometric chart, dry bulb temperature and wet bulb temperature, psychrometric processes- sensible heating and cooling, humidification, dehumidification, cooling and dehumidification heating and humidification, Bypass factor for heating and cooling coils, application of air conditioning systems in automobiles, study of Automotive air conditioning systems, automotive climate control – climate governing factors	

Learning Resources	1. *Mahesh M. Rathore, Thermal Engineering, Tata McGraw HillEducation, 2012* 2. *Yunus. Acengel., Michael A Boles, Thermodynamics – An Engineering Approach, 8th ed., Tata McGraw Hill- Education, 2015* 3. *Nag. P.K, Engineering Thermodynamics, 5th edition, Tata McGraw Hill Education, 2013*	4. *R. Rudramoorthy, Thermal Engineering, 4th ed., Tata McGraw-Hill, 2007* 5. *C.P. Kothandaraman, Fundamentals of Heat and Mass Transfer, 4th ed., New Age International Publishers, 2012*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	-	*15%*
Level 2	*Understand*	*25%*	-	-	*20%*	-	*25%*
Level 3	*Apply*	*30%*	-	-	*25%*	-	*30%*
Level 4	*Analyze*	*30%*	-	-	*25%*	-	*30%*
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Gunabalan, Manager, R&D Turbo Energy,Chennai,*	1. *Dr. Chandramohan, NIT Warangal,*	1. *Mr. S. Logeshwaran, SRMIST*
2. *Mr. Shantha Kumar, Lead Engineer, Royal Enfield,*	2. *Dr. Ganesh, Anna University, Chennai*	2. *Dr. C. Prabhu, SRMIST*

Course Code	21AUC202J	Course Name	AUTOMOTIVE ENGINES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know about Various components of the engine, materials and its functions*
CLR-2:	*impart knowledge about the combustion process in SI Engine*
CLR-3:	*impart knowledge about the combustion process in CI Engine*
CLR-4:	*provide an insight about the lubrication, cooling system used in IC engines*
CLR-5:	*provide an insight about the turbo, supercharging and scavenging system in IC Engines*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*identify the components of the engine, materials and its functions*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*	-
CO-2:	*evaluate the performance of SI Engines*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*	-
CO-3:	*evaluate the performance of CI Engines*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*	-
CO-4:	*understand the lubrication and cooling system in IC Engines*	*3*	*3*	-	-	-	-	*2*	-	-	-	-	-	*3*	*3*	-
CO-5:	*understand the turbo, supercharging and scavenging system in IC Engines*	*3*	*3*	-	-	-	-	*2*	-	-	-	-	-	*3*	*3*	-

Unit-1 – Intake and Exhaust Systems Components ***12 Hour***

Constructional details of engine components –Functions and materials- Valve timing diagram for SI and CI engine- Port timing diagram for SI and CI engine- Firing order and its significance –Tutorial 1: Comparison of Valve Timing Diagrams for SI and CI engine –Intake system components – Discharge coefficient, Pressure drop Air filter, intake manifold, Connecting Pipe Exhaust system components Exhaust manifold and exhaust pipe Spark arresters Exhaust mufflers, Types and operation-Exhaust after treatment systems.

Practice:

1. Dismantling study and assembling of IC engines – Measurement of Bore, Stroke, Ovality and Taper, 2.Valve Timing Diagram for Four Stroke Engine and port Timing Diagram for Two Stroke Engine

Unit-2 – Combustion in SI Engine ***12 Hour***

Stages of combustion-Nature of charge –Flame propagation –Flame velocity and area of flame front- Rate of pressure rise – Cycle to cycle variation- Abnormal combustion – Theories of detonation-Comparison of SI and CI engine combustion process- Introduction to Combustion chambers- Effect of engine operating variables on combustion –combustion chambers types-factors controlling combustion chamber design-Modelling SI engine combustion. -Overview

Practice:

1. Study of fuel supply system, 2. Performance test on Petrol engine

Unit-3 – Combustion in CI Engine ***12 Hour***

Stages of combustion-Nature of charge –Mixture formation in CI engines – Importance of air motion Swirl, squish and turbulence Swirl ratio. Fuel air mixing – Factors affecting delay period- Knocking in CI engines – methods of controlling diesel knock- CI engine combustion chamber: Types – Design objectives – Factors influencing Combustion chamber design- Modelling CI engine combustion. -Overview-Advanced combustion concepts: Homogeneous charged compression ignition- Premixed charged compression ignition-Reactivity charged compression ignition.

Practice:

1 .Performance test on diesel engine, 2. Test for optimum coolant flow rate in IC engines

Unit-4 – Lubrication and Cooling Systems	***12 Hour***
Need for cooling system- Types of cooling system –Air cooled system-Liquid cooled system –Thermosyphon system- Forced circulation system- pressure cooling system –Properties of coolant- additives for coolants Need for lubrication system- Lubrication methods: Mist lubrication system-wet sump any dry sump lubrication –Properties of lubricants-consumption of oil. ***Practice:*** *Determination of viscosity of the lubricating oil. 2. Determination of flash and fire point of the fuel.*	
Unit-5 – Turbo Charging, Supercharging and Scavenging	***12 Hour***
Objectives of Super charging-Methods to boost the engine power –Turbo charging methods-Thermodynamics of Turbocharging –Turbo lag-Windage losses Engine exhaust manifold arrangements-Classification of scavenging systems Mixture control through Reed valve Induction – Charging Processes in two-stroke cycle engine – Terminologies Shankey diagram – perfect displacement, perfect mixing. ***Practice:*** *1.Energy Balance test on an Automotive Diesel Engine, 2 Morse test on petrol engines*	

Learning Resources	1. *Ganesan V, "Internal combustion engines", 4th edition, TataMcGraw Hill Education, 2012.* 2. *Rajput R. K, "A textbook of Internal Combustion Engines", 2nd edition, Laxmi Publications (P) Ltd, 2007.* 3. *Internal Combustion Engine Fundamentals, 2nd Edition. John B. Heywood. ISBN: 9781260116106. Publication Date & Copyright: 2018.McGraw-Hill Education*	4. *Ramalingam K. K, "Internal Combustion Engines", Second Edition, Scitech Publications,2009* 5. *Edward F, Obert, "Internal Combustion Engines and Air Pollution", IntextEducation Publishers, 1980*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*25%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jayaraman.R,BLG Logistics,jayaraman.r@blgparekh.com*	1. *Dr.M.Parthasarathy, Vel Tech,nparthasarathy@veltech.edu.in*	1. *Dr. T.Prakash, SRMIST*
2. *Mr. Shanmuga Sundaram, RNTBCI, sankaran@rntbci.com*	2. *Dr.P.Nanthakumar, Amrita school of Engineering, p_nanthakumar@cb.amrita.edu*	2. *Dr. C.Prabhu, SRMIST*

Course Code	21AUC203J	Course Name	MANUFACTURING TECHNOLOGY FOR AUTOMOTIVE ENGINEERS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge of various conventional manufacturing processes*
CLR-2:	*utilize the work and tool holding devices*
CLR-3:	*identify the various surface finishing process and coating techniques*
CLR-4:	*identify the fundamental concepts of CNC machining*
CLR-5:	*compare various advanced manufacturing techniques for suitable applications*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply different welding and casting techniques for suitable applications*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*compare the advanced metal forming process and current role in industries*	*3*	*1*	-	-	-	-	-	-	-	-	-	-	*3*	*1*	-
CO-3:	*produce prismatic components and Gears*	-	*2*	-	*1*	-	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*apply the knowledge of CNC machining in various Automotive component manufacturing*	*2*	-	-	-	*3*	-	*2*	-	-	-	-	-	*2*	-	-
CO-5:	*select viable manufacturing process of complex parts alternative to conventional manufacturing*	-	-	*1*	*3*	-	-	*2*	-	-	-	-	-	-	-	*1*

Unit-1 - Conventional Manufacturing - Overview **12 Hour**

Introduction to Welding- classifications – Types – Working principles of ARC, MIG, TIG, SPOT, Laser welding – Welding defects – Welding Applicationin Automobile. Introduction to casting – Pattern materials & types – Shell, investment & pressure die casting – casting defects – casting application in Automobile. Introduction to Forging – types & defects – Rolling process – types & defects – Extrusion process & defects – tube drawing - sheet metal operations – Bending – stretch forming – Deep drawing – Ironing – Hydroforming

Unit-2 - Machining and Gear Manufacturing Process **12 Hour**

Introduction to Machining – theory of metal cutting – Mechanics of chip formation & types of chips – cutting tool materials – Tool life calculation – Tool wear – Tool signature for single point cutting tool – Lathe machine - Types of lathe – cutting fluids & Machinability – Material removal rate – Operating parameter – cutting speed, feed & depth of cut. Introduction to Milling machine – types – milling cutters & Indexing process – overview of surface machining, drilling operation – Gear forming process – Extrusion & stamping – Gear Hobbing process– types – Gear shaping & types - Powder metallurgy technique – sintering – properties of metal powders – particle size and blending – compaction – applications in automobile

Unit-3 - Surface Finishing Treatments **12 Hour**

Introduction to Finishing operations – Grinding machine - surface & cylindrical – external, internal & Centre less – Automotive Application of Lapping – Honing – Buffing – Deburring – shot blasting – shot peening. Superfinishing process – cylindrical & centerless micro honing – Application – Electrochemical polishing – protective & decorative coating techniques – Applications.

Unit-4 - CNC Machine Tools **12 Hour**

Evolution of CNC Technology – principles – features – advantages – CNC & DNC concept. Classification of CNC Machines – Turning centre, machining centre, EDM, Types of control systems – CNC controllers – characteristics – interpolators – computer-aided inspection. CNC Machine building – structural details – configuration & design – guide ways – Friction, Anti friction – spindle drives – DC shunt motor - Feed drives – stepper motor, servo principle, DC & AC servo motors – open loop & closed loop control – Axis measuring system – Gratings – encoders – Laser interferometer.

Unit-5 - Additive Manufacturing Techniques	***12 Hour***
Introduction to Additive Manufacturing – Importance of rapid prototyping – classification – Advantages – Stereo Lithography – Multi jet modelling – Powder based techniques – selective Laser sintering – 3D Printing – its working & applications – Fused deposition modelling – Laser powder bed fusion process.	

Learning Resources		
	1. *Seropkalpakjian, Manufacturing Engineering and Technology,7th ed., Pearson Education, 2013.* 2. *P.N. Rao, Manufacturing technology – Machining and MachineTools, Vol. 2, 3rd ed., Tata Mc Graw Hill, 2017* 3. *P.N. Rao, Manufacturing technology – Foundry forming and welding, Vol. 1, 4th ed. Tata Mc Graw Hill, 2013.*	4. *Mikel P Groover, Fundamentals of Modern Manufacturing, 4th ed., JohnWiley and Sons, 2009.* 5. *Sharma P C, A Text Book of Production technology – manufacturingProcesses, S Chand & Company, New Delhi.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*-*	*20%*	*20%*	*-*
Level 2	*Understand*	*30%*	*-*	*-*	*30%*	*30%*	*-*
Level 3	*Apply*	*50%*	*-*	*-*	*50%*	*50%*	*-*
Level 4	*Analyze*	*-*	*-*	*-*	*-*	*-*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Ajeet Babu ARAI,ajeetbabu.fid@araiindia.com*	1. *Dr. B. Mohan Anna University bmohan@annauniv.edu*	1. *Mr.S. Palanisamy, SRMIST*
2. *Mr.Dalpat Singh M & M, singh.dalpat@mahindra.com*	2. *Dr.R.Elansezhian, Pondicherry Engineering College,elansezhianr@gmail.com*	2. *Dr. J. Chandradass, SRMIST*

Course Code	21AUC301T	Course Name	CAD ANALYSIS FOR AUTOMOTIVE ENGINEERS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the various design concepts and modelling techniques*
CLR-2:	*introduce the latest developments in CAD Packages*
CLR-3:	*understand the basic knowledge of automotive components respective to design*
CLR-4:	*provides the knowledge on forces of connecting rod*
CLR-5:	*familiarize the design procedure of engine components*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*create the design models by various technique*	*3*	*-*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*2*	*-*
CO-2:	*develop the model using various features*	*3*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-3:	*explain the procedure involved in design*	*3*	*-*	*2*	*1*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-4:	*familiarize with various design standards*	*3*	*3*	*2*	*-*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-5:	*design various automotive components to suit industrial needs*	*3*	*-*	*-*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*1*	*-*

Unit-1 - Introduction to CAD — ***9 Hour***

Introduction to CAD, Product life cycle management, Design models – Pahl and Beitz model, Shigley model and Ohsuga model, Geometric modelling,Constructive solid geometry, Boundary representation, Introduction to Coordinate system, Model coordinate system, Transformations in 2D and 3D, Concatenated and Inverse transformation, Visibility techniques – Minimax test, Containment test, Hidden line removal – priority algorithm

Unit-2 - Modelling and Software Packages — ***9 Hour***

Introduction to Software Packages, Salient features and technical comparison, Modules and tools, Open-source tools (FreeCAD, LibreCAD), Need for dataexchange standards and types, Structure of STEP file system: Advantages and Disadvantages, Structure of IGES file system: Advantages and Disadvantages, outline of feature technology, Classification of features, Design by features, Applying features t o various automotive components, Advantages and limitations of feature-based modelling. Introduction to GD & T, Need of GD&T, Geometrical tolerance, Dimensional tolerance.

Unit-3 - Design of Cylinder and Piston — ***9 Hour***

Introduction to Cylinder And Piston, Principal Parts of an IC Engine, Cylinder and Cylinder Liner, Design of Bore, Length, Thickness of cylinder head, studs size of the cylinder head, Material for piston, Design of critical parameters of piston: Piston Rings, Piston Skirt, Piston pin. Modelling of cylinder and piston using CADsoftware.

Unit-4 - Design of Connecting Rod — ***9 Hour***

Introduction to Connecting Rod, Material selection for connecting rod, Forces Acting on the connecting rod, Dimensions of cross Section of the connecting rod, Dimensions of the crank pin at the big end, Dimensions of the piston pin at the small end, Size of bolts for securing the big end cap, Thickness of the big end cap.Modelling of Connecting Rod using CAD software.

Unit-5 - Design of Crankshaft — ***9 Hour***

Introduction to Crankshaft, Introduction about crank shaft and its function in an I.C Engine, Materials selection for crankshaft, Bearing pressures andstresses in crankshaft, Design Procedure for Crankshaft, Design of Centre Crankshaft When the crank is at dead centre, Design of Centre Crankshaft When the crank is at angle of maximum twisting moment, Design of Overhung Crankshaft When the crank is at dead centre, Design of Overhung Crankshaft When the crank is at an angle of maximum twisting Moment, Modelling of crankshaft using CAD software

Learning Resources	1. *Ibrahim Zeid, "CAD / CAM - Theory and Practice"., Tata Mcgraw-Hill, New Delhi, 2009* 2. *Radhakrishnan. P "CAD / CAM / CIM" New age international,2018* 3. *Mikell P. Groover, "CAD / CAM"., Prentice Hall of India PrivateLimited, New Delhi, 2003*	4. *Khurmi, "A text book of Machine Design", S Chand publication, 2016.* 5. *Bhandari V, "Design of Machine Elements", Tata McGraw-Hill Education,2010.* 6. *Shigley J, "Mechanical Engineering Design", Tenth Edition, Mc Graw Hill,2014.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*30%*	-	*30%*	-
Level 3	*Apply*	*50%*	-	*50%*	-	*50%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.B.Prabhakaran, Continental prabhakaran.balaraman@continental-corporation.com*	1. *Dr.P.D.Jeyakumar, Crescent Institute of Science andTechnology, pdjeyakumar@gmail.com*	1. *Dr.J. Chandradass, SRMIST*
2. *Mr.S.Vengatesan, RNTBCI, vengatesan.subramanian@rntbci.com*	2. *Dr.R.PrabhuSekar, Motilal Nehru National Institute of Technology, rprabhusekar@mnnit.ac.in*	2. *Mr.G.Naresh, SRMIST*

Course Code	21AUC301L	Course Name	DESIGN OF AUTOMOTIVE SYSTEMS LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	Describe the need of computer aided design
CLR-2:	Demonstrate the various 2D sketching tools
CLR-3:	Demonstrate the various 3D modelling tools

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Understand the need of computer aided design	2	-	2	2		-	-	-	-	-	-	-	2	-	2
CO-2:	Create 2D drawings using sketching tools	3	3	3	2	3	-	-	-	-	-	-	-	3	3	3
CO-3:	Develop 3D models using different features of solid modelling	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3

Practice -	30 Hour
Practice: 1 Introduction to Computer Aided Design and 2D Sketch tools	
Practice: 2 Modelling of Piston, connecting rod , crank shaft and, cam shaft	
Practice: 3 Modelling of Gearbox assembly	
Practice: 4 Modelling of Slip joint, Universal joint and Propeller shaft	
Practice: 5 Modelling of Differential Assembly	
Practice: 6 Modelling of Steering Gear box	
Practice: 7 Modelling of Clutches	
Practice: 8 Modelling of Front axle assembly	
Practice: 9 Modelling of braking system	
Practice: 10 Modelling of Wheel assembly	

Learning Resources	
1. Radhakrishnan. P "CAD / CAM / CIM" New age international, 2018 2. Introducing solidworks "Dassault systems", 2014 3. Matt Loambard, "Mastering Solidworks", 201	4. Nitin.S. Gokhale, "Practical finite element analysis", Hyperworks, 2020 5. Huei-Huang Lee, "Finite Element Simulations with ANSYS Workbench 2020", SDCPublications, 2020

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	30%	-	30%	-	30%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Mr.P. Nirmalkumar, Hubbell India, nirmal06kumar@gmail.com	1. Dr.P.D.Jeyakumar, Crescent Institute of Science and Technology, pdjeyakumar@gmail.com	1. Mr. P. Baskara Sethupathi, SRMIST,
2. Mr.SuhasKangde,Mahindra &Mahindra, kangde.suhas@mahindra.com	2. Dr.R.PrabhuSekar, Motilal Nehru National Institute of Technology, Prayagraj, rprabhusekar@mnnit.ac.in	2. Dr. J. Chandradass, SRMIST

Course Code	21AUC302J	Course Name	VEHICULAR STRUCTURES AND DRIVELINE SYSTEMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*familiarize the structure of Vehicle frames, Front and Rear axles*
CLR-2:	*acquire knowledge about various types of automotive driveline systems*
CLR-3:	*explore the various components and functions of steering and suspension systems*
CLR-4:	*understand the different types of automotive transmission systems*
CLR-5:	*impart the knowledge of braking system, Wheels and tyres*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate the basic structure of an automobile and various types of axles*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*identify the various types of automotive driveline systems*	*3*	-	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*classify the different types of steering and suspension systems*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	-	-	-
CO-4:	*classify the different types of transmission systems*	*3*	-	*2*	-		-	-	-	-	-	-	-	-	-	-
CO-5:	*identify the various types of braking systems, wheels and tyres*	*3*	-	-	*1*		-	-	-	-	-	-	-	-	-	-

Unit-1 - Frames, Front and Rear Axles ***12 Hour***

Different types of chassis layout- FF, FR,RR and 4WD - Types of vehicle body and Classifications - Frames- construction, Materials, Loads Acting on frames – Types of vehicle frames-Ladder frame, Tubular frame - Integral frame, X-frame, Roll-cage frames - Common vehicle platform- Need, merits and demeritsCase study - Volkswagen PQ platform, Nissan B platform, Front axle – Live axles, Dead axles, Drop axles, Push and tag axles – Rear axles - Semi, full andthree quarter floating – Types of rear axle housing - Split Banjo and Salisbury type – Multi link rear axles practice 1: Study and measurement of various types of vehicle frame, body and driver seat. 2: Study of different types of front and rear axles and final drives. Calculation of final drive ratio.

