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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Regulations 2021

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21AUE361T	Course Name	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	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:	*acquire basic knowledge in automotive electronics*
CLR-2:	*acquire the knowledge in EMI/EMC*
CLR-3:	*inferring various EMI Measurements and test standards*
CLR-4:	*Interpreting EMI Control Methods & EMC Design and Interconnection Techniques*
CLR-5:	*familiarize Advanced Automotive 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:	*describe various components used in automotive electronics*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*draw the performance on EMI/EMC*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*familiarize functions of several variables pertaining to EMI Measurements and test standards*	-	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*critiquing EMI Control Methods & EMC Design and Interconnection Techniques*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*extent knowledge in Advanced Automotive Systems*	*3*	-	*3*	-	*3*	-	-	-	-	-	-	-	*3*	-	-

Unit-1 - Fundamentals of Automotive Electronics	***9 Hour***
Semiconductors, Diodes, Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters, Sensors and actuators, Control Systems	
Unit-2 - Concepts of EMI/EMC	***9 Hour***
EMI/EMC Concepts Definition of EMI and EMC with examples, Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression..	
Unit-3 - EMI Measurements and Test Standards	***9 Hour***
EMI Measurements Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection t6echnique open area site, shielded anechoic chamber, TEM cell. National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, Frequency assignment - spectrum conversation.	
Unit-4 - EMI Control Methods and EMC Design and Interconnection Techniques	***9 Hour***
Shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator. Cable routing and connection, Component selection and mounting, PCB design- Trace routing, Impedance control, decoupling, Zoning and grounding.	
Unit-5 - Advanced Automotive Systems	***9 Hour***
Understanding of ECU's, ECU Communication protocols, Basics of Telematics, BAS, ASR, ACC, Auto Air-conditioning, Automotive diagnosis and detection, Auto transmission electronic control, Electronic steering control theory, Vehicle suspension control theory, Electronically controlled windows and doors & airbag technology, Electronic navigation system	

Learning Resources	1. *Prasad Kodali.V – Engineering Electromagnetic Compatibility,S.Chand&Co ,New Delhi2017* 2. *Clayton R.Paul – Introduction to Electromagnetic compatibility –Wiley & Sons –2009* 3. *Keiser – Principles of Electromagnetic Compatibility – ArtechHouse – 5th Edition – 2004* 4. *Donwhite Consultant Incorporate – Handbook of EMI / EMC – Vol I - 2003- Published by SAE International with a Product Codeof R-397,* 5. *Ljubo Vlacic, Michel Parent and Fumio Harashima, "Intelligent*	6. *Vehicle Technologies", Butterworth-Heinemann publications,Oxford, 2001.* 7. *Robert Bosch, "Automotive Handbook", 5th Edition, SAE, 2000. Ronald K Jurgen, "Navigation and Intelligent Transportation Systems –* 8. *Progress in Technology", Automotive Electronics Series, SAE, USA, 1998.William B Riddens, "Understanding Automotive Electronics", 5th edition, Butter worth Heinemann Woburn, 1998.* 9. *Bechhold, "Understanding Automotive Electronics", SAE, 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*	*10%*	-	*20%*	-	*10%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*20%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*40%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *K.Rajrajeswari, Senior Engineer, GARC,k.rajrajeswari@garc.co.in*	1. *Dr.P.Vijayablan, Prof/Mechanical, HITS, ChennaiVijayabalan(hindu.univ.ac.in*	1. *Dr.K.Kamalakkannan, SRMIST*
2. *R. Srinivasan,Senior Engineer, GARCr.srinivasan@garc.co.in,*	2. *P.Ganesh, Professor/Automobile/SVCE, Chennaivinaganesh@svce.ac.in*	2. *Dr. AJD Nanthakumar, SRMIST*

Course Code	21AUE362T	Course Name	VEHICLE CRASHWORTHINESS AND OCCUPANTS SAFETY	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 vehicle safety, its crashworthiness and various crash testing process
CLR-2:	interpret the knowledge on Ergonomics and human response to impact
CLR-3:	comprehend various Vehicle safety systems
CLR-4:	illustrate the testing procedure for light, vision and colour
CLR-5:	exemplify Light Measurements, Testing equipment, calibration and photometric practice

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 the basic concepts of vehicle safety	3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	develop and analyze the impact on Ergonomics and human response	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	interpret Vehicle safety systems and its components	-	3	3	-	-	-	-	-	-	-	-	-	2	3	-
CO-4:	analyze data to determine automotive lighting systems	3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	apply the knowledge in Light measurement techniques and its related testing practices	3	-	3	-	-	-	-	-	-	-	-	-	3	-	1

Unit-1 - Introduction Vehicle Safety, Structural Crashworthiness and Crash Testing — **9 Hour**

Automotive Safety-Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology. Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests

Unit-2 - Ergonomics and Human Response to Impact — **9 Hour**

Importance of Ergonomics in Automotive safety, Locations of controls, Anthropometry, Human impact tolerance Determination of Injury thresholds,Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy.

Unit-3 - Vehicle Safety Systems — **9 Hour**

EMI Measurements Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe,EMC analyzer and detection t6echnique open area site, shielded anechoic chamber, TEM cell. National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, Frequency assignment - spectrum conversation.

Unit-4 - Fundamentals of Light, Vision and Colour — **9 Hour**

Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light, Measures of radiation and light, standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system visual processing, lighting for results, modes of appearance, Pointers for lighting devices. Nature of the color Tri-chromatic Colorimetry, Surface color, color spaces and color solids, color rendering..

Unit-5 - Light Measurements, Testing Equipment, Calibration and Photometric practice	***9 Hour***
Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio- Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure Specification & Classification of Vehicles (including M, N and O layout), Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks	

Learning Resources	
	1. *Vehicle Crashworthiness and Occupant Protection, Paul Du Bois,Clifford C. Chou and others, American Iron and Steel Institute.* 2. *Vehicle Crash Mechanics, Huang, M., CRC Press 2002. Course Watts, A. J., et al "Low speed Automobile Accidents" Lawyers andJudges 1996* 3. *Jullian Happian-Smith 'An Introduction to Modern Vehicle Design'SAE, 2002* 4. *Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles,MEP, London, 1995* 5. *Edward .A, Lamps and Lighting, Hodder & Stoughton, London,1993.*
	6. *Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971. Olson L. P, Forensic aspects of driver perception and response, Lawyers andJudges 1996.* 7. *Pantazis. M, Visual instrumentation: Optical design & engineeringPrinciples, McGraw - Hill 1999.* 8. *Matthew Huang, "Vehicle Crash Mechanics".* 9. *David C. Viano, "Role of the Seat in Rear Crash Safety". 10. Jeffrey A. Pike,"Neck Injury".* 10. *Ching-Yao Chan, "Fundamentals of Crash Sensing in Automotive Air BagSystems".* 11. *Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics andHuman Factors", SAE Special Publication, November 2003.*

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*	*10%*	-	*20%*	-	*10%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*20%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*40%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *K.Rajrajeswari, Senior Engineer, GARC,k.rajrajeswari@garc.co.in*	1. *Dr.P.Vijayablan, Prof/Mechanical, HITS, ChennaiVijayabalan(hindu.univ.ac.in*	1. *Dr.K.Kamalakkannan, SRMIST*
2. *R. Srinivasan,Senior Engineer, GARCr.srinivasan@garc.co.in,*	2. *P.Ganesh, Professor/Automobile/SVCE, Chennaivinaganesh@svce.ac.in*	2. *Dr. AJD Nanthakumar, SRMIST*

Course Code	21AUE461T	Course Name	AUTOMOTIVE COMPONENT TESTING AND CERTIFICATION	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 various testing techniques
CLR-2:	interpret the knowledge on static testing of vehicle
CLR-3:	comprehend various Dynamic testing of vehicle
CLR-4:	illustrate Vehicle Component Testing
CLR-5:	exemplify Vehicle Lighting Testing

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 various components testing techniques	3	-	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-2:	develop and analyze the static testing of vehicle	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	interpret Dynamic testing of vehicle	-	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO-4:	analyze data to determine Vehicle Component Testing	3	3	3	-	-	-	-	-	-	-	-	-	3	-	2
CO-5:	apply the knowledge in Vehicle Lighting Testing	3	-	3	-	3	-	-	-	-	-	-	-	3	-	2

Unit-1 – Introduction to Various Testing Techniques	**9 Hour**
Specification & Classification of Vehicles (including M, N and O layout), Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS,CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks	
Unit-2 - Static Testing of Vehicle	**9 Hour**
Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls For M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin For Drive – Away – Chassis.	
Unit-3 - Dynamics Testing of Vehicle	**9 Hour**
Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed FuelConsumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test. Engine power test (petrol & diesel), Indian driving cycle, Vehicle mass emission, Evaporative emission (petrol vehicles).	
Unit-4 - Vehicle Component Testing	**9 Hour**
Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System.	
Unit-5 - Vehicle Lighting Test	**9 Hour**
Installation requirement for lighting, signaling & reflective devices Installation, Conspicuity & Reflective Marking, Photometry Test: Performance requirement for lighting, signaling and reflective devices – Head lamp, Front lamp, direction indicator lamp, signaling lamp and Warning triangles	