Unit-2 - Transmission System ***12 Hour***

Types of clutches, construction and working of single plate - Multi plate and centrifugal clutch - Torque capacity of clutch – Numerical Analysis - Simple problems Fluid coupling – Construction and principle of operation - Torque converters – Construction and principle of operation - Hydro kinetic drives - Multistage torque converters – Polyphase torque converters. Types of gear boxes - Working of sliding And constant mesh gear boxes - Construction and working of synchromesh gear box and principle of synchronizers - Planetary gear box - construction and working - Numerical in Gear box - Automatic transmission - Chevrolet turbo glide Construction and working - Chevrolet Power glide - Construction and working - Hydraulic clutch actuation for Automatic transmission. Practice 3: Dismantling, study and assembling of a given clutch and calculate the maximum torque carrying capacity. 4: Dismantling study and assembling of a given gear box and calculate the gear ratio

Unit-3 - Drive Line and Final Drives ***12 Hour***

Effect of driving thrust and torque reactions - Hotchkiss and torque tube drive – Front wheel drive - Propeller shaft –Construction, Critical Speed - Universal joint, Slip joint , Constant velocity joint and Tripod joint. Different types of final drive - Worm and worm wheel, Straight bevel gear, Spiral bevel gear and hypoid gear final drives - Double reduction final drive – Twin speed final drive - Differential- Principle and constructional details - Differential lock – Limited slip differential. Practice 5: Dismantling, study and assembling of propeller shaft, Universal joint, Slip joint, Constant velocity joint and Tripod joint 6: Dismantling, study and assembling of Final drive assembly and calculation of final gear ratio.

Unit-4 - Steering and Suspension Systems	***12 Hour***
Front wheel geometry - Caster, Camber, Toe in and toe out, SAI - Steering systems - True rolling motion of wheels and Numerical Analysis – Simple problems - Ackermann and Davis steering Mechanism - Constructional details of steering linkages for rigid and independent front axles. Steering gear box - Re-circulating ball type, Rack and pinion type, Worm and Nut type - Power assisted steering - Hydraulic and EPS – Four wheel steering Need for suspension system. Types of suspension - Non independent and independent suspension - McPherson and Wishbone suspension - Types of suspension springs - Leaf spring, Coil spring, Torsion bar, and Rubber springs – Shock absorbers – Pneumatic suspension - Rear axle suspension system - Independent, Trailing Arm - De-dion suspension and torsion beam - Anti-roll bar, Pan hard rod and Radius rod. Practice 7: Dismantling, study and assembling of different automobile steering systems Practice 8: Dismantling, study and of automobile suspension system.	
Unit-5 - Brakes, Wheels and Tyres	***12 Hour***
Theory of braking - Stopping distance - Braking efficiency, Numerical analysis - Drum brakes - Single cam, Double cam - Leading and Trailing shoe types - Disc brakes - Fixed, floating and radial mounted calipers - Ventilated discs, cross drilled discs, slotted discs - Mechanical and hydraulic brake actuation - Pneumatic braking system - Vacuum assisted hydraulic brakes - Air assisted hydraulic brakes - Need for ABS, ESP, EBD and Regenerative braking systems. Types of Wheels - Dimensions and Constructional details of wheels - Types - Construction - Cross ply, Radial ply - Tube and tubeless tyres - Tyre designation – Tread patterns Practice 9: Dismantling, assembling and bleeding of a hydraulic braking system. Practice 10: Study of different types of wheels and tyres	

Learning Resources		
	1. *Kirpal Singh, "Automobile Engineering - Vol I", StandardPublishers Distributors, 1999.* 2. *Crouse W.H, Anglin D.L, "Automotive Transmission and PowerTrain construction", McGraw Hill, 1976*	3. *Heldt P.M, "Torque converters", Chilton Book Co., 1992.* 4. *Newton Steeds &Garrot, "Motor Vehicles", SAE International andButterworth Heinemann, 2001.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2 - practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*30%*	-	-	*30%*	*30%*	-
Level 3	*Apply*	*50%*	-	-	*50%*	*50%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. R. Siva GM GMMCO – Caterpiller rsiva@gmmcoindia.com*	1. *Dr. PD Jayakumar Prof & Head, Dept of Auto, Cresent pdjeyakumar@cresent.education*	1. *Dr.K.Kamalakkannan SRMIST*
2. *Dr. Vijayabalan, Professor & Head Department of Mechanical Engineering HITS vijayabalan@hindustanuniv.ac.in*	2. *Mr .S. Kiran, SRMIST kirans@srmist.edu.in*	

Course Code	21AUC303J	Course Name	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge about the application of electrical and electronics in automotive systems*
CLR-2:	*understanding the working of charging and lighting accessories in automobile*
CLR-3:	*acquire the fundamental electronics applied vehicle motion control system*
CLR-4:	*familiarize the usage of Sensors and actuators in Automobile*
CLR-5:	*know about various electrical equipment diagnostics and testing methods*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*identify the need, requirement and function of basic vehicle batteries and its types*	*3*	*3*	*1*	*1*	*1*	*-*	*-*	*-*	*1*	*1*	*-*	*1*	*3*	*3*	*1*
CO-2:	*describe the charging, lighting and auxiliary electrical system for electrical vehicles*	*3*	*3*	*1*	*1*	*2*	*-*	*-*	*-*	*1*	*1*	*-*	*1*	*3*	*3*	*1*
CO-3:	*acquire and analyze the various fuel ignition and fuel injection system procedure*	*3*	*3*	*1*	*1*	*2*	*-*	*-*	*-*	*1*	*1*	*-*	*1*	*3*	*3*	*1*
CO-4:	*apply knowledge of vehicle dynamics to improve performance*	*3*	*3*	*1*	*1*	*2*	*-*	*-*	*-*	*1*	*1*	*-*	*1*	*3*	*3*	*1*
CO-5:	*analyze the protection system applied to electrical vehicles*	*3*	*3*	*1*	*1*	*2*	*-*	*-*	*-*	*1*	*1*	*-*	*1*	*3*	*3*	*1*

Unit-1 - System Architecture	***12 Hour***
Automotive Electrical and Electronics architecture – Components, connections, and power distribution, Vehicle Batteries- Fundamentals and types, Lead acid battery – Principle, Construction, Rating, Charging and Discharging mechanism, Peukert Criteria. Testing and Fault Diagnosis of Batteries, Starting System – Requirements and Functionalities, Starter motor Construction and Working principle, Starter Drive Mechanism – Introduction and types, Advancements in Battery Technologies. Practice 1: Battery Testing –Hydrometer, Load test, Individual Cell voltage test 2: Starter Motor –Continuity test, Insulation Test, Load test.	
Unit-2 - Electrical Accessories	***12 Hour***
Charging system - Introduction, Alternator – Construction and Working principle, Charging Circuits, Rectification, Voltage Regulator – Principle, construction, working and types, Lighting Circuits – Fundamentals and types, Lighting System regulations, Case Studies in Modern lighting system, Auxiliary Electrical system -Wiper system, Signaling and Warning system, Introduction to D.C charging system. Practice 3: Battery Testing –Hydrometer, Load test, Individual Cell voltage test4: Starter Motor –Continuity test, Insulation Test, Load test	
Unit-3 – Electronic Fuel Injection and Ignition System	***12 Hour***
Introduction – Engine management system, SI Engine Fuel Injector, Single point Fuel Injections, Multi Point Fuel Injections, Merits of MPFI, Testing of Fuel Injectors, programmed ignition system, Distributor less Ignition System, Waste spark analysis, Digital Engine Control Modes, EGR Control variable valve timing, Ignition Controlling – Introduction Closed loop ignition timing, Spark Advance Correction Scheme, Practice 5: Study of Lab view Programming6: ADC interfacing for IR Sensor.	
Unit-4 - ECU for Vehicle Control	***12 Hour***
Introduction – Vehicle motion control, Cruise Control System, Adaptive Cruise Control System – Construction, - Working, Throttle Actuator Stepper Motor Based Control, Antilock Braking Mechanism – Construction, Antilock Braking Mechanism – Working, Tire Slip Controller, Merits of ABS, Electronic Suspension System- Construction, Working Variable Damping, Variable Spring rate, Merits of Electronic suspension system, Electric Power Assisted Steering Mechanism- Construction Working, Four Wheel Steering, Steer-by-Wire, Lab: Review class.Practice 7: PWM Signal generation 8: H-Bridge Motor speed and position Control.	

Unit-5 - Brakes, Wheels and Tyres	***12 Hour***
Introduction – Telematics, GPS Navigation, GPS Structure, Dead Reckoning – Construction, Dead Reckoning – Working, Inertial Navigation System – Construction, Working, In vehicle infotainment systems, ADAS – Introduction, features, Electronic Control System Diagnostics, OBDII – Objective, Comparison of OBD I and OBD II, Diagnostics Fault Codes, Introduction to Model-based Sensor Failure Detection, Model-based Sensor Failure Detection working, Case Study on MAF Sensor calibration, Case Study on MAF Sensor calibration. Practice 9: UART communication for parking sensor 10: Fault Diagnosis using OBD handheld Devices.	

Learning Resources	1. *Tom Denton "Automobile Electrical and Electronic Systems" 3rdedition, Elsiever Butterworth-Heinemann 2004.* 2. *William.B.Ribbens, "Understanding Automotive Electronics" 7thedition Butterworth-Heinemann publications, 2012.*	3. *Ed Doering "NI MYRIO Project Essential Guide" 2013, National Technology and Science Press* 4. *Allan.W.M.Bonnick "Automotive Computer Controlled System2001,Butterworth- Heinemann* 5. *Robert Bosch Gmbh "Bosch Automotive Electric and Electronics" 5th edition Springer- 2007.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2 - practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill- lync*	1. *Mr. Sam Jebakumar, SRMIST, jebakumj@srmist.edu.in*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUC304J	Course Name	FINITE ELEMENT ANALYSIS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*predict how a product reacts to real-world forces, vibration, heat, fluid flow, and other physical effects*
CLR-2:	*model any physical system in to a finite element model and solve for its field variables*
CLR-3:	*solve real world complex problems which cannot be solved by analytical methods*
CLR-4:	*practice few commercial standard packages in solving complex problems*
CLR-5:	*understand the basics of multi-body systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply finite element technique to Engineering problems*	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	*improve their ability in solving differential equations for real world problems*	3	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-3:	*equip themselves familiar with multi-domain phenomenon like thermo-structural problems*	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	*familiarize themselves with the applications of finite element method & FEA packages*	3	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-5:	*solve kinematic and dynamic problems of multibody systems*	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction to FEA ***15 Hour***

Comparison Of FEA With Exact Solutions - Methods of engineering analysis - Numerical methods - Types of finite elements - Displacement or shape function Material behavior - Stiffness matrix - Steps involved in FEA –preprocessing and solution - Post processing - 2D and 3D stress element - Strain-displacement relationships - Discretization methods - Discretization process - Rayleigh ritz method - Galerkin method - Advantages and disadvantages of FEA - Applications of FEA

Practice*:*

1. Introduction to ANSYS 2. Cantilever Beam With Point Load at Free End

Unit-2 - One Dimensional Problems ***15 Hour***

Elements and node numbering - Global and local co-ordinates - Natural co-ordinates - Polynomial functions - Displacement function for 1D bar element - General stiffness matrix derivation - Stiffness matrix for 1D bar element - Assembly of stiffness matrix - Force vector - Spring element - Stiffness matrix for spring element - Boundary conditions - Imposing boundary conditions to bar element - Beam element - Stiffness matrix derivation of beam element - Truss element - Stiffness matrix for truss element

Practice*:*

3. Distributed Loading of a 1D Cantilever Beam 4. Application of Distributed Loads

Unit-3 - Two Dimensional Problems ***15 Hour***

Plane stress formulation - CST element - Shape function derivation for CST element - Strain displacement matrix for CST element - Stress strain matrix for CST element - Stiffness matrix derivation for CST element - Temperature effects - LST element - QST element - Axi –symmetric formulation – Iso-parametric formulation - Iso, sub. Super parametric element formulation - Four noded quadrilateral element - 1D heat conduction problems - Derivation of stiffness matrix

Practice*:*

5. Buckling Failure 6. Stress Analysis of Axi-Symmetry Structure.

Unit-4 - Multi-Domain Problems	***15 Hour***
Vibration analysis introduction - Modal analysis of a structure - fluid flow problems - Heat transfer problems - Thermo structural analysis - Introduction to biomedical and MEMS applications – ***Practice.*** *7 Analysis of 2D Truss 8. Thermal Analysis..*	
Unit-5 - Applications of FEA	***15 Hour***
Roll cage analysis - Rotor thermal analysis - Hub analysis - Knuckle analysis - Brake pedal analysis Bump analysis ***Practice:*** *9.Modal Analysis of A Roll cage 10.Crash Analysis of the Roll cage.*	

Learning Resources	1. *David V. Hutton, "Fundamentals of Finite Element Analysis",Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005* 2. *Ahmed A Shabana., "Computational Dynamics ", Wiley &Sons. thirdedition 2017*	3. *Bhavikatti S.S., "Finite Element Analysis", New Age InternationalPublishers, New Delhi, 2008.* 4. *ErdoganMadenci, Ibrahim Guven, "the finite element method and applications in engineering using ansys", Springer (India) Private Limited, NewDelhi, 2011.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination(40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*LearningCLA-2 - Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*25%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*25%*	*30%*	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. K Suresh HAL Sureshhal82@gmail.com*	1. *Dr. R. Jagadeeshwaran, BIT, profresearch@bitsathy.ac.in*	1. *Dr. J. Chandradass,, SRMIST*
2. *Mr. V. Raja Raman, Altair rajarav@asiapac.altair.com*	2. *Dr. Vijayabalan, Professor & Head Department of Mechanical Engineering HITS vijayabalan@hindustanuniv.ac.in*	2. *Mr. P. Baskara Sethupathi, SRMIST*

Course Code	21AUC401J	Course Name	VEHICLE DYNAMICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*learn the basic of overall components related to Vehicle Dynamics – Steering, Suspension, Brakes and Tyres, K & C and Wheel alignment*
CLR-2:	*enable students to understand the role of tyre characteristics and its mechanics for vehicle dynamics.*
CLR-3:	*enable the students to understand vehicle performance, handling and ride aspects and the issues involved in it such as braking, traction, road holding, vehicle control and stability*
CLR-4:	*prepare the students to understand Human response and ride comfort criteria.*
CLR-5:	*demonstrate how to address futuristic vehicle's dynamics requirements (ADAS), Homologation and challenges.*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*Understand different types of Steering, Suspension, Brakes, tires and their significance with respect to application.*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*1*	*2*	*1*	*2*	*1*	*3*	*3*	*2*
CO-2:	*Predict the necessary forces and moments during tyre/road interaction and basic tyre nomenclature.*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*1*	*2*	*1*	*2*	*1*	*3*	*3*	*2*
CO-3:	*Compute maximum traction, optimum braking force distribution and stability of the vehicles and their control strategies.*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*1*	*2*	*1*	*2*	*1*	*3*	*3*	*2*
CO-4:	*Demonstrate the application of fundamental governing equations for longitudinal, lateral and vertical dynamics and able to use state space approach.*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*1*	*2*	*1*	*2*	*1*	*3*	*3*	*2*
CO-5:	*Simulate the dynamic performance of vehicles*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*1*	*2*	*1*	*2*	*1*	*3*	*3*	*2*

Unit-1 - Fundamentals of Vehicle Dynamics and Tire Mechanics — ***12 Hour***

Introduction to Automotive Chassis – Basic of Steering system, types of steering, selection based on suspension & FAL, Ackermann Geometry, Wheel Alignment – Toe IN/Out, Caster, Camber and its impact in Tire performance. King Pin Inclination (KPI),King Pin Offset (KPO), Scrub radius, Suspension types – HCV, selection of suspension system based on road conditions/axle loads/ride comfort, Brakes – Disc & Drum brakes, Wheel rim types (Steel & Al Alloy), Wheel Rim Profile (B, J, JJ etc). Practical: Wheel alignment.

Tyre & Vehicle axes systems - Mechanical Properties of Rubber- Tyre types and construction -Tyre forces and moments - Slip, Grip and Rolling Resistance, Contact Patch and Contact Pressure Distribution -Cornering properties of tyres (Practical – Tyre cut section study) TPMS - Tire Brush Model Tyre Models – Magic Formula, Lateral Force Generation, Ply Steer and Conicity, Classification of Tyre Models and Combined Slip, Tire noise, NVH – Random Processes.

Practice 1: Introduction to modelling of dynamic systems using Simulink / Simscape / Modelica tools.

Practice 2: Simulation and analysis of single, two degree of freedom systems using Simulink / Simscape / Modelica. Case study to be offered by Volvo – Estimation of rolling resistance for a given tire fitted in a truck.

Co Teaching Area / Content by Volvo - Complete Vehicle Model (CVM) approach for truck design followed in Volvo Group.

Unit-2 - Longitudinal Dynamics and Vertical Dynamics — ***12 Hour***

Vehicle forces - Longitudinal forces and resistances - Rolling resistance, Aerodynamic drag force, Traction force, Deceleration and speed control, brake drag, Road gradient forces. Performance characteristics - Maximum tractive effort - Power plant and Transmission characteristics - Braking performance- Brake force distribution, brake efficiency, braking distance, Anti lock brake system and Traction control system.

Homologation for braking system IS 11852-2013. *Vehicle ride characteristics Sprung & Unsprung mass, Stiffness, damping ratio, Human response to vibration - Vehicle ride models -Quarter car model - pitch and bounce-bounce and roll model -Suspension performance for ride-vibration isolation - suspension travel - Road holding - Active and Semi-active suspensions, Suspension bushes - Introduction to random vibration - ISO road roughness and road profiles - RMS acceleration of sprung mass of vehicle for random road excitation.* *Practice 3: Magic Formula Tire model – Simulation of longitudinal and lateral forces.* *Practice 4: Simulation and analysis of Quarter Car model using Simulink / Simscape / Modelica.* *Case study to be offered by Volvo – Fundamental Equation of Motion for longitudinal dynamics of a truck* *Co Teaching Area / Content by Volvo - Longitudinal dynamics and Vertical Dynamics understanding in Complete Vehicle Model.*
Unit-3 - Lateral Dynamics and Vehicle Stability ***12 Hour***
General frame work for governing equations for ground vehicles - Bicycle Model- Low speed turning - High speed cornering-State space approach - Steady state handling characteristics of two axle vehicle- neutral steer-understeer-oversteer - Steady state gains from Bicycle Model during pure cornering - Vehicle handling tests (Constant radius cornering and fishhook) - Vehicle transient responses and understeer gradient effects due to lateral load transfer - roll steer - camber thrust - lateral force compliance and steering system compliance. On/Off center feel Homologation for steering system IS12222, IS11948. *Yaw plane stability and steering conditions - characteristic polynomial and stability factor – Handling response of a vehicle - Lateral transient response - Mimuro plot. Effect of suspension on cornering - Roll center and Roll axis - Roll moment distribution, ARB - Tyre relative angles - Caster theory - Role of suspension and nonlinearity of tyres on vehicle roll and its effect on Understeer co-efficient - roll over stability analysis - Control strategies required for vehicle.* *Practice 5: Shock absorber testing – Characterizing the shock absorber and formulating simple models for shock absorber using curve fitting.* *Practice 6: Control Strategy in ride modeling – Analysis of controllers like PID, Skyhook, LQR in ride comfort of vehicles using Simulink / Simscape / Modelica. Case study to be offered by Volvo – Quarter Car model formulation for a truck with cabin suspension and seat suspension.* *Co Teaching Area / Content by Volvo - Stability analysis of Trucks in Complete Vehicle Model.*
Unit-4 - Vehicle Dynamics for Electric, Hybrid and Autonomous Vehicles ***12 Hour***
introduction to EVs, HEVs, and AVs and their dynamics requirements - Dynamics behavior of the vehicle based on the battery pack location - Dynamics aspects based on the motor location and power distribution - NVH challenges for the EV and HEV- Experimental techniques - Frequency response functions - Modal analysis - Transfer path analysis - Single reference - Multi reference analysis. *Practice 7: Active Suspension system study using Quanser active suspension test rig. Practice 8:* *Control strategy for a basic ABS implementation using Simulink.* *Case study to be offered by Volvo – Bicycle model formulation for a truck system.* *Co Teaching Area / Content by Volvo - Differences in Complete Vehicle Model for Electric / Hybrid trucks when compared with Conventional trucks.*
Unit-5 - Modelling, Simulation and Advancements in Vehicle Dynamics Systems ***12 Hour***
ADAS, Role of ADAS, ADAS Levels, ADAS features - Adaptive Cruise Control, Adaptive Headlights, Antilock Brake Systems, Automatic Parking Assistance, Autonomous Emergency Braking, Blind Spot Monitor, Electronic Stability Control, Forward Collision Warning, Lane-departure Warnings, Lane-Centering Steering, Lane-keeping assistance. ISO 26262 – Overview. *Practice 9: Plotting longitudinal, lateral and vertical forces involved in vehicle motion using Carmaker software. Practice 10:* *Single Track model simulation and analysis using Simulink / Simscape.* *Practice 11: Basic kinematic Simulation with Motion Solve* *Case study to be offered by Volvo - Basic ABS system design for trucks* *Co Teaching Area / Content by Volvo - Simulation of trucks in Complete Vehicle Model*

Learning Resources	1. *J. Y. Wong, Theory of Ground Vehicles, 3rd Edition, Wiley-Interscience, 2008.* 2. *Thomas D Gillespie, Fundamentals of Vehicle Dynamics, 2nd Revised Edition, SAE International, Warrendale, 2021.* 3. *Reza N Jazar "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer International Publishing AG, Switzerland, 2017.* 4. *Katsuhiko Ogata, "Modern Control Engineering",5th Edition, Prentice Hall,Pearson, 2015*	5. *C. Sujatha, "Vibration and Acoustics: Measurements and Signal Analysis", McGraw Hill Education (India) Private limited, 20178.* 6. *Ellis.J.R - "Vehicle Dynamics"- Business Books Ltd., London- 1991..* 7. *Giles.J.G.Steering - "Suspension and Tyres", Illiffe Books Ltd., London- 1998. Chalmers – Vehicle Dynamics, Chalmers publication Library.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2 - practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Shantanu Chakraborty, Deputy General Manager, Volvo Group Trucks Technology, Banagalore.*	1. *Dr. V. Ganesh, Associate Professor, Dept. of Automobile Engineering, Sri Venkateswara College of Engineering, Pennalur.*	1. *Dr. AJD Nanthakumar, SRMIST*

Course Code	21AUC402J	Course Name	VEHICLE MAINTENANCE	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the fundamental workshop and maintenance concepts*
CLR-2:	*familiarize with the engine sub-systems nomenclature and maintenance*
CLR-3:	*understand the principles and construction of vehicle chassis and body*
CLR-4:	*familiarize with the operational characteristic of vehicle electrical system*
CLR-5:	*understand the concepts of various vehicle auxiliary system*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*interpret the workshop maintenance and practice*	-	-	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*diagnose the various engine sub systems for engine maintenance*	-	-	-	*2*	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the performance characteristics of vehicle chassis and body*	-	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*compare the operational characteristic of vehicle electrical system*	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*analyze the maintenance schedule of various vehicle auxiliary system*	-	-	-	-	*3*	-	-	-	-	-	-	-	-	-	-

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Unit-1 - Maintenance of Workshop Records and Schedule ***12 Hour***

importance of maintenance, scheduled and unscheduled maintenance, requirements of maintenance, preparation of check lists, vehicle down time, vehicle inspection, inspection schedule, maintenance of records, reports log books, trip sheets and other forms, safety precautions in maintenance, fleet maintenance requirement, work shop layout, tools and equipment, spare parts and lubricants stocking , manpower, training, workshop management, warranty, replacement policy.

Practice: *1. Layout for Garage and Preparation of Job Card Assignment (Two Wheeler/LCV/HCV), 2. Chart Preparation for Daily, Weekly, Monthly and Scheduled Maintenance*
3. Performance Evaluation of A Two-Wheeler Using Eddy Current Chassis Dynamometer

Unit-2 - Powertrain Maintenance ***12 Hour***

Dismantling of engine components and cleaning, cleaning methods, visual and dimensional inspections, minor and major reconditioning of various components, reconditioning methods, engine assembly, special tools used for maintenance and overhauling, engine tune up, layout of transmission system, servicing and maintenance of automobile clutch, servicing and maintenance of gear box, servicing and maintenance of propeller shaft, servicing and maintenance of differential system, troubleshooting checklist for engine, troubleshooting checklist for clutch, troubleshooting checklist gear box.

Practice: *4. Engine Tuning Process (Decarbonizing, Valve Lapping, Reboring, Valve Clearance and Shim Adjustment of Shafts), 5. Transmission System – Servicing and Maintenance (Clutch Gearbox Propeller Shaft Universal Joint and Slip Joint)*

Unit-3 - Vehicle Chassis and Body Maintenance ***12 Hour***

Maintenance and servicing of front axle, maintenance and servicing of rear axle, maintenance and servicing of suspension systems, maintenance and servicing of braking systems, overhauling of steering systems, maintenance of steering systems, wheel alignment, computerized alignment, wheel balancing, troubleshooting checklist for front axle, troubleshooting checklist for rear axle, troubleshooting checklist for suspension systems, troubleshooting checklist for steering systems, body panel tools for repairing, body panel tools for tinkering and painting.

Practice: *6. Steering System Servicing and Maintenance, 7. Tire Removal , Fitment, Computerized Wheel Alignment and Wheel Balancing 8. Determination of Side Slip, Suspension Efficiency, And Brake Efficiency Using Dynamometer.*

Unit-4 - Electrical System Maintenance	***12 Hour***
Testing methods for checking electrical components, checking of battery, checking of starter motor, checking of charging system, checking of, dc generator, checking of alternator, checking of ignition systems, checking of lighting systems, fault diagnosis of modern electronic controls, maintenance of modern electronic controls, checking of dash board instruments, servicing of dash board instruments, trouble shooting on engine management system, on board diagnosis using multi-scanner. ***Practice:*** *9. Measurement of HC, CO, CO2, and O2 Using Exhaust Gas Analyzer and Smoke Density Measurement* *10. Studying the Pattern of Secondary Ignition System Using Oscilloscope Type Engine Analyzer FSA 450 (Bosch)*	
Unit-5 - Maintenance of Auxiliary Systems	***12 Hour***
Servicing of fuel system of different types of vehicles, maintenance of fuel system of different types of vehicle, calibration and tuning of engine for optimum fuel supply, maintenance of cooling system, water pump, radiator, thermostat, anticorrosion and antifreeze additives, maintenance of lubrication system, different grades of oil, lubricant oil additive, lubricating oil changing, greasing of part, minor and major repairs of body parts, maintenance of door locking mechanism, maintenance of window glass actuating system. ***Practice:*** *11. Vehicle Assessment and Benchmarking of Tires by Tire Print Study, 12. Servicing of Coolant and Lubrication System.*	

Learning Resources	*1. MartyrA.J,PlintM.A, gine Testing Theory and Practice",3rdedition,Butterworth- Heinemann, 2007.Butterworth Heinemann, 2007.*	*2. Wolf-Heinrich Hucho, "Aerodynamics of road vehicles", 4th edition,2000* *3. Gousha H. M, "Engine Performance Diagnosis & Tune up Shop Manual".*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*25%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*25%*	*30%*	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. P. Poongukamaran, MD TICEL md@ticelbiopark.com	*1. Dr. Ganesh V, Professor SVCE vinaganesh@svce.ac.in*	*1. Jerome Stanley M, SRMIST*
	2. Dr. Vijayabalan, Professor & Head Department ofMechanical Engineering HITS vijayabalan@hindustanuniv.ac.in	*2. Dr.K.Kamalakkannan, SRMIST*

Course Code	21MEC202T	Course Name	MECHANICS OF SOLIDS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*utilize concepts of stress and strain to determine the axial deformations*
CLR-2:	*construct the shear force and bending moment diagram, and determine the stresses in beams*
CLR-3:	*determine the slope and deflection in beams for various loading conditions*
CLR-4:	*utilize concepts to design shafts based on strength and rigidity*
CLR-5:	*utilize concepts to design column and cylinders to predict the failure conditions*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concepts of theory of linear elasticity*	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze the force, bending moment and stresses in beams*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the slope and deflection in beams*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*apply the concept of torsion in shafts*	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*analyze the stresses in columns and pressure vessels*	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Concepts of Stress and Strain	***12 Hour***
Free body diagram, Types of stresses, strain, Poisson's ratio, stress-strain diagram, Elastic Constants, Deformation in axially loaded members, Strain energy, Impact loading, Thermal stresses- Stress at a point, Stress Tensor, Equations of Equilibrium, Different states of stress, Transformation of plane stress, Principal stresses and maximum shear stress - Mohr's circle for plane stress	
Unit-2 - Theory of Beams	***12 Hour***
Types of beams, support reactions, Shear Force Diagram, Bending Moment Diagram, Bending Stress & Shear stress in beams,	
Unit-3 - Deflection of Beams	***12 Hour***
Deflection of beams by double integration method- Macaulay's method-Moment area method-Castigliano's theorems, Maxwell's reciprocal theorem	
Unit-4 - Torsion of Shafts	***12 Hour***
Stresses in a Shaft, Deformations in a Circular Shaft, Stresses and Angle of Twist in the Elastic Range, Comparison of hollow and solid shafts	
Unit-5 - Columns and Pressure Vessels	***12 Hour***
Crippling load - Euler's theory and Rankine's theory, thin and thick pressure vessels, Lame's theory-case study on pressure vessels	

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston, John T. DeWolf, David F. Mazurek, Sanjeev Sanghi, "Mechanics of Materials: 8th Edition" McGraw Hill, 2020* 2. *William A. Nash, Merle C. Potter, "Strength of Materials: 6th Edition, Schaum's Outlines Series, McGraw Hill Education, 2014*	3. *Egor P. Popov, Engineering Mechanics of Solid, 2nd ed., Prentice Hall of India Pvt. Ltd., 2009* 4. *James M. Gere, Mechanics of Materials, 8th ed., Brooks/Cole, USA, 2013* 5. *Shigley. J. E., Applied Mechanics of Materials, International Student edition, McGraw Hill, 2000*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras skris@iitm.ac.in*	1. *Dr. E Vijayaragavan, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. A Vinoth, SRMIST*

Course Code	21MEC202L	Course Name	MATERIAL TESTING LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the specimen preparation procedures and correlate structure-property relationship of ferrous and non-ferrous alloy specimens*
CLR-2:	*acquire knowledge to perform grain size analysis and determine coating thickness and hardenability*
CLR-3:	*evaluate the variation in hardness and microstructure of heat-treated steel specimens and also to understand the tensile characteristics and deflection of materials*
CLR-4:	*have a better understanding on the mechanical behaviour of materials under compression, double shear, three-point bend and torsional loads*
CLR-5:	*understand the behaviour of materials subjected to fatigue, impact loads and to know the procedure of wear analysis*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*prepare different metal specimens and identify specimens by examining their microstructures*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-2:	*determine hardenability, coating thickness and analyze microstructure*	-	-	-	3	2	-	-	-	1	-	-	-	-	-	-
CO-3:	*investigate the variation in hardness and microstructures of heat-treated specimens and study their tensile characteristics and deflection of simply supported beams*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-4:	*Analyze the mechanical behaviour of materials subjected to compression, double shear, three- point bend and torsion loads*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-5:	*evaluate fatigue, impact and wear characteristics of materials*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-

Unit-1 - Specimen Identification	***6 Hour***
Study of metallurgical microscope, specimen preparation - mounting, polishing, etching. Identification of ferrous and non-ferrous alloys.	
Unit-2 - Coating Thickness and Phase Fraction	***6 Hour***
Determination of coating, case hardening thickness, hardenability. Evaluation of grain size and phase fraction.	
Unit-3 - Heat Treatment, Microstructure and Tensile Properties	***6 Hour***
Heat-treated steel specimens - investigation of microstructure and hardness. Tensile behaviour of steel specimens, deflection of simply supported beams.	
Unit-4 - Compression, Shear, Flexural and Torsion Properties	***6 Hour***
Compression, double shear, three-point bend and torsion tests of materials	
Unit-5 - Fatigue, Impact and Wear Properties	***6 Hour***
Fatigue test, impact test, wear analysis - pin-on-disc apparatus	