Learning Resources	1. *Raymond M. Brach and R. Matthew Brach, "Vehicle Accident Analysis and Reconstruction Methods", SAE International, 2011 Ulrich Seiffert and Lothar Wech, "Automotive Safety Handbook",SAE International, 2007* 2. *Introduction to Mechanical Testing of Components Howard Kuhn, Dana Medlin, ASM International, Volume 8, 2000*	3. *ISO Standards, ICS: 43.020, 43.040, 43.100* 4. *Don H. Wright Testing Automotive Materials and Components Jan 1, 1993SAE International* 5. *Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993. Keitz H. A. E, Light calculations and Measurements, Macmillan, 2002.*

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*	*10%*	-	*20%*	-	*10%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*20%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*40%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *K.Rajrajeswari, Senior Engineer, GARC,k.rajrajeswari@garc.co.in*	1. *Dr.P.Vijayablan, Prof/Mechanical, HITS, ChennaiVijayabalan(hindu.univ.ac.in*	1. *Dr.K.Kamalakkannan, SRMIST*
2. *R. Srinivasan,Senior Engineer, GARCr.srinivasan@garc.co.in,*	2. *P.Ganesh, Professor/Automobile/SVCE, Chennaivinaganesh@svce.ac.in*	2. *Dr. AJD Nanthakumar, SRMIST*

Course Code	21AUE462T	Course Name	VEHICULAR VIBRATION AND VEHICLE DYNAMICS	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:	*learn about the sources, analysis and solution of problems pertaining to vehicular vibrations*
CLR-2:	*learn about the sources and effects of tyre dynamic forces acting on a vehicle system*
CLR-3:	*acquire fundamental knowledge about ride comfort, vehicle stability issues and formulatefundamental mathematical relations for such issues to achieve a better design of automotive systems*
CLR-4:	*brief outline, reaction types and applications of polymers and determine average molecular weight of the polymer*
CLR-5:	*properties, surface characterization and applications of advanced engineering materials and measure the acidic strength of aqueous solution*

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:	*solve noise vibration harshness problems of the automotive systems*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*interrelate the forces generated in the tire with tire slip phenomenon*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*construct a mathematical model for vehicle suspension studies*	-	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*3*	*2*	-
CO-4:	*formulate the equation of motion of a vehicle in longitudinal direction*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-5:	*predict the directional stability of vehicles based on driving conditions*	*3*	-	*3*	-	*3*	-	-	-	-	-	-	-	*3*	-	*2*

Unit-1 - Concept of NVH	***9 Hour***
Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers. Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.	
Unit-2 - Tire Dynamics	***9 Hour***
Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire.Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on Various road surfaces. Tire vibration	
Unit-3 - Vertical Dynamics	***9 Hour***
Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and theirproperties	
Unit-4 - Longitudinal Dynamics	***9 Hour***
Aerodynamic forces and moments. Equation of motion. Resistance, rolling resistance, Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for different drives. Braking and Driving torque. Prediction of Vehicle performance	

Unit-5 - Lateral Dynamics	***9 Hour***
Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Roll axis, Vehicle under side forces. Stability of vehicle running on slope, banked road and during turn. Effect of suspension on cornering, Latest trends in Vehicle dynamic testing like Four poster, Multi axis simulator, etc.	