Learning Resources	1. *Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., McGraw Hill Education, 2017* 2. *Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed.,Cengage Learning, 2015*	3. *Ferdinand Beer, E. Russell Johnston, Jr., John DeWolf, David Mazurek, Mechanics of Materials, 7th ed., McGraw - Hill, 2017* 4. *Kazimi S. M. A, Solid Mechanics, 2nd ed.,Tata McGraw Hill, 2017* 5. *Laboratory Manuals - Metallurgy & Strength of materials laboratories*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*25%*	-	*20%*	-	*25%*	-	-
Level 3	*Apply*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 4	*Analyze*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-	-	-
Level 6	*Create*	-	-	-	*5%*	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Shankar Subburathinam, Engineering Manager – Caterpillar India Ltd*	1. *Dr. A. Suresh Babu, Associate Professor, CEG - Anna University*	1. *Mr. D. Selwyn Jebadurai,AP, SRMIST*
2. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley.*	2. *Dr. N. Arunachalam, Associate Professor, IITM*	2. *Mr. S. Arokya Agustin,AP, SRMIST*

Course Code	21MEC203T	Course Name	ENGINEERING MATERIALS AND METALLURGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge about phase diagrams, salient features of iron-carbon system and heat treatment process*
CLR-2:	*apply mechanism of plastic deformation, principle of strengthening methods*
CLR-3:	*utilize the mechanical behavior of materials and learn about failure analysis*
CLR-4:	*identify about structure, properties and applications of metals and non-metals*
CLR-5:	*acquire knowledge about properties and applications of advanced engineering materials*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*interpret binary phase diagram, describe the micro-constituents in iron-carbon system effect of heat treatment and surface hardening on the properties of materials*	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*explain different strengthening mechanisms, concepts related to plastic deformation*	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*discuss the failure of engineering materials, material testing and characterization techniques*	*1*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*classify metals and non-metals for various engineering applications*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*apply advanced materials for specific applications based on their properties and describe computational methods related to materials*	-	-	*3*	-	*2*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Phase Diagram and Heat Treatment — ***9 Hour***

Crystal structure, Imperfection in solids, Solid solutions – Types, factors governing solubility rules. Phase diagram – cooling curve, phase rule, types and interpretation. Iron- carbide (Fe-Fe3C) phase diagram, Microstructural aspects and invariant reactions in Fe-Fe3C diagram. Effect of alloying elements on Fe-Fe3C diagram. TTT and CCT diagrams. Various heat treatment and surface hardening process

Unit-2 - Elastic and Plastic Behaviour of Materials — ***9 Hour***

Stress Strain relation in elastic and plastic region, Mechanism of plastic deformation – slip and twinning, Slip systems, critically resolved shear stress, Shear strength of perfect and real crystals. Dislocation – climb, interaction, multiplication and pile ups. Strengthening mechanisms – Solid solution, Grain boundary, Dispersion, Precipitation, Fiber, Martensite strengthening, Strain aging and Strain hardening.

Unit-3 - Failure, Testing and Characterization of Materials — ***9 Hour***

Types of fracture in metals, Griffith's theory of brittle fracture, Stress intensity factor, Fracture toughness, Theory of Ductile to brittle transition. Creep – Creep curve, mechanism of creep deformation. Fatigue - S-N curve, low and high cycle fatigue, stages of fatigue. Sources of failure, Procedure of failure analysis. Hardness: Rockwell, Brinell, Vickers hardness, Nano-Indentation Technique. Introduction to characterization of materials - XRD, SEM and TEM.

Unit-4 - Properties of Advanced Materials — ***9 Hour***

Properties of plain carbon steel, Tool steel, Stainless steel, Cast iron. Need of micro alloying, HSLA steel - Dual phase steel, TRIP steel. Aluminum alloys – classifications, properties, applications, Titanium alloys. Polymers – Types, Properties and applications of PE, PP, PVC. Ceramics – Types, Properties and applications of Al2O3, ZrO2, SIC. Composites – classification, Reinforcement and matrix material, Rule of Mixture. Properties and applications of MMC, CMC and PMC. Functionally graded materials.

Unit-5 - Futuristic Materials and Computational Materials Design — ***9 Hour***

Smart materials – Types, Shape memory alloys. Nanomaterials: Carbon nanotubes, Graphene – properties and applications. Metallic foams, Metallic glasses, Super alloys, High entropy alloys, biomaterials, Multi-scale materials modelling. Integrated Computational Materials Engineering with application to Industry 4.0. Materials Informatics, Machine learning for design of materials, Property Optimization

Learning Resources	1. *Flake.C Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008* 2. *Dieter.G.E, Mechanical Metallurgy, McGraw Hill, Singapore, 2017* 3. *Budinski.K.G, Budinski.M.K, Engineering Materials Properties and selection,Edition 9, Pearson Publication, 2010* 4. *ASM Hand book, Failure analysis and prevention, Vol: 11, 2021* 5. *Reza Abbaschian, Lara Abbaschian& Robert E. Reed-Hill, Principles of Physical Metallurgy, Cengage Learning, 2013* 6. *Chaudhery Mustansar Hussain,,"Smart Materials and New Technologies", Springer, 2022* 7. *Shubhabrata Datta and J. Paulo Davim, Machine Learning in Industry, Springer, 2021.*	8. *James F. Shackelford et.al. CRC Materials Science and Engineering Handbook, Taylor & Francis, 2015.* 9. *William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction,10th ed., Wiley publication, 2018* 10. *Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science & Engineering, 4th ed., Cengage, 2018* 11. *Raghavan V. Physical Metallurgy: Principles and Practice, PHI Learning, 2015.* 12. *Shubhabrata Datta and J. Paulo Davim, Materials Design Using Computational Intelligence Techniques, CRC Press, Boca Raton, FL, USA, 2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*30%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr.V.S.Saravanan , Indo Shell Cast Private Limited, saravananvs@indoshellcast.com*	1. *Dr. Raju Abraham, Scientist-F, National Institute of Ocean Technology, Velachery-Tambaram Road, Pallikaranai, Chennai 601302, abraham@niot.res.in*	1. *Dr. Shubhabrata Datta, SRMIST*
2. *Mr. R.Sadagobaramanujam, TVS Sundram Fasteners Ltd, sadagobar@gmail.com*	2. *.Dr. N Arunachalam, IIT Madras, chalam@iitm.ac.in*	2. *Mr.M.Dhanasekaran, SRMIST*

Course Code	21MEC204L	Course Name	FLUID MECHANICS LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*identify the flow measuring devices*
CLR-2:	*apply the principles of Bernoulli's equation*
CLR-3:	*analyze the various energy losses in pipes*
CLR-4:	*assess the working of pumps/ Turbines*
CLR-5:	*measure forces around streamline body/bluff body in wind/ water tunnel*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate the coefficient of discharge in flow measurement devices*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-2:	*identify Bernoulli's equation for measuring different heads*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-3:	*determine and analyze the various energy losses in pipes*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-4:	*interpret the different types of pumps/turbines based on its performance*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-5:	*perform forces measurement around streamline body/bluff body in wind/ water tunnel*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-

Unit-1 - Flow Measuring Devices	***6 Hour***
Determine the coefficient of discharge of Orifice meter/ Venturimeter, Flow measurement using Pitot tube	
Unit-2 - Bernoulli's Principle	***6 Hour***
Determine total heads of fluids at given points in the pipe/ Bernoulli's theorem, forced vortex and find the depth of the forced vortex curve	
Unit-3 - Energy Losses in Pipes	***6 Hour***
Study of major Energy loss in a pipe, Study of Minor losses due to pipe fittings and bends	
Unit-4 - Pumps and Turbines	***6 Hour***
Performance test on Submersible pump/ Reciprocating Pump/ Jet pump/ Gear Pump, Performance test on Pelton turbine/ Kaplan turbine/ Francis turbine	
Unit-5 - Wind and Water Tunnels	***6 Hour***
Velocity and pressure measurement using pitot tube, hot wire Anemometry and pressure sensor, model mounting technique, Force calculations	

Learning Resources	
	1. *Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Introduction to Fluid Mechanics, 8thed., Wiley,2013*
	2. *Frank M. White, Fluid Mechanics,7th ed., McGraw-Hill,2018*
	3. *P.N.Modi,S.M.Seth,Hydraulics&FluidMechanicsIncludingHydraulicsMachines,20thed.,Standard Book House,2018*
	4. *KL Kumar., Engineering Fluid Mechanics,10th ed.,S Chand&Co.,2015 Laboratory Manual*

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	30%	-	30%	-	-
Level 2	Understand	-	30%	-	30%	-	30%	-	-
Level 3	Apply	-	40%	-	40%	-	40%	-	-
Level 4	Analyze	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100%		100%		100%		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Er. N. Palani, Scientist D/SAMEER – Chennai.	1. Dr. Dhiman Chatterjee, IIT Madras, Chennai, dhiman@iitm.ac.in	1. Dr. Pankaj Kumar, SRMIST
2. Er.D. Harihara Selvan,Technical Leader, GE Power,Noida - 201301	2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	2. Dr. Santosh Kumar Singh, SRMIST

Course Code	21MEC205T	Course Name	FLUID MECHANICS AND MACHINERY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*utilize the properties of fluid and pressure measurement techniques using manometer*
CLR-2:	*utilize the basic equations of fluid mechanics to solve fluid flow problems*
CLR-3:	*utilize the applications of dimensional and model analysis*
CLR-4:	*utilize the concept of boundary layer, lift and drag forces*
CLR-5:	*identify the working principle and design of hydraulic turbines and pumps*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*determine the properties of fluid*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*solve the fluid flow problems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*apply the mathematical techniques for practical fluid flow problem*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the boundary layer theory and flow over submerged bodies*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*identify the energy exchange process in fluid machinery*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fluid Properties and Fluid Statics	***9 Hour***
Types of fluids, Properties of fluid, Dynamic and Kinematic viscosity - Newton's law of viscosity- Surface tension and capillarity- -Bulk modulus of elasticity and compressibility, Fluid statics: Pascal's law, Hydrostatic law, Buoyancy and Meta centre, Pressure, Manometers - Piezometer- Applications and limitation - U-Tube, Single column, Differential U-tube, Inverted differential U-tube manometers.	
Unit-2 - Fluid Kinematics and Dynamics	***9 Hour***
Types of fluid flow, Lagrangian and Eulerian approach, Velocity and acceleration of fluid particles- Continuity equation- Euler equation of motion-Bernoulli's equation- Applications - Venturimeter- Orificemeter -Pitot tube-Nozzle flow meter- Types of flow lines, Stream line-Streak line and Path line-Impulse Momentum equation.	
Unit-3 - Dimensional Analysis and Flow Through Pipes	***9 Hour***
Dimensions, Dimensional homogeneity-Buckingham's pi theorem-Model analysis-advantages and applications-similitude, Dimensionless numbers-Model laws- Reynold's, Froude, Weber, Mach, and Euler model laws, Concept of fully developed pipe flows - Darcy equation –Major and minor losses-Pipes connected in series and parallel-Equivalent pipe.	
Unit-4 –Boundary Layer and Flow Around Submerged Bodies	***9 Hour***
Flow over flat plate - Laminar and turbulent boundary layers - Von Karman momentum integral equation - Boundary layer thickness – Displacement, momentum and energy thickness - Forces exerted by a flowing fluid on a stationary bluff and streamlined bodies -Separation of flow over bodies - Development of lift and drag forces.	
Unit-5 - Hydraulic Machines	***9 Hour***
Pumps and turbines - Classification - Centrifugal and reciprocating pumps - Working principle - Design parameters -Velocity triangle - Performance curves – Pelton turbine, Francis turbine and Kaplan turbine, - Working principle - Design parameters - Velocity triangle – Performance curves - Cavitation in pumps and turbines.	

Learning Resources	1. *Rajput.R.K, A text book of Fluid Mechanics and Hydraulic Machines, S.Chand& Company Ltd., 6th ed., 2015* 2. *Bansal.R.K, A text book of Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd., 9th ed., 2015* 3. *Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, 15th ed., 2002* 4. *Streeter.V.L, Wylie.E.B, Fluid Mechanics , McGraw Hill, 5th ed., 1984*	5. *Robert W. Fox & Alan T. McDonald & Philip J. Pritchard, Introduction to Fluid Mechanics, John Wiley & Sons Inc. 8TH ed 2011* 6. *Cengel, Y.A. and Cimbala, J.M. (2018) FluidMechanics. Fundamentals and Applications. 4th Edition. McGraw-Hill, New York.* 7. *White.F.M, Fluid Mechanics, Tata McGraw-Hill, 7th ed., 2011*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Er. N. Palani, Scientist D/SAMEER – Chennai.*	1. *Dr.S.Mohammed Ibrahim, IITKanpur*	1. *Dr.R.Senthil Kumar, SRMIST*
2. *Er.D. Harihara Selvan,Technical Leader, GE Power,Noida - 201301*	2. *Dr.S. Jayavel, IITDM, Kancheepuram*	2. *Dr.V. Rajasekar, SRMIST*

Course Code	21MEC206T	Course Name	KINEMATICS AND DYNAMICS OF MACHINES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply the kinematic analysis concepts to familiarize the working principle of machine tools*
CLR-2:	*familiarize the IC engine's valve and port mechanism and design the gear-box for power transmission systems*
CLR-3:	*apply the concepts of static and dynamics forces in IC engines and flywheels*
CLR-4:	*familiarize the balancing of forces and moments in rotor bearings, ships and aeroplanes*
CLR-5:	*familiarize the fundamentals of vibrations in Single degree of freedom systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concepts of theory of mechanisms to perform kinematic analysis*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze the kinematics of cam and follower, and gear trains*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*perform the static and dynamic force analysis of mechanisms*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the effect of unbalancing forces and gyroscopic effects in machines*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*formulate the governing equations and solve for single DOF systems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Kinematics of Mechanisms	***9 Hour***
Introduction to mechanism: Link, pair, kinematic chain, mechanism and machine - Degrees of Freedom - Mobility - Four Bar Chain, Grashof's law, Kutzback's and Grubler's criterion for planar mechanisms - Kinematic Inversions of kinematic chain, Kinematic Analysis: Velocity and acceleration analysis of Four bar and single slider crank mechanism by graphical method - Instantaneous center (IC) method, Kennedy's theorem, Velocity analysis of Four bar and single slider crank mechanism by Instantaneous center method	
Unit-2 - Kinematic Analysis of Machine Elements	***9 Hour***
Cams and Followers: Cam terminology, types of cams and followers, Types of follower motion - Kinematics of follower for parabolic, simple harmonic, uniform acceleration and cycloidal motions - construction of circular cam profile for radial and offset followers with different follower motions Gears: Gear terminology, types of gears - law of gearing - path of contact, arc of contact, sliding velocity - interference and undercutting of gears – Gear trains: types and applications - velocity ratio calculations in simple, compound and epicyclic gear train	
Unit-3 - Force Analysis	***9 Hour***
Applied and Constrained Forces – Free body diagrams – Static Equilibrium conditions – Two, Three and four force members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic force Analysis in reciprocating engines - Turning moment diagrams - flywheels- Case study on four bar mechanism	
Unit-4 - Balancing and Gyroscope	***9 Hour***
Balancing of rotating masses: Static and dynamic balancing of several masses rotating in same and different planes by analytical and graphical methods - Balancing of reciprocating masses by graphical method. Gyroscope: Gyroscopic forces, couple, precessional angular motion, Gyroscopic effects on automobiles, trains, aeroplane and ship	
Unit-5 - Fundamentals of Vibrations	***9 Hour***
Basics of vibrations - Terminology and types of vibrations - Governing equations for free undamped and damped vibrations of single degree of freedom system - logarithmic decrement. Forced vibration: Types of - of forced vibration single degree of freedom system under harmonic excitation.	

Learning Resources	1. *Rattan S.S., "Theory of Machines ", McGraw Hill Education, 4th edition, 2015* 2. *Thomas Bevan, Theory of Machines, 3rd Edition – P* 3. *Education Limited – 2005 – 3rd Edition*	4. *Robert L. Norton, Kinematics and Dynamics of Machinery, 2nd Edition, McGraw Hill, 2013.* 5. *Rao SS, 'Mechanical Vibrations, 5th Edition, Prentice Hall*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	1. *KR. Arun Prasad, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

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	21AUC305J	Course Name	AUTOMOTIVE MICROCONTROLLERS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	acquire the knowledge of 8051 Microcontroller architecture
CLR-2:	program 8051 using Assembly level programming
CLR-3:	use the high-level programming language for embedded application development
CLR-4:	get familiarized with the internals of AVR and program it using C language
CLR-5:	learn about the special on-chip peripherals available on automotive grade Microcontrollers

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	learn about the special on-chip peripherals available on automotive grade Microcontrollers	3	1	-	-	2	-	-	-	1	1	-	2	3	-	-
CO-2:	program 8051 microcontroller using assembly level language	3	3	2	2	2	-	-	-	1	1	-	2	3	-	-
CO-3:	apply Embedded C Programming in Microcontroller	3	3	2	2	2	-	-	-	1	1	-	2	3	2	-
CO-4:	program ATMEGA328 Microcontroller using Embedded C	3	3	-	2	2	-	-	-	1	1	-	2	-	2	-
CO-5:	identify and relate the various Microcontrollers in automotive subsystems	3	1	-	-	-	-	-	-	1	1	-	2	3	2	-

Unit-1 - 8051 Architecture — **15 Hour**

Introduction to Microprocessors and Microcontrollers, 8051 Microcontroller: Pin description, Architecture, Resources in advanced and next generation microcontrollers, Internal and External memories – Counters and Timers –Serial communication – Interrupts, 8051 Microcontrollers Instruction Set: Basic assembly language programming – Data transfer instructions - Instructions for Logical operations on the test among the Registers.