Learning Resources	1. *Singiresu S. Rao , "Mechanical Vibrations" 5th Edition, Pearson,September , 2010* 2. *Ambekar, A. G., "Mechanical Vibrations and Noise Engineering",Prentice Hall of India, New Delhi, 2006* 3. *Munjal , "Acoustics of Ducts and Mufflers" Wiley publications, 2010Beranek, L. L. and Ver, I, L., "Noise and Vibration Control Engineering –Principles and Application", John Wiley & Sons, Inc 2007* 4. *Beranek, Leo Leroy ,"Acoustic measurements" 10th Edition 2007*	5. *Manasi P. Joshi, "Noise &Vibration Measurement Techniques in AutomotiveNVH " 2012* 6. *Malcolm J. Crocker , "Handbook Of Noise And Vibration Control" John Wiley& Sons, Inc 2007* 7. *Theory of Ground Vehicles, J.Y. Wong, 4th edition, John Wiley & Sons, NewJersey* 8. *Vehicle Dynamics and Control, Rajesh Rajamani, 2nd edition, 2012, Springer,New York* 9. *Thomas D. Gillespie, "Fundamental of Vehicle Dynamics, Society ofAutomotive Engineers", USA 11th edition , 2006* 10. *William F.Milliken and Douglas L.Milliken, "Race car vehicle dynamics", 11thedition, SAE, 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*	*10%*	*-*	*20%*	*-*	*10%*	*-*
Level 2	*Understand*	*30%*	*-*	*20%*	*-*	*30%*	*-*
Level 3	*Apply*	*30%*	*-*	*20%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*40%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. K.Rajrajeswari, Senior Engineer, GARC,k.rajrajeswari@garc.co.in	*1. Dr.P.Vijayablan, Prof/Mechanical, HITS, ChennaiVijayabalan(hindu.univ.ac.in*	*1. Dr.K.Kamalakkannan, SRMIST*
2. R. Srinivasan,Senior Engineer, GARCr.srinivasan@garc.co.in,	*2. P.Ganesh, Professor/Automobile/SVCE, Chennaivinaganesh@svce.ac.in*	*2. Dr. AJD Nanthakumar, SRMIST*

Course Code	21AUE463T	Course Name	ADVANCED POWER TRAIN TECHNOLOGY	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:	*exploit the various Powertrain technology existing in the automotive systems*
CLR-2:	*address various Engine Tests Equipment's and its Measurement techniques*
CLR-3:	*brief outline of various Emission test and its measuring Equipment's*
CLR-4:	*brief outline of various Alternate Fuels used for the engines*
CLR-5:	*know various Electric and Hybrid Vehicle transmission 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:	*rationalize Powertrain technology existing in the automotive systems*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*utilize the concepts Engine Tests Equipment's and its Measurement techniques*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*perceive the importance of Emission test and its measuring Equipment*	-	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*utilize the concepts various Alternate Fuels used for the engines and its techniques*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-5:	*understand the importance of Electric and Hybrid Vehicle transmission systems*	*3*	-	*3*	-	*3*	-	-	-	-	-	-	-	*3*	-	-

Unit-1 - Existing Powertrain Technology — ***9 Hour***

Vehicle powertrain systems & components - Arrangement of the Transmission in Passenger / Commercial / All-Wheel Drive Passenger Cars / Transverse and Longitudinal Dynamics with All-Wheel Drive. Transmission Formats & Designs, Basic Gearbox Concept. Passenger Car Transmissions: Manual Passenger Car Transmissions (MT); Automated Manual Passenger Car Transmissions (AMT); Dual Clutch Passenger Car Transmissions (DCT); Automatic Passenger Car Transmissions (AT); Passenger Car Hybrid Drives; Continuously Variable Passenger Car Transmissions (CVT). Final Drives: Axle Drives for Passenger Cars, Axle Drives for Commercial Vehicles, Differential Gears and Locking Differentials, Hub Drives for Commercial Vehicles; Transfer Gearboxes.

Unit-2 - Engine Tests Equipment's and Measurement — ***9 Hour***

Engine dynamometers, types of dynamometers, dynamometer panels, engine controllers, data acquisition system, fuel consumption meter, air fuel ratio measurement, oil consumption measurement, temperature & pressure measurement, humidity measurement, calibration & maintenance. Engine test standards, full throttle & part throttle performance, road load testing, friction measurement, durability, maintenance.

Unit-3 - Emission Test and Equipment's — ***9 Hour***

Emissions from SI & CI Engines and its Control :Emission formation in S.I. engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, CO2, Soot, PM and PN.Effects of design and operating variables on emission formation in SI and CI engines. In-cylinder controlling techniques of emission. PM vs NOx trade-off. Measurement of CO, CO2, by NDIR. Hydrocarbon by FID – Chemiluminescent detector for NOx measurement, Smoke meters – Dilution tunnel technique forparticulate measurement. Procedures on Engine and Chassis Constant Volume Sampling procedures.

Unit-4 - Alternate Fuels — ***9 Hour***

Various fuels like CNG, LPG & LNG, Alcohol, SVO / Bio-fuels, Hydrogen, Fuel Cell used in IC engines

Unit-5 - EV and hybrid Vehicle Transmissions — ***9 Hour***

Requirements of transmission in electric vehicle, features of EV transmission, types, configurations, performance parameters, design consideration for EV transmission, Hybrid Vehicle Transmission: HEV requirements of torque, different types of configurations in HEV, performance of hybrid transmissions, design parameters of HEV transmission systems.