***Practice** 1: 8051- Assembly level programming – Basic Arithmetic and logical operations, 2: 8051-Finding 2's complement of a number*

Unit-2 - Programming 8051 — **15 Hour**

logical operations: bit level, byte level, internal ram bit address and sfr bit address, rotate and swap operation, arithmetic operations incrementing, decrementing -tool chains - avr-atmega328 operation on bits blinking with digital outputs –delay functions, arithmetic operations : addition, subtraction, jumps, calls and subroutines, interrupts and return, expanding i/o overview, memory mapped i/o, timing subroutine-software and hardware delay, lookuptable for 8051 pc,dptr as base address, serial data transmission-polling and interrupt driven for transmission and reception.

***Practice** 3: introduction to embedded c programming and IDE 4: atmega328 –EEPROM programming*

Unit-3 - Introduction to Embedded C — **15 Hour**

Program Languages for Embedded system application, Introduction to Higher level programming language, Advantages of Higher-level programming language, Basics of C program language – Data Types, variables–Interfacing sensors, Keywords, Pointers, Declarations, Constants and Operators, Introduction to Data type conversions Switch case and If Loop, For Loop and While Loop, Arrays and pointers, Functions and Structure, Embedded Programming Tool, IDE with Simulator, Embedded C Compilers, Data types and libraries in Embedded C.

***Practice** 5: ATMEGA328- Configuring on-chip ADC. 6: ATMEGA328-Programming Interrupts and Timers*

Unit-4 - Advanced Virtual Risk (AVR) Microcontrollers	***15 Hour***
Introduction to ATMEGA328, ATMEGA328 –Basic Features, ATMEGA328 – Core SFR'S and Ports, ATMEGA 328-Timer TMR0, TMR1, TMR2, ATMEGA 328-Capture Compare Module, ATMEGA 328-CCM in PWM Mode, ATMEGA 328-Interrupts Type1, Type 2 ATMEGA 328- Interrupt Model, Interrupts vectors, ATMEGA 328-Serial Communication Modules-I2C, SPI, ATMEGA 328-Serial Communication Basic Programs, Analog Modules –A/D converter, Comparator, Clock Oscillator, EEPROM. ***Practice** 7: ATMEGA328- Programming Serial Communication with Interrupts Type1, Type 2, 8: ATMEGA328-Working with RTC and I2C*	
Unit-5 - Automotive Grade Processors	***15 Hour***
Introduction to Automotive grade processors, Automotive grade processors ex: Rennes's, Quorivva, Automotive grade processors : NXP, Infineon, Architectural attributes of Automotive grade processors Based on subsystems, On-chip Peripherals overview, Special On-chip Peripherals for Body and chassis control applications, On-chip Peripherals for Engine and Power train control, Overview of Automotive communication protocols : CAN, LIN , Automotive communication protocols : Flex Ray, MOST, Automotive communication protocols : Ethernet,D2B and DSI, Introduction to Real-time operating system – for task scheduling activities, RTOS Classification - Hard Real-time and Soft Real time. ***Practice** 9: Implementing a moving average filter for sensor noise correction, 10: Building an Automotive Embedded application with ATMEGA328*	

Learning Resources	1. *Kenneth.J.Ayala "The 8051 Microcontroller, Architecture, Programming and Application" West Publishing Company,2002* 2. *Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi "AVR Microcontroller and Embedded Systems Using Assembly and C"Pearson Custom Electronics Technology, 2011.*	3. *Muhammad Ali Mazidi, Janice Mazidi, Janice Gillispie Mazidi-8051 Microcontroller and Embedded Systems, 2nd Edition, 2005* 4. *Gilbert Held "Inter and Intra Vehicle Communications: AuerbachPublications,2008* 5. *DataSheets of Kinetis 32-bit MCU based on ARM,InfineonXCxx series andMulticore Aurix Architecture*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*25%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill- Lync*	1. *Dr.S.Jeevananthan, Professor, Electrical and Electronics Engineering, PTU, drsj_eee@pec.edu*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUC403J	Course Name	AUTOMOTIVE FAULT DIAGNOSTICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand the importance and procedure of fault diagnostics in for automotive field
CLR-2:	familiarize the fault diagnostics using tools and equipment
CLR-3:	know about various case studies in fault diagnosis
CLR-4:	introduce diagnostics of engine system, anti-Lock braking system and Traction control system
CLR-5:	familiarize the sensing systems used to identify and rectify the electrical faults

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the concept of fault diagnosis	3	2	1	1	3	-	-	-	-	-	-	1	2	-	-
CO-2:	understand about on and off board diagnostics	3	2	1	1	3	-	-	-	-	-	-	1	2	-	-
CO-3:	perform fault diagnosis in automobiles	3	2	1	1	3	-	-	-	-	-	-	1	2	-	-
CO-4:	understand the various advances in fault diagnosis	3	2	1	1	3	-	-	-	-	-	-	1	2	-	-
CO-5:	perform electrical systems diagnosis in automobiles	3	2	1	1	3	-	-	-	-	-	-	2	1	-	-

Unit-1 - Diagnostics Techniques **12 Hour**

Introduction To Fault Diagnosis, Safe Working Practices and Techniques, Diagnostic procedures – Fundamentals, Systems and Standards, Mechanical and Electrical Diagnostic Techniques, Faults Codes, On - And - Off Board Diagnostics, Data Sources, Tools and Equipment's, Oscilloscopes, Scanners/Fault Code Readers, Engine Analyzers, Application Methods and Procedure.

Practice

1: Study of diagnosis tools and equipment, 2: Safety aspects with respect to man, machine and tools

Unit-2 - ON and OFF Board Diagnostics **12 Hour**

Introduction to ON and OFF Board Diagnostics, Introduction to Oscilloscope Diagnostics, Sensors Associated with Oscilloscope Diagnostics, Actuators Associated with Oscilloscope Diagnostics, On-Board Diagnostics Various Perspectives, Petrol/Gasoline On-Board Diagnostics, On-Board Sensors, On-Board Actuators, Sensors and Actuators Comparative Case Study.

Practice

3: Study of on and off board sensors 4: Introduction to Actuators

Unit-3 - Engine System **12 Hour**

Introduction Engine Systems Diagnostics, Engine Operation and Fuel System, Ignition System and Emission System, Electronic Fuel Injection Diagnostics, Starting and Charging System Diagnostics, Power Flow Control and Energy Efficiency Analysis, Engine Management and Faultfinding Information, Air Supply, Exhaust System Diagnostics, Cooling and Lubrication System.

Practice

5: Calibration of fuel pump, 6: Engine fault diagnosis using scan tool

Unit-4 - Chassis System	***12 Hour***
Introduction To Engine System Diagnostics, Anti-Lock Braking System Diagnostics, Traction Control System Diagnostics, Traction Control System Diagnostics – Steering, Traction Control System Diagnostics – Tires, Transmission Systems Diagnostics, Diagnostics on Steering, Diagnostics on Tires, Case Study on Diagnostics of Sub-Assemblies.	
Practice	
7: Fault diagnosis and service of transmission system 8: Fault diagnosis and service of driveline system	
Unit-5 - Electrical System	***12 Hour***
Introduction to electrical components and Circuits, Sensing, signal conditioning overview, Multiplexing, DE multiplexing overview, Lighting System Faults, Auxiliary Faults, In-Car Entertainment Security and Communications Implementation, Body-Electrical Systems, Instruments System Faults, Heating Ventilation And Air Conditioning electrical faults, Cruise Control, Air Bags Electrical faults.	
Practice	
9 : Study of Electrical wiring diagnosis tools 10: Fault diagnosis of Electrical wiring	

Learning Resources	1. *Tom denton "Advanced automotive fault diagnosis", Elsevier butterworth-heinemannlinacre house, jordan hill, oxford ox2 8dp, uk isbn-10: 0-75-066991-8* 2. *Tom Denton "Automotive Electronics Handbook", McGraw-HillPublishing Co.; 2nd Revised edition 1999, ISBN10:0070344531*	3. *Routledge "Automobile Electrical and Electronic Systems", 4 edition 2012,ISBN10:0080969429* 4. *Newnes "Understanding Automotive Electronics", 6th Revised edition2003, ISBN10:0750675993*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*25%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	--	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.G.Giri, Managing Director, Atalon , giri@atalon.co.in*	1. *Dr. SathishKumar. P, Assistant Professor, sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21AUE202T	Course Name	SENSORS, ACTUATORS AND SIGNAL CONDITIONERS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*define the sensors, their operations and select appropriate sensors for automotive applications*
CLR-2:	*define and classify the actuators and select to integrate them into an overall system*
CLR-3:	*identify signal conditioning operations and devices*
CLR-4:	*evaluate and analyze the sensor signals*
CLR-5:	*compare the input signals and select appropriate data conversion methods*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*acquire the knowledge of construction and operation of sensors and its applications in automobiles*	*3*	*3*	*1*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*
CO-2:	*understand the basics of actuators and its operations*	*3*	*3*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*2*	*1*	*-*
CO-3:	*know the fundamentals of signal conditioning devices and its operation*	*3*	*3*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*
CO-4:	*applications of operational amplifier and its applications*	*3*	*3*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*
CO-5:	*learn and implement the basics of data conversion devices*	*3*	*3*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*

Unit-1 - Automotive Sensors	***9 Hour***
introduction to sensors, variables to be measured for automotive engine control applications, airflow rate sensor – construction and operations, pressure measurement – strain gauge and map sensor, engine crank position sensor - -magnetic reluctance, hall effect sensor, optical crank position, throttle angle sensor – construction and operation, construction and operation, temperature sensor construction and operations and types, sensors for engine feedback control - ego sensor, ego characteristics, wide band lambda sensor, magnetostrictive principle and knock sensor, oil pressure sensors, accelerometer construction and operations, gyro sensors construction and operations, inertial measurement unit, sensors for climate control, switches and knobs313	
Unit-2 - Automotive Actuators	***9 Hour***
basics of actuators and its principles of operations, variables to be controlled for automotive engine control applications, pulse width modulated signal, h-bridge device for speed and direction control, electric motor actuator - dc motor, brushless dc motor, stepper motor mechanism, servomechanism, engine control actuators -fuel injector, ignition coil operation, egr actuator operation, electric actuators – overview, relays, reed switches – construction and operation, actuators applications, electric power assisted steering, rain sensing wipers, motorized seat position control, power window application	
Unit-3 - Introduction to Operational Amplifier	***9 Hour***
Introduction – Signal conditioning operations, Basics of operational amplifier, Ideal operational amplifier – Introduction, characteristics, Operational amplifier- open and closed loop, Operational amplifier- Inverting, Non- Inverting amplifier, Voltage follower; Differential amplifier - Difference mode gain, Common mode gain, Common Mode Rejection Ratio; Operation amplifier internal circuit, DC characteristics of operational amplifier, IC 741 internal circuit Introduction, IC 741 Operations, Filters – Introduction, High pass and low pass Filter, Band pass Filter	
Unit-4 - Operational Amplifier Applications	***9 Hour***
Applications of operational amplifiers, Basics of Instrumentation amplifiers, Operational amplifier using diodes- Half wave Rectifier, Full wave rectifiers, Precision diodes; Sample and Hold circuits, Voltage to Current converters, Current to Voltage converters, Applications of operational amplifiers as Adder, Subtractor,Multiplier, divider, Differentiator and Integrator, Instrumentation amplifier application, Voltage comparator, Peak detector	

Unit-5 - Waveform Generators, A/D And D/A Convertors	***9 Hour***
Comparator introduction, Comparator Applications, Regenerative Comparator Introduction, Square Wave Generator - Astable Multivibrator, Monostable Multivibrator and Bistable Multivibrator Introduction to Analog to Digital Converters, Types of Analog to Digital Converters – Direct TypeADC, Flash Type, Successive approximation type, Numerical Examples for ADC; Basics of Digital to Analog Conversion Techniques – R-2R Ladder DAC , Inverted R-2R Ladder DAC, Weighted Resistor type DAC, Numerical Examples.	

Learning Resources		
	1. *William. B. Ribbens, "Understanding Automotive Electronics" 8th Edition Butterworth-Heinemann publications, 2017.* 2. *Ronald. K. Jurgan "Automotive Electronics Handbook", 2nd Edition, McGraw-Hill, Inc 2005* 3. *Robert F. Coughlin, Frederick F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 6th Edition, PHI, 2000.*	4. *D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 4th edition, 2018.* 5. *Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill-Lync*	1. *Mr. Sam Jebakumar, SRMIST, jebakumj@srmist.edu.in*	1. *Dr.C.Carunaiselvane, SRMIST*
2. *Mr.G.Giri, Managing Director, Atalon , giri@atalon.co.in*	2. *Dr. SathishKumar. P, Assistant Professor, sathish.p@nitpy.ac.in, NIT, Karaikal*	2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE211J	Course Name	ANALOG AND DIGITAL CIRCUITS FOR AUTOMOTIVE APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	acquire knowledge about the BJT, MOS based amplifiers
CLR-2:	know the working of oscillator, wave Shaper and Multi vibrator circuits
CLR-3:	impart the techniques of minimizing digital logic circuits
CLR-4:	familiarize the combinational circuits for different digital applications
CLR-5:	familiarize the digital sequential circuits and memory devices

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the use of analog circuits that are essential for Automotive Application	3	2	1	-	2	-	-	-	1	1	-	1	3	-	-
CO-2:	understand the Oscillators, Wave Shaping and Multi Vibrator Circuits	3	3	1	-	2	-	-	-	1	1	-	1	3	-	-
CO-3:	apply the Boolean expression minimization techniques and implement using logic gates,	3	3	1	-	2	-	-	-	1	1	-	1	-	2	-
CO-4:	design and implement the Combinational Circuits	3	3	1	-	2	-	-	-	1	1	-	1	3	-	-
CO-5:	design and implement Sequential Circuits and understand the Memory Devices	3	2	1	-	2	-	-	-	1	1	-	1	3	-	-

Unit-1 - Introduction to Analog Circuits — **12 Hour**

Introduction to Analog circuits, BJT Small signal Model, CMOS Circuit Model, CMOS Circuit Mode, Biasing Circuits, MOS amplifiers, Frequency response of amplifiers, Operational amplifiers. Differential amplifiers, Application of amplifiers in Automobile.

Practice

1: Operation of BJT and CMOS as amplifier 2: Characteristic of Op Amp

Unit-2 – Oscillator Wave Shaping and Multivibrator Circuits — **12 Hour**

Oscillator: Introduction, Analysis of LC oscillator, Wave shaping: RC and RL Filters, Differentiator, Integrator, Clippers, Clamper, Comparator, UJT-Saw tooth Waveform Generator, Multivibrators: astable, Monostable and Bistable, Schmitt trigger circuits.

Practice

3: Study and Design of Filters 4: Study and Design of multivibrators

Unit-3 - Logic Gates and Arithmetic Application — **12 Hour**

Logic circuit implementation: AND, OR, NOT, NAND, NOR, EXOR, EX-NOR, TTL Logic, CMOS Logic, Arithmetic application: Boolean Postulates,Demorgan's Theorem, , Min term, Max term, POS,SOP form, K-MAP – Overview,

Practice

5: Study of Logic Gates through Basic Digital IC's 6: Minimization of Boolean Expression using K map

Unit-4 - Combinational Circuits	***12 Hour***
Introduction to Combinational Circuit, Arithmetic and logic functions: Adder and Subtractor operation and circuit example, Serial adder/Subtractor, BCD addition, Data transmission: Multiplexer, Demultiplexer, Decoder, Encoder, Parity Checker, Parity Generator, Code Convertor. ***Practice*** *7: Combination Logic Adder, Subtract or, Differentiator Circuits 8: Circuit realization of UX, DEMUX 9: Circuit realization of Code Converter.*	
Unit-5 - Sequential Circuits and Memory Devices	***12 Hour***
Latches and Flip-flops: SR, JK, D, T characteristic table and Equation, Counters: Asynchronous Counters, Synchronous Counters, ProgrammableCounters. Registers: Shift Registers, Universal Shift Register, Sequence Generator, Memory Devices: RAM, ROM, PROM, EPROM, EEPROM, Programmable Logic Devices: PLA VS PLD, Introduction to FPGA. ***Practice*** *10: Circuit realization of Flip-flops*	

Learning Resources	1. *David A.Bell "Electronic Devices and Circuits", Oxford HigherEducation Press, 5th Edition, 2010* 2. *M. Morris Mano, "Digital Design", 5th Edition, Prentice Hall of India Pvt. Ltd., 2014 / Pearson Education (Singapore) Pvt. Ltd.,New Delhi.*	3. *Donald P.Leach and Albert Paul Malvino, "Digital Principles andApplications", 6th Edition, TMH, 2006.* 4. *Sedra and Smith, "Micro Electronic Circuits"; 7th Edition, Oxford University Press, 2011. Millman and Halkias. C., Integrated Electronics, TMH, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*25%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*30%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-			
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill- Lync*	1. *Dr.S.Jeevananthan, Professor, Electrical and Electronics Engineering, PTU, drsj_eee@pec.edu.in*	1. *Dr.C.Carunaiselvane, SRMIST*
	2. *Mr. Sam Jebakumar, SRM IST, jebakumj@srmist.edu*	2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE311T	Course Name	PRINCIPLES OF LINEAR SYSTEMS AND SIGNALS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand and classify the signals, their operations and the systems*
CLR-2:	*test and execute the continuous time system's response, stability in time domain*
CLR-3:	*formulate and solve the continuous time system equations using Laplace transform*
CLR-4:	*solve and examine the discrete time system using Z transform*
CLR-5:	*execute the Fourier series-based representation of continuous time signal systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*acquire the fundamentals of signal operation and basics of system*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*perform time domain analysis of a continuous time system with various inputs*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*analyse and examine the Continuous Time System in frequency domain using Laplace transform*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*test the stability and the response of discrete time system using Z transform*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-5:	*know the fundamentals involved in continuous time signal analysis*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-

Unit-1 - Signals and Systems ***9 Hour***

Size of a signal – Signal Energy, Signal Operations –Time shifting, Time scaling, Signal Operations – Time reversal, combined operation, Classification of signals – Continuous-Time, Classification of signals – Discrete-time signals, Classification of signals –Analog and Digital signals, Classification of signals –Periodic and Aperiodic signals, Classification of signals - Energy and Power signals, Classification of signals – Deterministic and Random signals, Excitation signals- Unit Step function, Excitation signals-Unit impulse function and Exponential function, Even functions and Odd functions- Properties, Classification of system – Linear and nonlinear systems, Classification of system –Time invariant, time varying, Classification of system –Time invariant, time varying, Classification of system – Instantaneous and dynamic, Classification of system – causal and non-causal system, Classification of system –Analog and Digital system

Unit-2 - Time Domain analysis of Continuous Time Systems ***9 Hour***

System response to internal condition–Zero input response, System response to internal condition –Zero input response, Unit Impulse response Impulse response, System response to external input – Zero state response, System response to external input – Zero state response, System response to external input –Convolution integral, System response to external input –Convolution integral, System response to external input –Interconnected systems, System response to external input –Interconnected system, System stability –Internal Asymptotic stability, System stability –Internal Asymptotic characteristics modes, Dependence of system behavior on characteristics modes, Response time of system –time constant, rise time, Response time of system –resonance Phenomenon. stability, Relationship between BIBO and asymptotic stability, Relationship between BIBO and asymptotic stability, Dependence of system behavior on

Unit-3 - Continuous Time System Analysis Using Laplace Transform ***9 Hour***

Laplace transform – Inverse Laplace transform, Properties of the Laplace transform – Time shifting, Properties of the Laplace transform – frequency shifting, Properties of the Laplace transform – time differentiation property, Properties of the Laplace transform – time integration property, Properties of the Laplace transform – Time convolution Properties of the Laplace transform – frequency convolution, Solution of differential and integral - differential equation –Zerostate response, Solution of differential and integral - differential equation –Zero state response, Solution of differential and integral-differential equation – stability, Solution of differential and integral - differential equation – Inverse system, System Realization –Introduction, System realization - Direct Form I Realization,System realization - Direct Form II Realization, Analysis of a simple feedback control system, Analysis of a simple feedback control system, Frequency response of an LTIC System Frequency response of an LTIC system

Unit-4 - Discrete Time Analysis Using Z-Transform	***9 Hour***
Z-Transform introduction, Finding inverse transform, Properties of Z-transform, Z-transform solution of linear difference equations – Zero-state response of LTID system, Z-transform solution of linear difference equations – Stability and Inverse system, Z-transform solution of linear difference equations – Stability and Inverse system, System Realization System Realization.- Examples Frequency response of discrete time systems – Periodic nature of frequency response, Frequency response of discrete time systems – Periodic nature of frequencyresponse, Frequency response of discrete time systems – Aliasing and sampling rate, Frequency response of discrete time systems –Aliasing and sampling rateFrequency response from pole-zero location, Relationship between Laplace transform and z-transform, Bilateral Z-transform –Introduction, Bilateral Z-transform –Properties.	
Unit-5 - Continuous Time Signal Analysis	***9 Hour***
Periodic signal representation by trigonometric Fourier series, The Fourier spectrum, Periodic signal representation by trigonometric Fourier series - Effect of symmetry, Periodic signal representation by trigonometric Fourier series - Determining the Fundamental Frequency and Period, Existences andConvergence of Fourier series, Exponential Fourier series - Exponential Fourier spectra, Exponential Fourier series - Perceval's theorem, LTI System response to periodic inputs, Aperiodic signal representation by Fourier integral, Relationship between the Fourier and Laplace transform, Properties ofFourier transform.	

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J Cornwell, "Vector Mechanics for Engineers: Statics and Dynamics"McGraw - Hill, New Delhi, Tenth Edition, 2013.*	2. *Shames, I.H., and Krishna Mohana Rao, G., "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.Jegan Amirthalingam, Associate Director, Skill-Lync*	1. *Dr.S.Jeevananthan, Professor, Electrical and ElectronicsEngineering, PTU, drsj_eee@pec.edu.in*	1. *Dr.Arunkumar Jayakumar SRMIST*
		2. *Dr. P. Supraja, SRMIST*

Course Code	21AUE312T	Course Name	AUTOMOTIVE INFOTRONICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*state and classify the various driver and vehicle support systems*
CLR-2:	*interpret and construct the vehicle communication systems according to the requirement*
CLR-3:	*differentiate and construct the various automotive safety systems*
CLR-4:	*develop and examine the comfort suitable for the driver's convenience*
CLR-5:	*investigate and test the required security for the vehicles*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*define and identify the driver convenience, perception and general vehicle control*	*3*	*2*	*-*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-2:	*solve and implement the sensors, their modelling for the vehicle communication systems*	*3*	*3*	*-*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*2*
CO-3:	*relate and formulate the required safety systems for the required vehicle model*	*3*	*3*	*-*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*
CO-4:	*examine and value the relationship between driver and vehicle in comfort perspective*	*3*	*3*	*-*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-5:	*design and experiment the automotive security systems for its performance*	*3*	*3*	*-*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*

Unit-1 - Driver and Vehicle Support Systems	***9 Hour***
Driver information - navigation routing, integrated navigation, Real-time traffic, traveller information, Driver perception - vision enhancement, electronic mirror, Parking and reversing aid, state of the road surface systems, Driver convenience-driver identification, hands – free and remote control, Driver convenience - automated transactions, Driver monitoring - driver vigilance monitoring Driver health monitoring, General vehicle control - automatic stop and go, Vehicle Platooning, Longitudinal control - road and lane departure collision avoidance, Longitudinal control - road and lane departure collision avoidance Cont., Lateral control - lane change and merge collision avoidance, Lane change and merge collision avoidance .Cont, Rear -end collision avoidance, obstacle and pedestrian detection, Intersection collision warning, Vehicle monitoring – tachograph, Vehicle monitoring - alerting systems, vehicle diagnostics	
Unit-2 - Automotive Telematics	***9 Hour***
Global positioning system – Basics and working, Geographical information systems - Data representations, - Analysis and modeling, geographical information systems – Applications, Signpost navigation system, Dead reckoning navigation system, Automotive vision system, Intelligent Speed Adaptation system, Fleet Tracking system, Voice based Turn-by-Turn system, Smart-phone App Integration, Automotive Collision Notification system, Integrated theft recovery system, Intelligent Speed Adaptation system .Cont, Voice recognition cell phone dialing system, Emergency calling system.	
Unit-3 - Infotronics for Automotive Safety Systems	***9 Hour***
Active safety systems – Introduction, - Features, Anti-lock braking system, Automatic Emergency Braking, Electronic Brake force Distribution system, Electronic Stability Control, Adaptive cruise control, Tyre pressure monitoring system (TPMS), Lane keep assist, Lane departure warning system, Blind spot monitoring system, Forward collision warning system, Electronic Stability Program, Traction control system.	
Unit-4 - Infotronics for Automotive Comfort Systems	***9 Hour***
Passive safety systems – Airbag System, Seat belt tightening system, Laminated Glasses, Crumble zone. Convenience features- Active suspension system, Adjustable ORVMs, Electrical Power assisted steering, Collapsible and tillable steering column, Adaptive lighting system, electrically adjustable seats, Rain sensing Wiper systems, Reverse parking camera, Hands free Bluetooth, Automatic Temperature control, Connected Mobility assistance and telematics, USB charging and navigation systems, Intelligent windshield wipers, and Adaptive climate control.	

Unit-5 - Infotronics for Automotive Security Systems	***9 Hour***
Anti-theft technologies – mechanical, electromechanical, – Electronic immobilizers, Alarm and warning system, Stolen vehicle tracking system, Remote keyless entry, Smart card system, Number plate recognition, Security antenna and transponders, electronic ignition lock, Radio security system, Fingerprint vehicle unlock, GPS security systems, Speed governing system, Vehicle tracking system, Anti-hijack system, Vehicle Immobilizer, Steering-wheel lock, Vehicle GPS tracking.	

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip JCornwell, "Vector Mechanics for Engineers: Statics and Dynamics", McGraw - Hill, New Delhi, Tenth Edition, 2013.*	2. *Shames, I.H., and Krishna Mohana Rao, G., "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.E. Joshuapaul, Technical Support Engineer -Embedded, Skill-Lync*	1. *Dr. SathishKumar. P, Assistant Professor,sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE313T	Course Name	ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	insight on the fundamentals of neural network
CLR-2:	feed-forward and Feed-backward
CLR-3:	fuzzy Set and Membership function
CLR-4:	fuzzy logic controller and application
CLR-5:	neuro-fuzzy system and application

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	understand the similarity of biological networks and Neural networks Perform the training of neural networks using various learning rules	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	understanding the concepts of forward and backward propagations understand neural control operation and application for image processing	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	understanding the fuzzy sets along with its correlation to classical set Fuzzy reasoning	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	insight on the fundamentals of PID controller vs. Fuzzy controller Case study on Fuzzy logic Controller for Speed control of Motor & Battery Thermal Management Systems	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	understanding the FNN Model and Fuzzy ARTMAP- Understanding the Neuro-Fuzzy systems and hardware Implementation	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction to Neural Networks **9 Hour**

Need Of Ann & Biological Motivation, Components Of Ann-Connection, Weights, Biases, Activation Function, Output Of A Neuron, Propagation Functions, Learning Rules, Supervised And Unsupervised Learning, Reinforced Learning, Perceptron, Feed Forward Network And Hopfield Network, Neural Network Models, Neural Network Models –Adaline Neural Network Models –Madaline, Neural Network Models –Back Propagation Network, Radial Basis Function Neural Network, Self-Organizing, Convolution Nn, Recurrent Neural Network

Unit-2 - Neural Network Models and Application **9 Hour**

Neural Network-Feed Forward Application, Neural Network-Back Propagation Network Application, Layers In Neural Network-Single Layer, Layers In Neural Network- Multilayer, XOR Function and Linear Separability, Threshold Functions-Sigmoid Function, Step Function, Ramp & Linear Function, Function Approximation With Neural Networks, System Identification With Neural Networks, Block Box Model Structure, Static & Dynamic Neural Network in system Identification, Model Parameters estimation with Neural Network, Control system and Neural Networks, Neural Networks in Predictive control, Model Reference Neural Controller, Case Study Object Identification & Image Processing

Unit-3 - Fuzzy Sets and Fuzzy Relations **9 Hour**

Basic Concepts of Classical Sets, Boolean Logic, Basics of Fuzzy Sets, Representation of Fuzzy Sets, Membership Function, Trapezoidal, Gaussian and Its Determination, Fuzzy Set Properties, Logic Operations, Fuzzy Reasoning, Binary Fuzzy Relation, Types Of Fuzzy Relations, Membership Matrix, Union and intersection of Fuzzy Relations, Composition of Fuzzy Relations, Fuzzy Reasoning- Fuzzy If-Then Rules.

Unit-4 - Embedded Fuzzy Application	***9 Hour***
Introduction to conventional Control System, PID controller, Fuzzy logic Controller (FLC), Fuzzy logic Controller (FLC)- Description, Design, Membership values, Rule table, Fuzzy logic Controller (FLC) – Fuzzification, Knowledge base and Defuzzification, Fuzzy logic Controller (FLC) –Analysis with computer aided Tools, Fuzzy based antilock braking system, Performance and robustness of Fuzzy controller, Self-Organizing Fuzzy controller, Fuzzy logic Controller for Automotive Embedded System applications, Case study on Fuzzy logic Controller : Automatic Gearboxes, Case study on Fuzzy logic Controller for Speed control of Motor, Case study on Fuzzy logic Controller for Battery Thermal Management Systems.	
Unit-5 - Hybrid Fuzzy-Neuro Systems & Hardware Implementation	***9 Hour***
Introduction to Hybrid Systems, Fuzzy Neuron Overview, Multilayer FNN architectures, Types of decision Region, FNN Model, Fuzzy ART, Fuzzy ARTMAP, Fuzzy ARTMAP- Incremental supervised Learning, Learning Normalized analog input patterns, ANFIS-architecture, Linguistic Fuzzy Model, Fuzzy Rules, Fine- tune Fuzzy Rules, Hardware Implementation –Analog Techniques	

Learning Resources	1. *Ross, T.J., 2009. Fuzzy logic with engineering applications. JohnWiley & Sons.* 2. *Introduction to Artificial Neural Systems Jacek M. Zurada, JAICOPublishing House Ed. 2006.*	3. *Simon, H., 1999. Neural networks: a comprehensive foundation. Prentice hall.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*25%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.G.Giri, Managing Director, Atalon ,giri@atalon.co.in*	1. *Dr.S.Jeevananthan, Professor, Electrical and Electronics Engineering, PTU, drsj_eee@pec.edu.in*	1. *Dr.Arunkumar Jayakumar, SRMIST*
		2. *Dr. P. Supraja, SRMIST*

Course Code	21AUE314T	Course Name	CAD AND SIMULATION FOR ELECTRONICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	understand concepts of modeling in 2D and 3D
CLR-2:	gain knowledge on computer graphics and Simulation
CLR-3:	understand CAD Packages for electronics and recent technologies
CLR-4:	use concepts of Computer Graphics in Printed Circuit Boards and Packaging
CLR-5:	use relevant CAD Standards for Circuit Simulation

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	use and Relate the role of CAD in Electronics and board design	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	understand the basic Math fundamentals behind CAD software Graphics	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	design and Execute Circuits Boards Simulations	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	design Models for Electronic Packaging using CAD	3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	circuit Simulation can be done using CAD standards	3	-	2	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to CAD Electrical and Electronics **9 Hour**

Introduction to CAD electrical and electronics, Adding and creating drawing, inserting a component, Connecting a component, Relocating Components, Inserting a Child Components, Aligning and Editing the Components, Create a Library Symbol, Symbol Builder, Circuit Builder, Inserting a One-line Motor Circuit, Inserting a Dual One-line Power Feed Circuit, Copy circuitry, Save circuit to icon menu, Component Attribute Tools: Wires, Wire layers, Wire types, Insert wire, Modify wire. Signal Arrows, Source arrow, Destination arrow. Ladder tools, Wire numbers, Automatic wire numbers, Wire tagging, PLC I/O wire numbers, Generate PLC Layout Modules, PLC parametric selection, Module layout, Insert PLC modules, Edit PLC module, PLC Database File. Panel Layout, Foot Prints, Footprints from Schematic list, Footprints from icon menu, Din rails, Balloons, Wire Annotations, Create Assembly, Editing & Modifying Footprints. Terminals, Placing a Terminal, Terminal Editor.

Unit-2 - Graphics Concepts and Algorithms **9 Hour**

introduction to computer graphics, interactive graphics display, display devices, pixels, algorithms in computer graphics, , 2d and 3d transformations, translation, rotation scaling – concatenation, homogeneous transformation, translation and scaling, refection and rotation, shear transformation, concatenated transformation - inverse transformation. Rendering in nature, visibility and occlusion, depth buffering, painter's algorithm, ray tracing. Visualization of: vector fields and flow data, time-varying data, basic animation techniques like traditional, keyframing.