Learning Resources	1. Crouse W.H, Anglin D.L, "Automotive Transmission and PowerTrain construction", McGraw Hill, 2005. 2. Heldt P.M, "Torque converters", Chilton Book Co.5th edition, 2000Newton Steeds &Garrot, "Motor Vehicles", SAE International and Butterworth Heinemann, 2001. 3. Iqbal Husain, "Electric and Hybrid vehicles Design Fundamentals" ,CRC Press,second edition 2013 4. James Larminie, John Lowry, "Electric vehicle technology Explained"secondEdition, Wiley Publication, 2012 5. Heinz Heisler, "Advanced Engine Technology"., SAE InternationalPublications, USA,1998	6. John B Heywood. "Internal Combustion Engine Fundamentals"., Tata McGraw-Hill 1988 7. Patterson D.J. and Henein N.A,"Emissions from combustion engines and theircontrol"., Ann Arbor Science publishers Inc, USA, 8. Ultrich Adler , "Automotive Electric / Electronic Systems"., Published by Robert Bosh GmbH,2010

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	10%	-	20%	-	10%	-
Level 2	Understand	30%	-	20%	-	30%	-
Level 3	Apply	30%	-	20%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. K.Rajrajeswari, Senior Engineer, GARC,k.rajrajeswari@garc.co.in	1. Dr.P.Vijayablan, Prof/Mechanical, HITS, ChennaiVijayabalan(hindu.univ.ac.in	1. Dr.K.Kamalakkannan, SRMIST
2. R. Srinivasan,Senior Engineer, GARCr.srinivasan@garc.co.in,	2. P.Ganesh, Professor/Automobile/SVCE, Chennaivinaganesh@svce.ac.in	2. Dr. AJD Nanthakumar, SRMIST

Course Code	21AUE464T	Course Name	ELECTRIC VEHICLE TECHNOLOGY AND TESTING	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:	provide an insight into how electric vehicle operate
CLR-2:	demonstrate the functional requirements Plug-in Hybrid Electric Vehicles
CLR-3:	demonstrate how Electric Machines and Drives in HEVs vary as per design requirement
CLR-4:	perform the detailed analysis on Batteries, Ultra capacitor, Fuel Cells, and Controls
CLR-5:	selection of the appropriate EV testing and Charging 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:	learn the basic concepts of electric vehicle technology and electric vehicles	3	-	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-2:	develop and analyze hybrid and electric drive trains	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	analyze data to determine appropriate design calculations of hybrid system under study	-	3	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-4:	interpret various vehicle power sources in hybrid vehicle technology	3	3	3	-	-	-	-	-	-	-	-	-	3	2	-
CO-5:	apply the concepts in sizing and testing of Electric vehicles and its testing	3	-	3	-	3	-	-	-	-	-	-	-	3	2	-

Unit-1 - Introduction	**9 Hour**
State of the Art of HEVs, Challenges and Key Technology of HEVs. Hybridization of the Automobile: Vehicle Basics, Basics of the EV, Basics of theHEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs). HEV Fundamentals: Introduction, Vehicle Model, Vehicle performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics.	
Unit-2 - Plug-in Hybrid Electric Vehicles	**9 Hour**
Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Component Sizing of Blended PHEVs, Vehicle-to-Grid Technology. Power Electronics in HEVs: Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.	
Unit-3 - Electric Machines and Drives In HEVs	**9 Hour**
Introduction, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors	
Unit-4 - Batteries, Ultra-Capacitor, Fuel Cells, and Controls	**9 Hour**
Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control,Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage Systemand Battery Management System.	
Unit-5 - EV Testing and Charging System	**9 Hour**
Electric Vehicle Technology and Charging Equipment's, Basic charging Block Diagram of Charger, Difference between Slow charger, fast charger & Rapid charger, AC charging and DC charging, Slow charger, fast charger & Rapid charger, Inboard and off board charger specification, Different typesof EV charger connectors and their speed, rating and features, EV testing standards and regulations.	

Learning Resources	1. *Iqbal Husain, "Eclectic and Hybrid vehicles Design Fundamentals" , CRC Press, second edition 2013, ISBN 9781439811757 James Larminie, John Lowry, "Electric vehicle technology Explained" second Edition, Wiley 2012, ISBN-13: 978- 1119942733*	2. *Ali Emadi, "Hand book of Automotive Power Electronics and MotorDrives", CRC Press 2005, ISBN 9780824723613.* 3. *Ali Emadi, Mehrdad Ehsani, John M. Muller,"Vehicular Electric Power Systems"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 (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*10%*	-	*20%*	-	*10%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*20%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*40%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
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