Unit-3 - Analog Circuit Simulation **9 Hour**

Introduction to simulation, Purpose Of Simulation, Simulation Examples, Circuit Equation Modulation, Simulation of Modified Nodal analysis method, Modified Nodal analysis, Active device Models overview, DC Circuit Simulation Overview, Newton's Method on DC analysis, AC Circuit Simulation Overview, AC Circuit Simulation Example Program, Noise Simulation, Noise Simulation Example Program, Transient system Simulation, Verilog-A Overview, Verilog-A Example Program, Fast Simulation Methods, General Simulators Overview,

Unit-4 - Circuit and Component Analysis **9 Hour**

Introduction to Circuits, DC Steady State analysis, Simulation Example :Voltage regulator, AC Analysis, Simulation Example : Cascade amplifiers with MacroModels, Cascade amplifiers with Macro Models, Simulation example : Transient analysis Phase Locked Loop circuit, Process and device simulation Overview,Process simulation, diffusion, Oxidation, Ion implantation, Simulation Example: NMOS Transistor, Device simulation, NMOS IV Curves, Parameters Extraction for analog circuit simulation Overview, Device Characterization, Least squares curve fitting, Extraction and Optimization, MOS DC models

Unit-5 - Printed Circuits Boards and Packaging	***9 Hour***
Components of a CAD package and its highlights, Circuit design with CAD package, Work layout and component layout, Process flow-chart, Printingtechnologies for Printed Wiring Boards, semiconductor Packaging Overview, Semiconductor Packages, Semiconductor Packages design case study, Board-level packaging aspects, Packaging Examples Case study, CAD output files for PCB fabrication, CAD output files Slandered file format, Photo plotting and mask generation, Photo Mask File Generation, Introduction to DFM, DFR , DFT, Computer-Aided Analysis Application	

Learning Resources		
	1. *Ibrahim Zeid, "CAD / CAM - Theory and Practice"., Tata Mcgraw-Hill, New Delhi, 2001* 2. *Newman and Sproull R. F., "Principles of interactive computergraphics", Tata Mcgraw-Hill, New Delhi,1997*	3. *Mikell P. Groover, "CAD / CAM"., Prentice Hall of India Private Limited,New Delhi, 1997* 4. *The Circuits and Filters Handbook Third Edition "Computer Aided DesignAutomation" Edited By Wai-Kai Chen*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.E. Joshuapaul, Technical Support Engineer -Embedded, Skill-Lync*	1. *Dr. SathishKumar. P, Assistant Professor,sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE317J	Course Name	AUTOMOTIVE CONTROL ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*familiarize about the importance of feedback control in automotive applications*
CLR-2:	*understand the status of the system in terms of stability*
CLR-3:	*develop the knowledge of controller and compensator design*
CLR-4:	*familiarize and execute stability analysis on linear system*
CLR-5:	*understand the concept of frequency response and analyze feedback systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*find the transfer function for linear control systems*	*3*	*2*	*1*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*perform time response analysis for standard prototyping systems*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*perform stability analysis for the system under study*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*apply frequency analysis for the system under study*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-5:	*design and implement controllers and compensators for the system under study*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-

Unit-1 - Introduction to Feedback Systems — ***12 Hour***

Introduction to Systems and its types, Examples of automotive feedback systems, ADAS, Engine Management system, Linear Time invariant systems, Parameter varying system and Nonlinear system, Impulse response of a system and transfer function representation, Transfer function of a D.C motor, Transfer function of Throttle position sensor, Velocity Sensor, Accelerometer Model, Introduction to Block diagram algebra, Block diagram algebra Numerical examples, Introduction to Signal Flow Graph, Signal Flow Graph numerical problems
Practice: 1 (Introduction to Control System Tool Box), Practice: 2 (Transfer Function - DC Motor Speed control)

Unit-2 - Performance of Feedback Systems — ***12 Hour***

Introduction to time response analysis, Transient response and steady state response, Sensitivity of a feedback system, Standard test inputs for feedback system analysis, Transient response and steady state response - Numerical Problems, Time response analysis of a first order prototyping system, Time response analysis of First order prototyping system - Numerical Problems, Time response analysis - Cruise control model, Time response analysis of second order prototyping system, Time response analysis of second order prototyping system - Numerical Problems, Complex Plane root location and transient response, Steady state error of feedback control system - Numerical Problems .
Practice: 3 Simulation of cruise control, Practice: 4 Simulation of suspension system

Unit-3 - Stability Analysis of Linear System — ***12 Hour***

Introduction to the Concept of Stability, Bounded-input, Bounded-output stability(BIBO), Rout –Hurwitz stability criterion, Rout –Hurwitz stability - Basic Numerical Problems, Rout – Hurwitz stability - Basic numerical Problems Cont., Rout – Hurwitz stability in controller parameter selection, Stability analysis of tracked vehicle turning control, Stability analysis of tracked vehicle turning control Cont., The Root locus procedure for stability analysis, Root locus Analysis - Basic Problems, Root locus Analysis of speed control system, Controller design using root locus for a closed loop control system-Numerical Example
Practice: 5 Stability analysis of Second Order Unity Feedback System , Practice: 6 Determination Of Root Locus Plot And Controller Specifications

Unit-4 - Frequency Response Analysis of Feedback Systems	***12 Hour***
Introduction to Frequency response, Sinusoidal excitation and response to a system, Introduction to Frequency response plots and performance specification, Bode plot - constant gain, Bode plot - differentiator ,integrator and second order term, Phase Margin and Gain Margin fundamentals, Procedure to plot bode diagram – Gain margin, Phase margin and stability conditions, Bode Diagram - Numerical Problems, Polar Plot – Overview, Polar Plot - Numerical Problems, Nyquist criterion for non-minimum phase system, *Practice: 7 Determination Of Bode Plot Using Mat lab Control System Toolbox for 2nd Order System & Obtain Controller Specification Parameters, Practice: 8 Determination Of Nyquist Plot*	
Unit-5 - Controller Design for Linear Feedback System	***12 Hour***
Introduction to controllers P, PI, PD,PID, Effect of Proportional, Integral and differentiator constants, PID design for an automotive feedback system, Frequency domain interpretation of PID controller, PID Numerical Problems, Lead compensator, Lag compensator, Lead Lag compensators Numerical Examples, Design of phase lead and phase lag compensation, Time domain and frequency domain interpretation of design of phase lead and phase lag compensation, Notch Filter, Notch Filter Numerical Problems *Practice: 9 Implementation of Proportional-Integral-Derivative (PID) controller using Control System Toolbox, Practice:10 Designing Compensators*	

Learning Resources	1. *Richard.C.Dorf and Robert.H.Bishop, "Modern Control System"12th edition Pearson Prentice Hall, 2013.* 2. *Benjamin.C.Kuo, "Automatic control systems", Prentice Hall of India,7th Edition,1995*	3. *P N J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.E. Joshuapaul, Technical Support Engineer - Embedded, Skill-Lync*	1. *Dr. SathishKumar. P, Assistant Professor,sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE411T	Course Name	POWER ELECTRONICS FOR ELECTRIC VEHICLE APPLICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	define and understand the power semiconductor components and its characteristics
CLR-2:	distinguish and demonstrate the different DC-DC and AC-AC converters topology
CLR-3:	interpret and relate the operation, characteristics and performance parameters of rectifiers
CLR-4:	compare and contrast the operation, switching techniques for various types of DC-AC inverters
CLR-5:	design and develop the motor drives for automotive motor control applications

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	list and recognize the various power semiconductor devices suitable for motor drive applications	3	1	-	-	-	-	-	-	-	-	-	-	3	-	2
CO-2:	identify and solve the DC-DC and AC-AC converters suitable for the desired requirements	3	2	2	1	-	-	-	-	-	-	-	-	3	-	2
CO-3:	experiment and sketch the various AC-DC Rectifier configurations and their input and output Waveforms	3	2	2	1	-	-	-	-	-	-	-	-	3	-	2
CO-4:	relate and use the DC - AC Inverters with various sources and control techniques	3	2	2	1	-	-	-	-	-	-	-	-	3	-	2
CO-5:	investigate and select the various motor drives suitable for the desired applications	3	2	2	1	-	-	-	-	-	-	-	-	3	-	2

Unit-1 - Automotive Semiconductor Devices — **9 Hour**

Introduction to power semiconductor devices, Diodes: Construction, characteristics and applications – Rectification, Diodes – Freewheeling, Diodes – Clamping Devices, Transistors: BJT, Power MOSFETs, and - Low-Voltage Load Drivers, IGBTs: Construction, characteristics and applications. Operation parametrization: Turn ON and Turn OFF techniques, Series and Parallel operation Power Integrated Circuits, Power Integrated Circuits Examples, Smart Power Devices, Emerging Device Technologies - Super- Junction, Emerging Device Technologies - Sic Devices, Protection circuit, Power Losses and Thermal analysis in semiconductors, Interpretation of data sheets.

Unit-2 - Chopper — **9 Hour**

Chopper circuit – Construction, Operation and Types, DC chopper: Buck, Boost, and Buck-Boost Converter: Construction, Principle of Operation and Characteristics – Duty cycle, Control strategies: Variable and constant frequency- Bi-directional operation, overview, Buck, Boost, and Buck-Boost Converter Circuit overview, Buck Converter - Components, Buck Converter - circuit, Buck Converter - Analysis, Buck Converter, Boost Converter - Components, Boost Converter - Circuit, Boost Converter - Analysis, Boost Converter – Analysis, Buck-Boost Converter – Components, Buck-Boost Converter – Circuit, Buck-Boost Converter – Analysis, Push-Pull Converter: Half Bridge and Full Bridge operation, AC choppers: Construction, Working and types.

Unit-3 - Converters — **9 Hour**

Rectifiers: Characteristics and Circuit Configuration, Full Bridge Diode AC-DC Rectifier, Three-Phase Full-Bridge Diode Rectifier -Circuit Configuration, Three- Phase Full-Bridge Diode Rectifier – Analysis, Three-Phase Full-Bridge Diode Rectifier – Waveforms, Design of Dynamic Breaking Unit, Calculation of DC-Link Power, Three-Phase Full-Bridge. Thermistor AC-DC Rectifier-Circuit Configuration, Three-Phase Full-Bridge Thermistor AC-DC Rectifier-Analysis, Three-Phase Full-Bridge Thermistor AC-DC Rectifier-Waveforms, Topology and Operation Modes, 2 pulse and 6 pulse: Construction, Principle of Operation and Characteristics - Fire Angle Control Scheme, Ripple Inverters: Types of Inverters overview, Voltage Source Inverters: 120 and 180 degree mode of operation, Current Source inverters, Current Source inverters applications, Control Techniques –PWM generation and types, Harmonics , Current control techniques – Hysteresis Current Control Filter circuits, Multilevel inverters

Unit-4 - Automotive Motor Drives	***9 Hour***
Drive module architecture, DC motor drives: DC motor- Construction, Working Principle and types, Speed control techniques, converter fed operation, Introduction to brushless motor drive. DC motor drives-Types, Torque Production in Brushed DC-Motor Drives, Series operation connected DC motor drives, Induction Motor Drives: Induction motor- Construction, Working Principle and types, Speed control techniques, inverter fed operation, Introduction to permanent magnet motor drive, Induction Motor Drives., Induction motor Variable Speed Drive operating modes, Torque and speed control of Induction - Motor Drives, Fundamentals of Scalar and vector control for induction motor, Types of scalar control for induction motors, Vector control for induction motors, Types of vector control for induction motors, Induction motor drives for Electric Vehicles, Configurations Drive module for Electric vehicles.	
Unit-5 - Power Electronics Interface for Electric Vehicles	***9 Hour***
Schematic diagram of the battery electric vehicles, Power distribution, Power Management Control Strategy, Back-to-Back power converters, Calculation of DC-Link Power, Design of heat sink, G2V and V2G operation in EV, Power Quality Improvement, Automotive standards	

Learning Resources	1. *Ali_Emadi" Handbook of automotive power electronics and motor drives",3rd Edition, 2014* 2. *Ned Mohan, T.M.Undeland, W.P.Robbins," Power Electronics: Converters, applications and design", John wiley and Sons, 3rd Edition, 2006.*	3. *Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 4th Edition, New Delhi, 2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.Jegan Amirthalingam, Associate Director, Skill-*	1. *Mr. Arockiya Vijay, SRMIST, arockiaj1@srmist.edu.in*	1. *Dr.C.Carunaiselvane, SRMIST* 2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE412T	Course Name	STATE SPACE ANALYSIS AND DIGITAL CONTROL SYSTEM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	define and understand the basics of discrete systems and digital control
CLR-2:	design and implement digital controllers for discrete time models
CLR-3:	formulate state space models for dynamics system
CLR-4:	acquire the fundamentals of pole placement design and state observers
CLR-5:	explore the techniques involved in optimal control design

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	perform mathematical modeling of a system and investigate its stability	3	3	2	2	-	-	-	-	-	-	-	1	3	2	-
CO-2:	identify and solve the various digital controllers for discrete time models	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-
CO-3:	experiment on the various state space models for dynamics systems	3	3	2	2	-	-	-	-	-	-	-	1	3	2	-
CO-4:	relate and use the pole placement design and state observers	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-
CO-5:	investigate and implement the optimal control design	3	3	2	2	-	-	-	-	-	-	-	1	3	1	-

Unit-1 - Signal Processing in Digital Control — **9 Hour**

Introduction Signal Processing, Control system terminologies, Classical approach to analog controller design, Classical approach to analog controller design.Cont., Introduction to digital control system, configuration of basic digital control system scheme, Basic discrete time signals, Time domain models of discrete time system, Transfer function Overview, Transfer function Models, Introduction to Stability analysis, Stability on z-plane and the Jury stability criterion, Sampling as impulse Modulation, Practical aspects on the choice of sampling rate, Principles of Discretization, Rout Stability criterion, Rout Stability criterion - Numerical examples

Unit-2 - Models of Digital Control Systems and Algorithm — **9 Hour**

Introduction to Z transform, Z domain specification, Z-domain description of sampled continuous time plant, Z-domain description of sampled continuous time plant. Cont., Implementation of Digital controllers, PI, PD, PID controllers, Tunable PID controller, Tunable PID Speed Control problem,Conversion of Canonical state variable to transfer function model, Digital temperature control, Concepts of controllability, Z-plane specification for control system design, Introduction to digital compensator, Digital compensator design using frequency response, Digital compensator design using root locus plots,

Unit-3 - Control System Analysis with State Variable Methods — **9 Hour**

Introduction to state space analysis, State variable representation of system, State variable representation, State space analysis of systems overview, State space analysis of systems. Cont, Conversion of transfer function to state variable model, Transfer function to state variable model numerical Examples, Transfer function to state variable model numerical Examples. Cont, Conversion of Canonical state variable to transfer function model, Conversion of Canonical state variable totransfer function model Numerical Examples, State observers for linear systems Examples, Concept of observability Numerical examples, State feedback withintegral control, Multivariable control system overview., Multivariable control system Numerical Examples, Digital state space Models, Digital state space Models Examples

Unit-4 - Pole Placement Design and State Observers — **9 Hour**

State feedback Overview, Stability improvement by state feedback, Introduction to Pole Placement, Necessary and sufficient conditions for arbitrary pole- placement, Voltage Source Inverters-Single phase inverters, State regulator design, State observers, Design of state observers, State observers for linear systems, State observers for non- linear systems, State observers examples, Digital control system with state feedback, State feedback with integral control, Dead beat control concept, Multilevel inverters, Dead beat control by statefeedback and Dead beat observers, System identification and adaptive control

Unit-5 - Lyapunov Stability Analysis and Optimal Control	***9 Hour***
Basic stability definitions, Theorems on stability, Sign definiteness of functions and matrices, Lyapunov Stability Theorems for linear and nonlinear systems,Lyapunov's first or indirect method, Lyapunov's second or direct method, Lyapunov function candidate and Matrix Equation, Parameter Optimization, Optimal control examples, Performance indices, Quadratic Performance index, Quadratic Performance index example, Performance indices examples, Quadratic Performance index example State regulator design, State regulator design through Lyapunov equation, Duality and Observability, Optimal state regulator through the matrix rickety equation, Optimal digital controlsystems	

Learning Resources	1. *M G opal "Digital Control and State Variable Methods", 4th edition,Tata McGraw Hill Education Pvt.Ltd. 2012* 2. *Kats uhiko Ogata "Discrete time control system" 2nd edition,Prentice Hall Pvt.Ltd,2012* 3. *J.Nagrath and M.Gopal, "Control System Engineering", New Age International publishers, 5th Edition, 2007.*	4. *Richard.C.Dorf and Robert.H.Bishop, "Modern Control System" 12th editionPearson Prentice Hall, 2013.* 5. *Benjamin.C.Kuo, "Automatic control systems", Prentice Hall of India, 7thEdition, 1995.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*30%*	-	*30%*	-
Level 3	*Apply*	*50%*	-	*50%*	-	*50%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill- Lync*	1. *Mr. Arockiya Vijay, SRMIST, arockiaj1@srmist.edu.in*	1. *Dr.C.Carunaiselvane, SRMIST*
	2. *Dr. SathishKumar. P, Assistant Professor,sathish.p@nitpy.ac.in, NIT, Karaikal*	2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE413T	Course Name	MODEL BASED SYSTEM DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	define and understand the concept of V-development approach in automotive controller design
CLR-2:	distinguish and demonstrate the different modelling techniques used in model-based system design
CLR-3:	understand the architecture of ECU and Rapid prototyping Hardware
CLR-4:	understand the concept of real time simulation and HIL simulation
CLR-5:	create models of physical systems using design of experiment methods

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	identify and build mathematical models for components in a system	3	2	-	-	1	-	-	-	-	-	-	-	-	3	-
CO-2:	investigate on the continuous refinement and improvement to generate accurate models	3	3	-	-	2	-	-	-	-	-	-	-	-	3	-
CO-3:	experiment and run Hardware-in-the-Loop Simulations (HIL)	3	3	-	-	2	-	-	-	-	-	-	-	3	3	-
CO-4:	relate and apply basic control algorithms to a real physical system	3	3	-	-	2	-	-	-	-	-	-	-	-	2	3
CO-5:	apply verification and validation methods to a physical system model	3	3	-	-	2	-	-	-	-	-	-	-	-	3	-

Unit-1 - Model Based Design Approach — **9 Hour**

introduction to design process, design validation and verification and requirements, design process implementation, introduction to model based design, model based design in functional level, model based design in architecture level, model based design in implementation level, key barriers in adaptation of model based engineering, introduction to v-development cycle, v-developments cycle significance, v-development cycle in automotive domain, rapid control prototyping, model-in-loop simulation, software-in-loop simulation, hardware-in-loop simulation, processor in the loop simulation, vehicle in the loop simulation, constraints in HIL,MIL,SIL,PIL

Unit-2 - Modelling Techniques and development — **9 Hour**

Introduction to graphical modelling, State Flow Modelling, State machines Modelling, Algorithmic models, Transfer function modelling, State space modelling, Event based Modelling, Statistical modelling for system identification, Mathematical Modelling for automotive applications, Simple motor and generator model, Simple IC engine model, Controller model, IC engine Controller model, Quarter car model, Cruise control model, Motor model and development, Generator model Development, Motor controller model and development, Motor controller model and development.

Unit-3 - ECU Architecture and Design — **9 Hour**

Rapid Prototyping hardware architecture and features, Programming analog ,digital interface, Protocol interface and implementing controller, ECU Design – Need for ECUs, Advances in ECUs for automotive application, Requirements for ECU design, Design complexities of ECU, Selection of sensors for ECU design, Selection of interfaces for ECU design, Selection of actuators for ECU design, Selection of actuators for ECU design .Cont., ECU Hardware -Architecture of anadvanced Microcontroller, Overview of on chip peripherals, ECU on chip peripherals. Cont, ECU protocol interfaces, GPIO on the advanced Microcontroller ECU, Overview of ECU programming, ECU interface challenges

Unit-4 - Real-Time Simulation	***9 Hour***
Introduction to real-time simulation, Standalone Plant Simulation, Standalone Controller Simulation, Plant and controller simulation on single target, Plant andcontroller simulation on single target. Cont, RT simulation by Separating the plant from the controller, Real-time simulation. Cont, Controller and Plant on real time target, Controller and Plant on real time target Cont, V and V using HIL RT Model, V and V using HIL RT Model case study, Implementation of communicationinterfaces, Verification of communication interfaces, A/D Outputs implementation, Control algorithm implementation, Timing requirements in control algorithm, Verification of timing requirements in control algorithm, Control algorithm optimization	
Unit-5 - Model Based System Design Application	***9 Hour***
Introduction to model based system design software tools, Modelling a series hybrid electric vehicle, Modelling a series hybrid electric vehicle, Driver model, Battery model, Modelling electric motor, Modelling speed tracking controller, Modelling of a single cylinder IC engine in powertrain block set, Modelling of a single cylinder IC engine in powertrain block set, Modeling of an IC engine controller in powertrain block set, Modeling of an IC engine controller in powertrain blockset. Virtual modelling of electrified powertrains, Virtual modelling of electrified powertrains. Development a hybrid vehicle model, Development a hybrid vehicle model. Supervisory logic implementation of Hybrid vehicle, HIL simulation of Hybrid vehicle	

Learning Resources	1. *Pete r Wilson and H.AlanMantooth "Model based Engineering forcomplex Electronics system" 2013,Newness* 2. *Web course by Zachariah chambers and Marc Herniter –Rose*	3. *Rashid M.H., "Power Electronics Circuits, Devices and Applications", PrenticeHall India, 3rd Edition, New Delhi, 2004.* 4. *Hulman institute of technology on "Introduction to model-based design and advanced model based design."*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	30%	-	*30%*	-
Level 4	*Analyze*	*30%*	-	30%	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.G.Giri, Managing Director, Atalon ,giri@atalon.co.in*	1. *Dr. SathishKumar. P, Assistant Professor,sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE414J	Course Name	MODELLING AND CONTROL OF ELECTRIC AND HYBRID VEHICLES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*state and classify the electric and hybrid power train technologies*
CLR-2:	*investigate and interpret the performance characteristics of EV / HEV power train components*
CLR-3:	*classify and test the various EV / HEV energy storage technologies*
CLR-4:	*develop and relate the various Energy management control techniques for EV and HEV vehicles*
CLR-5:	*formulate and implement the Vehicle Dynamics Control Systems for EV and HEV vehicles*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*compare and operate the different electric and hybrid vehicle power train configuration*	*3*	*2*	*2*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-2:	*demonstrate and design the EV / HEV power train model and its components*	*3*	*3*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-3:	*identify and examine the storage batteries, fuel cells and ultra-capacitors used in vehicles*	*3*	*2*	*2*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-4:	*construct and solve the EV / HEV power and energy management systems*	*3*	*3*	*3*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-5:	*design the driver, vehicle, environmental model of EV/HEV dynamics control system*	*3*	*3*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*

Unit-1 - Introduction to Electric Vehicles — ***12 Hour***

Introduction to Electric Vehicles, Energy storage for EV, EV Configuration, Hybrid Electric Vehicles- Degree of Hybridization, Battery Electric Vehicles (BEV's) vs. Fuel Cell Electric vehicle (FCEV)technologies, Case Study on Tesla and Toyota Mirai

Practice: 1 (Introduction Lab), Practice: 2 (Introduction to Virtual Instrumentation and Rapid control prototyping hardware), Practice: 3 (Power/Energy Management System)

Unit-2 - Electric and Hybrid Power Train Technologies — ***12 Hour***

Selection of Motors: Criteria, Electric Motor Performance characteristics–Power-Torque characteristics, DC Motors Vs. AC Motors, Steady state Performance analysis, Advantage of BLDC motors, Battery Performance Characteristics- Battery Terminologies (OCP, SOC, DOD, Energy Density, Power density, Inverters and Motor drives, Regenerative Braking Characteristics

Practice: 4 (Data acquisition using data loggers and virtual instrumentation hardware), Practice: 5 (Interfacing Analog input, Signal conditioning using control hardware)

Practice: 6 (Control of actuators with Rapid control prototyping hardware)

Unit-3 - Modelling and Characteristics of EV/HEV Power Train Components — ***12 Hour***

Architecture of EV system, Electro chemical reactions, Battery technologies – Basic principle and Modelling of Lead acid battery and Lithium based Ultra- capacitors –Basic principle and Modelling, Fuel cells: Basic principle and Modelling

Practice: 7 (Testing and validation of Electric Vehicle Battery), Practice: 8 (Testing and Validation of Electric Motor for power assisted Steering system), Practice: 9 (Speed control for Electric Vehicle motors)

Unit-4 - Energy Storage — ***12 Hour***

Energy management controllers, Battery Management system (BMS) for EV and HEV, Rule based Control Strategies for HEV and PHEV –Deterministic Rule- based, Fuzzy rule-based control strategies, Optimization based Control Strategies –Global Energy Management Optimization, Real-time Energy Management Optimization

Practice: 10 (Direction control of Electric Vehicle motors), Practice: 11 (Electronic differential Design for Electric Vehicles), Practice: 12 (Revision)

Unit-5 - Energy Management Systems for EV and HEV	***12 Hour***
Fundamentals of Vehicle Dynamics Control (VDC) Systems –Driver Model, Fundamentals of Vehicle Dynamics Control (VDC) Systems –Environment Model, Working principle of VDC Systems, VDC System Overview, VDC implementation on Electric and Hybrid Vehicles-structure of the control system, Control system Design and simulation study, *Practice: 13 (Revision Lab), Practice: 14 (Lab Model Examination), Practice: 15 (Evaluation & Discussion)*	

Learning Resources	1. *Amir Khajepour, M. Saber Fallah, AvestaGoodarzi-"Electric and Hybrid Vehicles Technologies, Modeling and Control - A MechatronicApproach" Wiley Publication,1st edition, 2014* 2. *Iqbal Husain, "Electric and Hybrid vehicles Design Fundamentals",CRC Press, 2nd edition, 2013*	3. *James Larminie, John Lowry, "Electric vehicle technology Explained", WileyPublication, 2ned edition, 2012* 4. *Ali Emadi, MehrdadEhsani, John M. Muller,"Vehicular Electric PowerSystems" Marcel Dekker, Inc., 2004*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*-*	*15%*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*-*	*25%*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*-*	*30%*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*-*	*30%*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.Jegan Amirthalingam, Associate Director, Skill-Lync*	1. *Mr. Arockiya Vijay, SRMIST, arockiaj1@srmist.edu.in*	1. *Dr.Arunkumar Jayakumar, SRMIST*
		2. *Dr.T.Praveenkumar, SRMIST*

Course Code	21AUE415T	Course Name	VEHICLE STABILITY AND CONTROL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	define the concepts of vehicle stability and fundamentals of vehicle dynamics
CLR-2:	design and Develop Vehicle, Road and driver models
CLR-3:	understand Longitudinal and Lateral stability control schemes
CLR-4:	distinguish between the effects of Longitudinal and Lateral stability
CLR-5:	interpret the relation between vertical dynamics and ride stability control

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	use and relate fundamental mathematical concepts to create a Vehicle Model	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	identify and Optimize parameters like driver behavior and road quality as inputs to check vehicle stability	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	recognize the effects of Longitudinal and Lateral stability	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	design and check a vehicle for longitudinal and lateral stability	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	create mathematical models of suspension behavior and control	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction to Vehicle Stability — **9 Hour**

Introduction to stability of motion, concept and analysis of stability in motion, static stability, dynamic stability, mathematical forms for vehicle dynamicequations, eigen values, eigen values Roth's stability, Roth's stability criterion. co-ordinates of vehicle dynamics model, notation of vehicle dynamics model, longitudinal vehicle motion –during acceleration, longitudinal vehicle motion –during braking, vertical vehicle motion, one dof quarter car model, lateral vehicle motion –bicycle model, bicycle model in steady state cornering

Unit-2 - Vehicle, Road and Driver Modeling — **9 Hour**

Introduction to Vehicle Modeling, Vehicle Modeling, And Vehicle Modeling. Cont., Friction coefficient, Calculation of forces, Tire modelling, Tire Characteristics, Effect of Wheel radius, Effect of Wheel radius. two track models, Reduced two track non-linear model, Road Model – Requirements of road model, Course path of a Road Models, Road surface quality, Wind Strength – Effects, Human factors in driver automation, Simple PID driver Model

Unit-3 - Longitudinal Dynamics and Control — **9 Hour**

Introduction to longitudinal control, Adaptive Cruise Control, Collision avoidance system, Automated Highway systems, Cruise controller design, PI Controller for first order plant, PI Controller for second order plant, PID Cruise-controller design for second order actuator, Autonomous cruise control –Speed control, Autonomous cruise control –Headway control, Adaptive cruise control –Cruise control with preview based on onsite information, Vehicle Platooning, String stability, ACC –Autonomous control with constant spacing, ACC –Autonomous control with constant time gap policy, String stability of CTG spacing Policy, String stability of CTG spacing Policy.

Unit-4 - Lateral Dynamics and Control — **9 Hour**

Automated lane keeping, Steering control for automated lane keeping, Lane keeping with Bicycle model, Lane keeping with Bicycle model - state feedback, Steady state error from dynamic equation, Steady state error from dynamic equation. Cont., Unity feedback loop system, Unity feedback loop system. Cont., Loop analysis with a proportional controller, Loop analysis with a proportional controller. Cont., Loop analysis with a lead compensator, Loop analysis with a lead compensator. Cont., Simulation of performance with Lead compensator, Simulation of performance with Lead compensator. Overview of four-wheel steering, Four-wheel steering system numerical example, Yaw rate and acceleration response, Lane Change Maneuver – 2WS VS 4WS

Unit-5 - Vertical Dynamics and Control	***9 Hour***
Introduction to automotive suspension, passive suspension, quarter car model – passive suspension, active suspension system, tradeoffs and limitation ofactive suspension, performance variable of quarter car suspension, natural frequencies for the quarter car, mode shapes for the quarter car, approximate transfer functions using decoupling, approximate transfer functions using decoupling. Cont., verification using the complete quarter model, verification using the complete quarter model. Cont., optimal passive suspension with 2dof model, optimal active suspension with 2dof model. Cont., linear quadratic control, LQR applications - active suspension, LQR applications - active suspension, LQR formulation for active suspension design, LQR formulation for active suspension design cont.	

Learning Resources		
	1. *Dean Karnopp "Vehicle Dynamics, Stability, and Control", 2ndedition, CRC Press, 2013* 2. *A.GalipUlsoy, HeuiPeng, Melih C "Automotive Control System",Cambridge University Press 2012*	3. *Rajesh Rajamani "Vehicle Dynamics and Control", Second Edition, Springer2012* 4. *Kiencke U and Nielsen L "Automotive Control Systems for Engine, Drivelineand Vehicle" 2nd edition, Springer 2005*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.E. Joshuapaul, Technical Support Engineer -Embedded, Skill-Lync*	1. *Dr. SathishKumar. P, Assistant Professor, sathish.p@nitpy.ac.in, NIT, Karaikal*	1. *Dr.C.Carunaiselvane, SRMIST*
		2. *Dr.T.Praveenkumar SRMIST*

Course Code	21AUE416T	Course Name	ELECTRONIC ENGINE MANAGEMENT SYSTEM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the components and operation of engine management systems*
CLR-2:	*learn about the various Engine sensors and actuators*
CLR-3:	*learn about the various SI engine electronic ignition and injection systems*
CLR-4:	*understand the various CI engine electronic ignition and injection systems*
CLR-5:	*understand and study the engine emission control systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply knowledge on modern engine control strategies*	*3*	*1*	*2*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*
CO-2:	*analyze basic electrical and electronic devices and sensors, Ignition and Fuel Injection Systems involved in SI engine management*	*3*	*2*	*1*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*3*	*-*	*-*
CO-3:	*analyze basic electrical and electronic devices and sensors, Ignition and Fuel Injection Systems involved in CI engine management*	*3*	*1*	*2*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*
CO-4:	*understand the role of various actuators in engine management*	*3*	*1*	*3*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*3*	*-*	*-*
CO-5:	*describe the key Computer controlled engine Systems*	*3*	*1*	*2*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*1*	*3*	*-*	*-*

Unit-1 - Automotive Electronics and control	***9 Hour***
Introduction to Electronic Engine management System, Open and Closed loop control strategies, Electronic Fuel Injection Systems, Single-Point, Multi-Point Fuel Injection systems, electronic ignition systems, Starter Motor working, Introduction to Engine control, PI, PD, PID Control, Look up tables, Fuzzy logic control technique, Adaptive control techniques, SI and CI Engine Control, Combustion Performance and emission Parameters.	
Unit-2 - Sensors and Actuators	***9 Hour***
Inductive, Hall Effect Sensors, Thermistor, Piezo Electric Sensors, Piezo Resistive Based Sensors, Throttle Position, Mass Air Flow Sensors, CrankShaft Position and Cam Position Sensors, Engine Speed Sensor, Knock Sensor, Exhaust Oxygen Level Sensor (Two Step, Linear Lambda and Wide Band, Manifold Temperature and Pressure Sensors, Solenoid And Stepper Motor, Relay – Overview	
Unit-3 - SI Engine Management	***9 Hour***
Layout and working of SI engine management systems, Group and sequential injection techniques, Contactless (Breaker less) Electronic ignition system, Solid state ignition system, K - Getronics, L - Getronics fuel injection system, Cold start and warm up phases, idle speed control, Acceleration and full load enrichment Deceleration fuel cut off, Fuel control maps, electronic spark timing and control, Spark advance, Spark Retardation, Closed loop control of knock	
Unit-4 - CI Engine Management	***9 Hour***
Introduction to CI engine management, Fuel injection system parameters affecting combustion, Noise in CI engines, Emissions from CI engines, electronically controlled Unit injection system, Common rail Diesel injection system, Diesel injection system components Principle and working, Fuel pump, Fuel injector, Rail pressure limiter, Flow meter, EGR valve.	
Unit-5 - Digital Engine Control System	***9 Hour***
Engine Mapping, Effect of Air-fuel ratio/Spark timing/Exhaust gas Re circulation, knock control algorithm, EGR Control algorithm, Integrated engine, control system, Electromagnetic compatibility, EMI suppression techniques, on board diagnostics Tool, Trouble shooting on EMS and On boarddiagnostics system	

Learning Resources	1. *William Ribbens "Understanding Automotive Electronics"Paperback ISBN: 9780128104347 Imprint: Butterworth- Heinemann, 8th edition, 2017.* 2. *Tom Denton "Automotive Electronics Handbook", - - McGraw-Hill Publishing Co.; 2nd Revised edition, 1999, ISBN10:0070344531*	3. *Diesel–Engine Management Hardcover – 20 Jan 2006 by Robert BoschGmbH (Author), SAE Publications.* 4. *Gasoline Engine Management (Bosch Professional Automotive Information)Paperback – 13 Aug 2014, SAE Publications.* 5. *Automotive Fuel and Emissions Control Systems, 4th Edition James D.Halderman ©2016 | Pearson.*

Learning Assessment

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Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.Jegan Amirthalingam, Associate Director, Skill- Lync*	1. *Dr, Teoh Yew Heng, University Sains, Malaysia,yewhengteoh@usm.my*	1. *Dr.Arunkumar Jayakumar, SRMIST*
2. *Mr.G.Giri, Managing Director, Atalon ,giri@atalon.co.in*	2. *Mr. Sam Jebakumar, SRM IST,jebakumj@srmist.edu.in*	2. *Dr.T.Praveenkumar SRMIST*

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